Valuing the Endangered Silvery Minnow and the Protection of Minimum Instream Flows in New Mexico

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ABSTRACT: The survey-based contingent valuation (CV) method is used to value the protection of the endangered silvery minnow (*Hybnognathus amarus*), and minimum instream flows in New Mexico's rivers. Instream flows are not a recognized category of beneficial use under New Mexico water law. All other western states recognize some degree of benefits accruing from provision of instream flow. The CV survey uses a dichotomous choice format for eliciting valuation responses, and includes split sample treatments for tests of: (1) sensitivity to changes in the scope of the good, and (2) response effects from a reminder of group size supporting the public good. Results show that there are significant positive values for the maintenance of minimum instream flows, and the preservation of flows associated with the silvery minnow's habitat. The evidence rejects the hypothesis of insensitivity to changes in scope, and shows no response effects to the group size reminder. Together, these tests provide evidence against the recent hypothesis that CV results are dominated by a "contribution model" of valuation responses. While the degree of acceptable precision of CV results remains hotly debated for legal proceedings, our purpose is targeted to investigating the *prima facia* case for important benefits associated with protecting minimum instream flows **in New Mexico.**

KEY WORDS: instream flows, endangered species, contingent valuation, contribution model.

I. INTRODUCTION

The protection of instream flows has emerged as a serious issue in western states. While the prior appropriation doctrine is the common denominator in western water law, individual states differ substantially in the mechanisms available for the protection of instream flows. New Mexico trails the other western states in not providing a mechanism or avenue for the protection of instream flows, and has been historically resistant to change (DeYoung, 1993; Nelson et al., 1978). Across the west, there is accumulating evidence on the nonmarket benefits (e.g., recreation, fish and wildlife habitat) of protecting instream flows. In New Mexico, minimum instream flows and associated riparian habitats are critical to the preservation of a number of endangered native fresh water fish species, including the recently-listed silvery minnow (*Hybnognathus amarus*) in the middle Rio Grande (Bestgen and Platania, 1991). A change in the status quo requires that a *prima facia* case be made for the public benefits of maintaining instream flows for the protection of at-risk fish species. This study uses the survey-based contingent valuation (CV) method to estimate nonmarket values for protecting the silvery minnow and minimum instream flows in New Mexico. Asking respondents to a New Mexico telephone survey whether they would contribute to a trust fund set up to protect minimum instream flows, we use econometric techniques to test the predictions of competing theoretical models and ultimately obtain an estimate of the aggregate value of maintainin instream flows in New Mexico rivers.

The CV method is a valuable tool for measuring the economic value of nonmarket environmental goods, and can provide important quantitative information in the larger

decision making system. While controversial in some settings, applications of CV are increasing rapidly. Application of the CV method to measure nonuse or passive use values, not associated with any direct *in situ* use of the resource, has recently received the qualified endorsement of a blue-ribbon panel that included several Nobel Laureate economists (Arrow et al., 1993). Nevertheless, debate over the method remains polemic (e.g., Diamond and Hausman, 1994; Hanemann, 1994).

Continued refinement of the CV method requires formal hypothesis testing and the accumulation of evidence; this implies the mapping of performance characteristics for selected survey instruments and experimental designs. The survey instrument used here includes a dichotomous choice format for eliciting valuation responses, and split sample treatments for tests of: (1) sensitivity to changes in the scope of the good, and (2) reminder effects on group size supporting the public good. Both tests are designed to respond directly to specific concerns raised recently over the validity of CV results, and in particular the hypothesis that CV surveys are dominated by a *contribution model* of valuation responses (e.g., Green et al., 1994; Kahneman and Knetsch, 1992; Kahneman et al., 1993; Kahneman and Ritov, 1994).

II. BACKGROUND ON INSTREAM FLOW PROTECTION AND VALUES

A rapidly growing population in an arid climate has placed increasing demands on New Mexico's limited water supply. The struggle over water allocation and management has led to careful scrutiny of the provisions and principles of New Mexico water law. Throughout the

west there is growing concern for the protection of instream flows (Bokum et al., 1992; MacDonnell and Rice, 1993). Instream flow can be defined as the flow of water in its natural channels without diversion. There is little dispute that maintaining some degree of instream flow is desirable to protect and enhance recreation, water quality, and biodiversity. What is disputed is the degree to which maintenance of instream flows inhibits existing consumptive uses of water, and what additional actions, if any, are implied by a minimum instream flow regime.

Like all western states, the basic tenet of New Mexico water law is the prior appropriation doctrine.[1] The four main features of the prior appropriation doctrine are: (i) early claimants hold senior rights, latter claimants hold junior rights; (ii) rights are usufructory, and water must be put to beneficial use, (iii) an extended period (e.g., three to four years) of nonuse is cause for the revocation of water rights; and (iv) water rights can be transferred from one party to another. New Mexico does not recognize instream flows as a beneficial use of water, and has been politically resistant to any disruption in the status quo (DeYoung, 1993). In the past, New Mexico has been singled out for its successful prior

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[1] **Article XVI of the Constitution of the State of New Mexico includes provisions for allocating water: (1) All existing rights to the use of any waters in this state for any useful or beneficial purpose are hereby recognized and confirmed; (2) The unappropriated water of every natural stream, perennial or torrential, within the State of New Mexico, is hereby declared to belong to the public and to be subject to appropriation for beneficial use, in accordance with the laws of the State. Priority of appropriation shall give the better right; (3) Beneficial use shall be the basis, the measure and the limit of the right to use water (Bokum et al. 1992). In contrast to some other western states (e.g., Arizona), the New Mexico Constitution does not explicitly mention diversion. Although, longstanding historical interpretation makes this requirement clear in New Mexico (Bahr and Perman, 1984; DeYoung, 1993). Similarly, while undefined, beneficial use has traditionally been legally interpreted**

appropriation system, and in particular its avoidance of any politically formulated preference categories of beneficial use (e.g., Williams, 1985). However, there has always been an implicit political preference against instream flow protection, and explicit legal preference in state case law to impose a diversionary requirement on beneficial use.

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as agricultural, municipal, and industrial.

Given that beneficial use typically requires that water be diverted from the streambed, voluntary private market transfers to provide instream flows are still generally unavailable or heavily restricted in most western states. In response, a variety of alternative protection actions have been explored. These include applications of the common law public trust doctrine, and explicit "public interest" or "public welfare" clauses in state statutes.[2] Further, in some states, a single public agency may purchase water rights to protect instream flows, and typically restricted to some minimum requirement. It has long been argued that operation of the New Mexico water rights system provides sufficient *de facto* protection of instream flows (Reynolds, 1977; DeYoung, 1993). Such an system is open to abuse and stands in direct contrast to accumulating ecological evidence of degraded and dewatered riparian ecosystems (Bestgen and Platania, 1991; Bokum et al., 1992; Platania, 1991). Protecting minimum

[2] Griffin and Hsu (1993) derive the theoretical conditions for an efficient water market that accommodates both traditional diversionary and instream interests. Necessary conditions are complex and include a public agency for facilitating transfers, recognizing the presence of instream flow interests, and full identification of return flow coefficients for all diversion and consumption uses. Achieving efficiency is also complicated by the public good characteristics (nonrivalness and nonexclusiveness) of instream flow protection (Colby, 1993). There are also distributional concerns. In New Mexico, there is longstanding concern that opening voluntary market transactions to instream flows would negatively affect traditional communal water use systems (acequias). See DeYoung (1993) and references therein.

instream flows has been identified as critical to the maintenance of riparian ecosystems and fish and wildlife habitats.

In August 1994, the silvery minnow (*Hybnognathus amarus)* was officially added to the list of endangered species by the U.S. Fish and Wildlife Service (USFWS). This tiny fish (approximately 3 1/2" length) was once abundant throughout the Rio Grande system, but now lives in five percent of its original habitat - relegated to a 170 mile stretch in the middle Rio Grande. Maintenance of this habitat depends on some level, as yet to be determined, of instream flows (Bestgen and Platania 1991; Winter, 1994). The silvery minnow is one of eleven threatened or endangered freshwater fish species in New Mexico, approximately half of the total number of freshwater fish species in New Mexico. Perfunctory arguments that the current state system provides *de facto* protection of instream flows are increasingly matched against federal regulatory requirements to protect listed species (Potter, 1993). Thus, there is a federal nexus; e.g., the failure by New Mexico to provide any avenue for the protection of instream flows may necessitate future costly federal ESA actions.

Any future federal ESA actions to protect instream flows will not come without warning. In response to the problem of diminished instream flows, the USFWS has long argued that the use of instream flows for the maintenance of habitat for flora and fauna, maintenance of fisheries and recreation, and maintenance of streambeds for controlling erosion and flooding should be recognized in New Mexico as beneficial uses of water (e.g., Nelson, 1978). Federal agencies such as the U.S. Forest Service (USFS) have also sought,

unsuccessfully, to use the public trust doctrine to obtain New Mexico water rights for the maintenance of instream flows (Ranquist, 1980).[3]

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[3] **In a key interpretation of the implied reserved right principle, a 1978 Supreme Court ruling (*U.S. vs. New Mexico*, 438 U.S. 696) determined that the federal government agencies cannot generally appropriate water for instream flows, unless the state agrees or establishes an instream flow act or provision (Ranquist, 1980). Because New Mexico does not recognize the maintenance of minimum instream flow as a beneficial use of water, federal agencies have been hampered from appropriating water rights to maintain the flows necessary for habitat preservation.**

In New Mexico, the State Engineer has broad authority over water appropriations (DuMars, 1982). Although not specifically directed to instream flows, state water statutes were amended in 1985 so that all new appropriations and transfers of both ground and surface water are subject to conservation and *public welfare* considerations. Protest of any appropriation or transfer is allowed for "legitimate" public welfare concerns (Bokum et al., 1992). Based on this public welfare clause, the State Engineer could deny an application that would result in a depletion of instream flows required for fish, or that threatened riparian habitats. Like beneficial use, the concept of public welfare remains undefined, and has not been employed to protect instream flows (Bokum et al. 1992; Gomez, 1993).[4]

The legacy of disregard in New Mexico stands in contrast to evidence on the nonmarket benefits of protecting instream flows in the west. This empirical evidence comes in a variety of forms; it has been thoroughly reviewed elsewhere, and is discussed only in brief here. In a methodological and empirical review, Loomis (1987) argues that dollar values for instream flows can be reasonably estimated using nonmarket valuation techniques, and often compare favorably against the value of water in traditional beneficial uses. Colby (1990, 1993) also finds strong economic arguments for providing instream flow levels that enhance recreation and wildlife habitat. Both Loomis (1987) and Colby (1990, 1993) recognize the

[4] Gomez (1993) cites the State Engineer's chief water lawyer as questioning whether public welfare can be quantified in any objective manner, and whether social factors should even be considered in public welfare deliberations on transfer permits.

importance of both use and nonuse values associated with instream flows. Nonuse values may be especially important when unique environments or endangered species are involved.

Published studies on recreational values associated with instream flows continue to accumulate. Ward et al. (1991) use a regional travel cost model linked to a biophysical model (including flow) to estimate values for recreational angling in New Mexico. Using a discrete choice random utility model for a study of California households, Loomis and Creel (1992) find that increasing summer flows in the San Joaquin Valley provide recreation benefits competitive with agricultural values. Using dichotomous choice CV, Duffield et al. (1992) and Harpman et al. (1993) estimate values of recreational angling in Montana and Colorado rivers, respectively.[5]

This valuation study investigates the *prima facia* case for public preferences for instream flow protection in New Mexico. It is expected that the nonmarket values investigated in this study will be significantly composed of non-use, or passive use values not directly related to any *in situ* use of the resource. Our focus is on the protection of minimum instream flows (not recreational optimal flows), and endangered and threatened fish species that are not typically targeted by anglers. We make no attempt to decompose value estimates, which may in part reflect current or expected future onsite use of the instream

[5] In an unpublished CV study of licensed anglers, Duffield and Patterson (1992) find evidence of positive willingness to contribute to a hypothetical trust fund to protect flows in several Montana rivers. While there is suggestive evidence that hypothetical values may overestimate relative to actual contributed values from a control group, the mail survey results are affected by sample selection and low response rates.

flows. While often showing relatively large nonuse values (e.g., Loomis et al., 1993), such decompositions are of questionable theoretical validity, and are not a fundamental requirement.

III. SURVEY INSTRUMENT AND EXPERIMENTAL DESIGN

The CV survey was part of a regular quarterly-profile telephone survey of New Mexico. It was designed and administered in February 1995 by the Survey Research Center of the Institute for Public Policy (SRC-IPP) at the University of New Mexico. The survey used random digit dialing and was based on a probability-based sample, and included attitudinal and perception questions on topics about New Mexico institutions and politics, as well as numerous socio-economic questions.

In their prescriptive review of CV, Arrow et al. (1993) advocate the use of in-person surveys, large samples and the avoidance of mail surveys. Telephone surveys are viewed as a middle alternative. Telephone surveys are significantly cheaper than in-person interviews, and may reduce the occurrence of response effects such as social desirability bias. The case for preferring in-person over telephone surveys is unclear, and additional research has been advocated by a number of sources. However, the use of telephone surveys in CV studies remains relatively rare. In response, we adopt a formal hypothesis-testing approach, and evaluate whether complex valuation information can conferred in a carefully administered telephone survey.

The survey instrument includes reminders of household income, budget constraints and available substitutes, and uses a dichotomous choice elicitation format. The CV section of the survey was pretested using two focus groups of approximately 20 respondents each. The SRC-IPP staff of 12 trained interviewers also provided a reading and discussion of the CV section. Wording of the instrument was refined after each focus group.

The payment vehicle for the hypothetical market is a special trust fund used to buy or lease water for the purpose of maintaining instream flows. The trust fund payment vehicle was chosen to match those actually implemented by some western states (e.g., Montana in 1989), and a river trust that is in initial development in New Mexico (Winter, 1994). The trust fund would span a period of five years. Respondents are asked for their willingness to pay an annual contribution into the trust fund to purchase water rights to maintain instream flows. An explicit feature of the experimental design is to phrase the dichotomous choice valuation question as a willingness to "contribute" a specified dollar amount ? , which is varied across the sample. The voluntary contribution format is commonly used in CV studies of nonexclusive environmental goods, including the protection of instream flows (Duffield and Patterson, 1992), and endangered species (Stevens et al., 1991).

While McConnell (1994) notes an absence of testable models of how people answer CV-style questions, Kahneman and colleagues argue in a series of recent papers that there are, in fact, two competing models for how individuals answer valuation questions: the

purchase model and the contribution model.[6]

[6] **The distinction between the purchase and contribution model can be found in Green et al., (1994), Kahneman et al. (1993), and Kahneman and Ritov (1994), and stems from earlier work by Kahneman and Knetsch (1992). The purchase and contribution model are consistent with the Stevens et al. (1994) distinction between a utilitarian model and a duty-based Kantian model, respectively, for how respondents may be interpreting nonuse value questions for wildlife.**

The "purchase" or exchange model that underlies much of the historical CV literature constructs a hypothetical (private good or political) market. Within this constructed market the individual is asked to compare two states of the world and provide the Hicksian income adjustment that makes her indifferent to a posited change in an environmental good or service. Willingness to pay (or be paid) responses are interpreted as exchange values, and expressions of valid measures of welfare change. A general measure of support for the purchase model is the ubiquitous finding of significant price (or "bid") responsiveness in referendum-style dichotomous choice models (McConnell, 1994). The purchase model may also best apply to use values for familiar or near-market commodities (e.g., outdoor recreation), where general sensitivity to changes in the scope of the good are regularly observed (e.g., Harpman et al., 1993). The purchase model emphasizes the acquisition of a precisely demarcated commodity.[7]

The contribution, or donation, model posits that individuals view public goods provision as good causes that need/require support (Kahneman and Knetsch, 1992; Kahneman et al., 1993). Under the contribution model, WTP expresses an attitude to a public good or general cause. As such, the contribution model entails generally low sensitivity to changes in the scope of the environmental good or service. Recent evidence of embedding effects in CV responses are often interpreted as supporting the contribution model. Contributions that

[7] Carson and Mitchell (1995) review and provide evidence that a well-defined CV survey instrument will commonly show sensitivity to changes in the scope of the good for elicited values, including passive use values. Contrary evidence from a variety of "embedding" tests is attributed to ill-defined commodities and poor survey design in general.

express attitudes may be the source of intrinsic satisfaction, and thus may be the source of social desirability bias and "warm glow" effects. The contribution model may also be particularly applicable to nonuse or passive use values (Kahneman and Ritov, 1994).

In order to advance CV research, the standard constructed market exchange model and the more recent challenger, the contribution model, must produce competing hypotheses. Discussion has centered around several CV studies that have shown insensitivity to changes in the scope of the good. However, it is unclear what exactly was tested in some cases, whether any violation of the standard exchange model actually occurred, or whether the results were simply anomalies from poorly administered surveys (Carson and Mitchell, 1995). More recently, CV critics have argued that the exchange model should be invariant to a reminder of the number of potentially contributing households, whereas the contribution model posits that such a reminder may be influential. In the initial empirical test of this hypothesis, Green et al. (1994) identify highly significant reminder effects that *lowered* valuations for several public goods by 50 percent or more.

Our telephone survey instrument uses a 2 x 2 experimental design for hypothesis testing. The two specific hypotheses to be tested are: (1) sensitivity to changes in the scope of the good, and (2) reminder effects on group size supporting the public good.

The valuation section of the survey begins by asking some general awareness questions on New Mexico water issues and defining instream flows. Respondents are then provided with some information concerning instream flows and water law. This text is shown

below:

> Instream flows support fish and wildlife, vegetation and habitat, recreation and viewing opportunities. Minimum instream flows can also protect water quality by diluting pollution. Maintaining instream flows may prevent costly federal government actions to protect endangered species and water quality.
>
> At present New Mexico does not recognize instream as a beneficial use of water. If New Mexico were to recognize instream flows as a beneficial use, private individuals and groups, and government agencies could buy or lease water to be left in rivers and streams. It is possible that the price of some agricultural commodities and municipal water rates could increase, and some development could be restricted.

The experimental treatment used to test the sensitivity of a change in scope is given by the bracketed material in the text below. There are a range of nesting and sequencing phenomenon that have been loosely referred to as "embedding effects." Following Carson and Mitchell's (1995) categorization, we conduct an external (split-sample) test of component sensitivity for nested goods.[8]

> By federal law the critical habitat of endangered fish species must be protected, and this may require maintaining minimum instream flows. In New Mexico, endangered fish species are found in a number of the major rivers including the Gila, Pecos, Rio Grande and the San Juan. [The Silvery Minnow is a small fish found in the Middle Rio Grande and is currently listed as an endangered species.]
>
> Now I would like to ask you several questions about the dollar value your household puts on protecting minimum instream flows [specifically to protect the silvery minnow].There are no right or wrong answers. Before answering, remember your household income and budget, and decide what you could realistically afford. Money spent on protecting instream flows is money not available for other goods, public programs, or other environmental programs. The establishment of a special trust fund for buying or leasing water is used in some states to protect fish species.

The treatment for the group size reminder directly preceded the valuation question, and was chosen to closely follow that used in Green et al. (1994):

> If such a special trust fund was set up in New Mexico, and requests were made statewide, up to a half million households could contribute. So each dollar of average household contribution produces a half million dollars for the special trust fund.

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[8] This test corresponds to Kahneman and Knetsch's (1992) concept of *perfect embedding*, applied in a split-sample context.

For modeling, the presence of the group size reminder is hereafter indicated by the dummy variable, RM (RM=1, reminder treatment, RM=0, control group, no reminder).

The text of the dichotomous choice valuation question for the maintenance of minimum instream flows specifically for the silvery minnow, the nested good, was:

> **Would your household contribute $? dollars each year for five years to a special trust fund used to buy or lease water from willing parties to maintain minimum instream flows for the silvery minnow in the Middle Rio Grande?**

The text of the dichotomous choice valuation question for instream flow protection in the major rivers of New Mexico, the inclusive good, was:

> **Would your household contribute $? dollars each year for five years to a special trust fund used to buy or lease water from willing parties to maintain minimum instream flows in the major rivers of New Mexico?**

For modeling, the test of scope is hereafter indicated by the dummy variable, SM (SM=1 indicates the silvery minnow question, SM=0 indicates general instream flow question).

An important element of the experimental design in a dichotomous choice CV survey is the number and size of the offered payment amounts, ? , that are allocated across the sample. A large literature has developed around this topic, and no consensus has emerged. The pragmatic approach chosen here was to allocate 8-10 separate amounts across the expected quarterly profile sample size of 675-700 completed observations, with iterative updating to fill out the probability of acceptance curve, while keeping excess weight out of the upper and lower 15 percentiles (Kanninen, 1995). Using the dichotomous choice pre-test results for $5, $10, and $20, a single initial payment amount ($20) was selected, and the observed probability

of acceptance calculated for approximately the first 50 observations. Subsequent additional payment amounts were added several at a time, with some filling across the mid-range of the probability of acceptance distribution. Using the CATI (computer-assisted telephone interview) lab facilities, acceptance rates were observed and updated on a daily basis for the seven day sampling period. The set of nine separate payment amounts was ($)A = {5, 20, 30, 40, 50, 75, 100, 150, 200}.

Additionally, the structure of the payment amounts had to be coordinated with the 2 x 2 experimental design. Table 1 shows the observed acceptance rates to the dichotomous choice valuation question broken down by elements of the experimental design (structure of the contribution amounts, test of the reminder effect, and test of scope).

IV. THEORETICAL CONSIDERATIONS AND MODEL SPECIFICATION

The household's maximum willingness to pay into the special trust to provide protection of minimum instream flows can be defined as the Hicksian compensating variation

(HCV) measure of the welfare change:

where e(·) is the household's expenditure function, p is a vector of prices for market goods, Q is the level of instream flow protection, and U is the level of utility or well-being of the household. A minimum protection level for instream flows is represented by Q^1, against an

initial lack of protection, Q^0. Thus, WTP^{HCV} is an income adjustment that represents the maximum amount of money the household is willing to pay to acquire the change in instream flow protection from Q^0 to Q^1 ($Q^1 > Q^0$), while maintaining utility at the initial level, U^0. It also implies that the property right is not currently held by those valuing instream flows.

In the specific case of minimum instream flows, the protection outcome Q^1 can be thought of as a vector of geographic locations (different rivers or river stretches) or components q_j^1, $Q^1 = \{q_1^1, q_2^1,...,q_j^1,..., q_n^1\}$. As a theoretical condition, imposing weak

monotonicity on the valuation of any nested geographic component implies:

This says that increasing the scope of minimum instream flow protection should not decrease the valuation. Imposing strong monotonicity would imply the strict inequality. Monotonicity conditions on nonmarket values are testable hypotheses (Carson and Mitchell, 1995).

In practice the welfare measure WTP^{HCV}, or hereafter just WTP, is a stochastic variable, and may be conditioned a number of determinants. Further, in the dichotomous choice elicitation format, WTP is an unobservable variable and must be statistically inferred though the yes and no responses to the given dollar payment amount, A, which is varied across the sample. In estimation we follow Cameron's (1988) censored logistic regression approach, which emphasizes the determinants of WTP, and facilitates hypothesis testing

(Cameron, 1991).[9]

Begin by assuming that underlying, latent, willingness to pay into the trust fund is a linear function of a vector of explanatory variables, X, which may include respondent

characteristics and elements of the experimental design:

where ß is a vector of coefficients to be estimated, and e_i is an error term assumed to be distributed logistically with mean 0 and standard deviation b. The logistic distribution is further characterized by the additional scale parameter ?, where ?=b√3/p (Park and Loomis, 1992).

To estimate the latent WTP, we introduce a binary indicator variable of yes (W_i=1) and

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[9] **This valuation approach has been applied in recent studies on water resources (Duffield et al., 1992; Whitehead and Blomquist, 1991), and endangered species (Hagen et al., 1991).**

no (W_i=0) responses to the dichotomous choice valuation question as follows:

The probability of a yes response in the logistic model is represented as:

where ? is the coefficient on the censoring threshold, ? , and ? is the vector of coefficients on the explanatory variables, X. The equation to be estimated can be represented as the linear-in-the-parameters "logit" or log of the odds ratio, $ln[P_i/(1-P_i)] = a?_i + ?X_i$. Given that the WTP scale parameter, ?, is equal to the negative of the inverse of the estimated coefficient on the payment amount (?=-1/a), the coefficients of the logit model can be used to recover the

underlying, latent WTP, or "variation function" (Cameron, 1988; Park and Loomis, 1992): Thus, dividing through by the coefficient on the payment amount, yields the vector of coefficients on the latent WTP equation (ß=-?/a). Equation (6) can be interpreted as the result of an ordinary least squares regression, where expected WTP is conditional on the fitted values for the coefficients.

Further, using Cameron's censored logistic approach and maximum likelihood techniques, the scale parameter ?, the vector of coefficients ß, and associated standard errors can be estimated directly for the WTP function. For the sample of individual observations, n,

the simplified log-likelihood for the censored logistic approach is:

Estimates from both logit and WTP models are presented in the empirical results below.

V. EMPIRICAL RESULTS

Estimates from selected valuation models can be used to test the two component hypotheses that together provide evidence for, or against, the contribution model. In this section we test these hypotheses using three distinct, but related, methods. We describe a non-parametric test, and a set of parametric tests based on statistics from logit and maximum likelihood (Cameron) models.

The results of conducting nonparametric tests of scope and reminder effects using the observed acceptance rates $P(W_i=1)$ are shown in Table 1. Wilcoxson Signed Rank Tests for Paired Difference Experiments, were conducted with pairings at each payment level, ? , forming the probability distributions (McLave and Deitrich, 1985:496). For the test of scope (SM=1 versus SM=0), the evidence rejects the null hypothesis that the probability distributions are identical (at a less than 0.02 significance level for the two-tailed test, and 0.01 for the one-tailed test). Thus, there is initial evidence of sensitivity to a change in the scope of the good. For the test of the reminder effect (RM=1 versus RM=0), the evidence supports the null hypothesis that the probability distributions are the same. These tests have

limited appeal as they do not control for respondent characteristics. We use the valuation models developed in section IV above to estimate treatment effects within a regression framework.

The telephone survey included a wide variety of attitudinal and socio-economic questions. Descriptive statistics with response rates for selected variables are shown in Table 2, which also includes the expected effect each variable will have on the probability of responding yes to the contribution question.

Probability models were estimated incorporating treatment indicators and variables suggested by economic theory and previous CV studies.[10] Table 3 presents the results of estimating three separate logit models (I, II, III). Logit-I is a linear-in-the-parameters model with 10 explanatory variables, and the censoring threshold, ? . Logit-II is an extended linear model that tests for the effect of an additional five explanatory variables.

Comparing the first two logit specifications, there is little to separate them in terms of overall goodness-of-fit statistics. The evidence from separate likelihood ratio tests (LRT) rejects the null hypothesis that all model coefficients are zero, and shows that both models are highly significant overall at the 0.01 level. Both models have McFadden R^2 values of 0.15 and

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[10] A variety of linear and log-linear probit and logit models were estimated. Model diagnostics were quite similar when using the same set of explanatory variables, with logit models typically outperforming the probit models slightly. Results from Box-Cox transformations on the bid variable were indeterminate between the linear and log-linear models. In contrast to the linear models, the log-linear models do not allow for negative value predictions; something we were unwilling to rule out for the controversial protection of instream flows. Given that estimated coefficients on the log-linear logit models were also often in a range producing undefined estimates of the mean, we focus on the linear logit models.

just less than 70 percent correct predictions. As a check on model specification, Logit-III is a parsimonious specification with only the features of the experimental design (? , SM, RM) included. This model is statistically significant at a level of less than 0.01 with a McFadden R^2 of 0.06, and gives 63 percent correct predictions.

All model specifications are consistent with basic economic theory. The estimated coefficients on the offered contribution amount, ? are statistically significant at the 0.01 level and negative. In models (I,II), which include income levels, protection of instream flow is found to be a normal good. The estimated coefficients are positive and significant at less than the 0.05 level for each of the four income category variables (INC2, INC3, INC4, INC5).[11]

In the models (I, II) conditioned on respondent characteristics, the estimated coefficients on age (AGE) and an index of self-reported political ideology (POL-IDEO) are negative and significant at the 0.05 level. Younger and more liberal respondents are more likely to contribute a given amount. Additionally, the estimated coefficients for an index of

[11] As is common, income responses were obtained for intervals (See Table 2). A variety of income category groupings were used in preliminary specifications, with the final set chosen on the basis of statistical efficiency. None of the primary hypotheses tests results for scope and reminder effects were sensitive to the choice of income groupings.

perceived importance of protecting instream flows (IMPORT), and a binary indicator (RECOG) of whether individuals feel instream flows should be legally recognized as a beneficial use, are positive and highly significant at the 0.01 level.

The primary hypotheses in this study are tested within the logit model using the estimated coefficients on the treatment indicators SM (silvery minnow habitat versus all major rivers) and RM (reminder of group size). The coefficient on SM is highly significant at the 0.01 level and negative in each specification. We reject the null hypothesis that the probability of agreeing to contribute a positive amount is insensitive to a change in the scope of the good (H_0:$?_{SM} = 0$, versus H_a:$?_{SM} \neq 0$). Moreover, the negative sign supports, within a one-tail test, the strong monotonicity hypothesis that the implied value of the inclusive good (instream flows in all New Mexico rivers) is greater than the value of the nested, or included good (instream flows to protect the silvery minnow in the middle Rio Grande). The coefficient on RM is not significantly different from zero in any model. We cannot reject the null hypothesis that the group size reminder has no effect on expressed values (H_0:$?_{RM} = 0$, versus H_a:$?_{RM} \neq 0$). Together, these two test results provide evidence contrary to the implications of the contribution model.

The specification logit-II provides a check on the robustness of the treatment effects across a larger set of explanatory variables. Additional variables include an interaction term (INTERACT) between the dummy variables testing sensitivity to scope (SM) and the group size reminder effect (RM) and binary indicators for awareness of the endangered status of the protected fish in each sample treatment (AWARE), membership in an environmental organization (ENV-ORG), current or recent ownership of a NM fishing license by any household member (FSH-LIC), and residential status in Bernalillo County (BERN-CO), which includes the primary urban area of Albuquerque. The model estimates show that the coefficients on all five additional explanatory variables are not significantly different from zero. Further, the signs and general significance of all other explanatory variables remain stable. Thus, specific hypotheses test results concerning the contribution model are robust across a wider set of additional explanatory variables, including the interaction between the experimental treatments.

Table 4 presents the results of estimating the underlying WTP functions directly using Cameron's (1988) maximum likelihood approach. Three alternative WTP specifications are again used to test the primary hypotheses, although only WTP-1 corresponds directly to one of the logit models (I). Specification WTP-1 shows that the signs and significance of the estimated logit coefficients are maintained. In particular, the estimated coefficient on RM is insignificant; the evidence supports the null hypothesis of no group size reminder effect (H_0:$\beta_{RM} = 0$, versus H_a:$\beta_{RM} \neq 0$). Further, the estimated coefficient on SM is negative and significant at the 0.01 level; the evidence supports the alternative hypothesis of sensitivity to a change in the scope of instream flow protection (H_0:$\beta_{SM} = 0$, versus H_a:$\beta_{SM} \neq 0$).

Specifications WTP-2 and WTP-3 allow a set of nested hypotheses tests to be conducted using likelihood ratio tests. Specification WTP-3 is a joint model that allows the parameters on each explanatory variable to differ across the test of scope treatment (SM), and tests for the consistency of the insignificant reminder effect (RM) across the scope treatment. The model WTP-2 represents the extreme restriction that there is no SM treatment, and provides a reference for the joint model WTP-3. It also shows that the signs and significance of all other variables are maintained when the significant SM dummy is dropped.

Using the joint model (WTP-3) results, the evidence from a likelihood ratio test supports the alternative hypothesis of a significant difference at the 0.01 level in the sets of estimated coefficients for the SM treatment groups, against the null of no difference. The joint model shows that there is a behavioral difference in valuation responses under the test of scope. Specifically, for the larger inclusive good (general instream flow protection on all major rivers in NM), all income group coefficients remain significant at less then the 0.05 level and there is a larger bid responsiveness (implicit in the estimated coefficient on ?). Age and political ideology are now insignificant. The nested good (instream flow protection for the silvery minnow) shows reduced income effects and responsiveness to the bid level, while older and more conservative respondents remain significantly less willing to contribute. However, in both SM treatment groups the estimated coefficient for the RM dummy is insignificantly different from zero.[12]

[12] While not presented here, an additional joint model was estimated that incorporated the restriction that the coefficient on the reminder (RM) is the same for both SM treatment groups. Evidence from a likelihood ratio test shows no significant difference between this specification and WTP-3.

In summary, across these WTP specifications, the findings with respect to the primary hypotheses that emerged from the nonparametric Wilcoxson test and the logit models continue to appear. There is significant sensitivity in valuation responses to a change in the scope of instream flow protection. The direction of this sensitivity satisfies the strong monotonicity hypothesis with respect to the valuation of nested goods. There is no statistical evidence of any response effect due to a group size reminder; this holds across two significantly different levels of instream flow protection. Table 5 summarizes many of the diverse hypothesis test results (nonparametric, logit, and WTP models).

With no evidence that valuation responses are consistent with the contribution model framework, we turn to estimating the expected value of instream flows consistent with the exchange model interpretation of stated values. Using specification WTP-1 and the sample means for all variables, except SM, we obtain the function, WTP = 83.54 - 58.32· (SM).[13] Using the joint model specification WTP-3, mean predicted annual household willingness to pay for protection of instream flows specifically for the silvery minnow on the middle Rio Grande is $28 (standard error of $3.79), versus $92 (standard error of $5.88) for the protection of minimum instream flows on all major NM rivers and the 11 total listed fish species. These estimates of annual household willingness to pay are comparable with

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[13] **The mean predicted annual household willingness to pay for the split samples using specification WTP-1 is $30 (standard error of $4.68; n=287) for the nested good, protection of minimum instream flows specifically for the silvery minnow on the middle Rio Grande, versus $79 (standard error of $4.93; n=280) for the inclusive good, protection of minimum instream flows on all major NM rivers and the 11 total listed fish species.**

estimated values identified in previous nonuse value studies of western instream flows; Colby (1993) cites a range of annual household values from $40 to $80.

While not the specific focus of this study, estimates of annual household values can also be aggregated. Using the results from specification WTP-3 and a conservative figure of 500,000 households, estimates of annual statewide values are $14 million for the nested good, and $46 million for the inclusive good. Further, using these results and a conservative discount rate of 10 percent, aggregating over the five years of the hypothetical trust fund program gives a present value of $58 million for minimum instream flow protection in the middle Rio Grande, and $1.9 billion for minimum instream flow protection on all major New Mexico rivers.

Estimated values are clearly subject to specification error, statistical error, the choice of discount rate, etc. Further, the nature of the experiment does not provide marginal values that can easily be converted into a Mm^3 or cfs basis for comparison with alternative uses of water. However, such considerations do not negate the *prima facia* evidence that significant positive values exist for the protection of minimum instream flows in New Mexico. Even accepting arguments that all CV estimates should be calibrated downward (e.g., dividing by two in legal damage assessments), the resultant values would still warrant important consideration in public policy debates.

V. DISCUSSION AND CONCLUSIONS

In their recent review of CV, Brookshire and McKee (1994) argue that there are two grounds from which a valuation technique may be criticized: (i) the theoretical basis is flawed, and (ii) the empirical estimates lack the necessary robustness for their intended purposes. In this study, the first ground for criticism is addressed by jointly testing two hypotheses from the *contribution model*. The second ground for criticism is addressed through the *primia facia* argument and the specific context of minimum instream flow values in New Mexico.

Much of the recent debate surrounding CV centers on acceptable levels of precision for use in natural resource damage assessments and liability cases. However, when using CV for a wide variety of *ex ante* policy, and methodological research issues, the same burden of proof as legal proceedings may not be necessary (e.g., in-person interviews and suggested n > 1000 for each sample treatment (Arrow et al., 1993)). Our primary objective was in investigating the *prima facia* case for nonmarket benefits associated with protecting minimum instream flows. Such evidence is important in establishing whether instream flow concerns warrant consideration, or even have legitimate standing in future New Mexico deliberations over water resources management (e.g., determining allowable beneficial use or public welfare).

Application of a carefully administered CV telephone survey shows that New Mexico households place a positive expected value on the maintenance of instream flows, and the preservation of habitat for endangered and threatened fish species. Valuation responses are shown to be sensitive to a change in the scope of the good, and insensitive to a reminder of

group size, evidence against the contribution model of valuation responses.

These expressed preferences of New Mexico residents strengthen the case for the revision of the longstanding status quo in New Mexico. Given the right impetus, the prior appropriation doctrine has been shown to be responsive elsewhere in the West to changing public preferences (MacDonnel and Rice, 1993). Economists and other social scientists can continue to contribute to this research by investigating the relative merits of alternative mechanisms for instream flow protection (e.g. water markets or public welfare intervention). Prudence and pragmatism require that such analyses be done in the context of potentially irreversible losses of native fish species.

REFERENCES

Arrow, K., Solow, R., Leamer, E., Portney, P., Radner, R., and H. Schuman. 1993. Report of the NOAA Panel on Contingent Valuation. *Federal Register* 58(10):4601-4614.

Bahr, T., and P. Herman. 1981. *Water Problems and Research Needs for New Mexico.* New Mexico Water Resources Institute Report No. 135.

Bestgen, K., and S.Platanea. 1991. Status and Conservation of the Rio Grande Silvery Minnow, Hybognathus Amarus. *The Southwestern Naturalist* 36(2):225-232.

Bokum, C., Gabin, V., and P. Morgan. 1992. *Living Within Our Means: A Water Management Policy for New Mexico in the Twenty-First Century*. NM Environmental Law Center.

Brookshire, D., and M. McKee. 1994. "Is the Glass Half Empty, Is the Glass Half Full? Compensable Damages and Contingent Valuation." *Nat. Res. Journal* 34:51-72.

Cameron, T. 1988. A New Paradigm for Valuing Non-market Goods Using Referendum Format: Maximum Likelihood Estimation by Censored Logistic Regression. *Journal of Environmental Economics and Management* 15(4):355-379.

Cameron, T. 1991. "Censored Logistic Regression Model - Reply." *Journal of Environemntal Economics and Management* 20(3):303-304.

Carson, R., and R. Mitchell. 1995. Sequencing and Nesting in Contingent Valuation Surveys. *Journal of Environmental Economics and Management* 28:155-173.

Colby, B. 1990. Enhancing Instream Flow Benefits in an Era of Water Marketing. *Water Resources Research* 26(6):1113-1120.

Colby, B. 1993. Benefits, Costs and Water Acquisition Strategies: Economic Considerations in Instream Flow Protection. In: L. MacDonnell and T. Rice. (eds.) *Instream Flow Protection in the West.* Natural Resources Law Center, U. of Colorado Law School.

Diamond, P., and J. Hausman. 1994. "Contingent Valuation: Is Some Number Better Than No Number?" *Journal of Economic Perspectives* 8(4):45-64.

DeYoung, T. 1993. "Protecting New Mexico's Instream Flows." In: L.MacDonnell & T. Rice. Eds. *Instream Flow Protection in the West.* Nat.Res.Law Center,U.of Col. Law School.

Duffield, J., Neher, C., and T. Brown. 1992. Recreation Benefits of Instream Flow: Application to Montana's Big Hole and Bitterroot Rivers. *Water Res. Research* 28(9):2169-2181.

Duffield, J., and D. Patterson. 1992. Field Testing Existence Values: Comparison of Hypothetical and Cash Transactions. In: Western Regional Research Publication. W-133: Benefits and

Costs in Natural Resource Planning.

Dumars, C. 1982. New Mexico Water Law: An Overview and Discussion of Current Issues. *Natural Resources Journa*l 22(Oct):1045-1062.

Gomez, D. 1993. "Water Law Murky on Transfer Standards." *New Mexico Lawyer* 5(3):1,6.

Green, D., Kahneman , D., and H. Kunreuther, 1994. How the Scope and Method of Public Funding Affects Willingness to Pay for Public Goods. *Pub.Opin.Quarterly* 58:49-67.

Griffin, R., and S. Hsu. 1993. The Potential for Water Market Efficiency When Instream Flows Have Value. *American Journal of Agricultural Economics* 75(2):292-303.

Hanemann, W. 1994. "Valuing the Environment Through Contingent Valuation." *Journal of Economic Perspectives* 8(4):17-44.

Hagen, D., J. Vincent, and P. Welle. 1992. "The Benefits of Preserving Old-Growth and the Northern Spotted Owl." *Contemporary Policy Issues* 10:13-26.

Harpman, D., E. Sparling, and T. Waddle. 1993. "A Methodology for Quantifying and Valuing the Impacts of Flow Changes on a Fishery." *Water Resources Research* 29(3):575-582.

Kahneman, D., and J. Knetsch. 1992. "Valuing Public Goods: The Purchase fo Maoral Satisfaction." *Journal of Environemntal Economics and Management* 22:57-70.

Kahneman, D., and I. Ritov. 1994. Determinants of Stated Wllingness to Pay for Public Goods: A Study in the Headline Method. *Journal of Risk and Uncertainty* 9:5-38.

Kahneman, D., I. Ritov, K. Jacowitz, and P. Grant. 1993. Stated Willingness to Pay for Public Goods: A Psychological Perspective. *Psychological Science* 4(5):310-315.

Kanninen, B. 1995. "Bias in Discrete Response Contingent Valaution." *Journal of Environmental Economics and Management* 28(1):114-126.

Loomis, J. 1987. The Economic Value of Instream Flow: Methodology and Benefit Estimates of Optimum Flow. *Journal of Environmental Management* 24:169-179.

Loomis, J., and M. Creel. 1992. Recreation Benefits of Increased Flows in California's San Joaquin and Stanislaw Rivers. *Rivers* 3(1):1-13.

Loomis, J., M. Lockwood, and T. DeLacy. 1993. Some Empirical Evidence on Embedding Effects in Contingent Valuation of Forest Protection. *J of Env.Econ & Mang* 24:45-55.

MacDonnell, L., and T. Rice. (eds.) 1993. *Instream Flow Protection in the West.* Revised Edition. Natural Resources Law Center, University of Colorado School of Law.

McConnell, K. 1994. "Reflections on the Ohio Decision." *Nat.Res. Journal* 34(1):93-108.

McLave, J., and F. Deitrich. 1985. *Statistics*. 3rd.ed. Dellen Publishing Co.

Nelson, W., and D. Horvack. 1978. "Instream Flow Strategies for New Mexico." Report for the Western Instream Flow Team, U.S. Fish and Wildlife Service.

Park, T. and J. Loomis. 1992. Comparing Models for Contingent Valuation Surveys: Statistical efficiency and the Precision of Benefit Estimates. *Northeastern Journal of Agricultural Economics* Oct:170-176.

Platania, S. 1991. Fishes of the Rio Chama and Upper Rio Grande, New Mexico, With Preliminary Comments on Their Longitudinal Distribution. *Southwestern Naturalist* 36(2):186-193.

Potter, L. 1993. "People Preserving Rivers: The Public and its Changing Role in Protecting Instream Flows." In: L. MacDonnell and T. Rice. Eds. *Instream Flow Protection in the West.* Revised Edition. Nat. Res. Law Center, U. of Colorado School of Law

Reynolds, S. 1977. Memorandum, re:House Bill 228 (2/7/77). State Eng. Files, Santa Fe, NM.

Ranquist, H. 1980. “Res Judicata: Will it Stop Instream Flows as Being the Wave of the Future?” *Natural Resources Journal* 20:121-151

Stevens, T., J Echeverria, R. Glass, T. Hager, and T. More. 1991. "Measuring the Existence Value of Wildlife: What Do CVM Estiamtes Really Show?" *Land Econ.*67(4):390-400.

Stevens, T., T. More, and R. Glas. 1994. "Measuring the Existence Value of Wildlife: Reply." *Land Economics* 69(3):309-312.

Whitehead, J., and G. Blomquist. 1991. "Measuring Contingent Values for Wetlands: Effects of Information About Related Environmental Goods." *Water Res.Research* 27(10):2523-2531.

Williams, S. 1985. "The Law of Prior Appropriation: Possible Lessons for Hawaii." *Natural Resources Journal* 25(4):911-934.

Winter, E., 1994. “Fish Out of Water: Silvery Hits T&E List.” *The Rio Grande River Keeper: News Letter of Rio Grande Restoration,* Fall/Winter.

Table 1. Acceptance Rates by Payment Amount and Experimental Treatment

Payment,	**SM=1 and RM=1**	**SM=1 and RM=0**	**SM=0 and RM=1**	**SM=0 and RM=0**	***Totals***

?					
$5	16/25 (.64) [1]	12/21 (.57)	9/14 (.64) [2]	16/23 (.70)	53/83 (.64) [3]
$20	18/21 (.86)	12/17 (.71) [3]	18/21 (.86)	9/19 (.47) [1]	57/78 (.73) [4]
$30	6/24 (.25) [1]	9/28 (.32) [1]	13/29 (.45)	12/16 (.75) [1]	40/97 (.41) [3]
$40	7/18 (.39) [2]	6/17 (.35) [1]	8/19 (.42) [1]	15/21 (.71) [1]	36/75 (.48) [5]
$50	4/13 (.31) [1]	9/25 (.36) [1]	8/17 (.47) [2]	6/19 (.32) [2]	27/74 (.37) [6]
$75	10/26 (.39)	9/12 (.75)	8/19 (.42)	9/21 (.43) [2]	36/78 (.46) [2]
$100	6/17 (.35)	3/20 (.15) [1]	10/26 (.39)	5/19 (.26) [2]	24/82 (.29) [3]
$150	1/9 (.11)	3/18 (.17) [1]	10/14 (.71)	8/20 (.40) [1]	22/61 (.36) [2]
$200	2/9 (.22)	1/10 (.10) [1]	1/8 (.13)	1/13 (.08) [1]	5/40 (.13) [2]
Totals	70/162 (.43) [5]	64/168 (.38) [9]	85/167 (.51) [5]	81/171 (.47) [11]	300/668 (.45) [30]

The numbers in parentheses are percentage rates; the bracketed [ ] numbers in selected cells give the number of unusable responses or failures to answer the valuation question; these observations are not used in calculating acceptance rates.

Table 2. Descriptive Statistics for Selected Variables (n=698).

Variable	Description	Mean	Std. Error	Useable Responses	Expected Sign
AGE	Age in years	43.52	15.61	687	?
IMPORT	Importance of instream flows: Scale 0-10; 0=Not important at all, 10=Extremely important.	8.16	2.10	689	+
RECOG	Should instream flows be recognized as beneficial use: 1=Yes, 0=No.	0.85	0.36	657	+
ENVIR-OR	Environmental organization member: 1=Yes, 0=No.	0.13	0.33	689	+
BERN-CO	Bernallilo County resident: 1=Yes, 0=No.	0.45	0.50	696	?
FISH-LIC	Own fishing license:1=Yes, 0=No.	0.43	0.00	692	+
POL-IDEO	Political ideology: Scale 1-7; 1=Strongly Liberal, 7=Strongly conservative.	4.38	0.00	680	_
INC	Household income categories 1-9. 1=<$10K; 2=$10-20K; 3=$20K-30K; 4=$30K-40K;5=$40K-50K; 6=$50K-60K; 7=$60K-70K; 8=$70K-80K; 9=(>$80K).	4.10	2.28	636	+
INC1	Income categories 1-3 ($0-$30K)	0.47	0.49	301	+
INC2	Income category 4 ($30K-$40K)	0.27	0.45	174	+
INC3	Income category 5 ($40K-$50K)	0.09	0.29	59	+
INC4	Income category 6 ($50K-$60K)	0.05	0.23	33	+
INC5	Income category 8 and 9 ($70K+)	0.10	0.31	69	+
AWARE	Aware of New Mexico fish species on endangered list:1=Yes, 0=No.	0.46	0.50	689	+
RM	Treatment for test of sensitivity to Reminder of group size:1= received Reminder, 0= did not receive Reminder	0.49	0.50	698	?
SM	Treatment for test of sensitivity to scope of the good: 1=instream flows for silvery minnow, 0=instream flows for major NM rivers	0.49	0.50	698	?
INTERACT	Interaction term: SM*RM	0.24	0.43	698	?
?	Payment amount for dichotomous choice valuation question: $A={5,20,30,40,50,75,100,150,200}	63.93	53.54	698	-

Table 3. Estimation Results for Logit Models.

Variables	Logit-I n=567	Logit-II n=561	Logit-III n=668
INTERCEPT	**-1.35 (-2.05)	*-1.32 (-1.94)	***0.59 (3.37)
(?)	***-0.011 (-5.49)	***-0.011 (-5.50)	***-0.011 (-6.27)
INC2	**0.57 (2.55)	**0.52 (2.31)	
INC3	***0.98 (2.86)	**0.86 (2.43)	
INC4	***1.41 (3.00)	***1.34 (2.83)	
INC5	**0.67 (2.07)	*0.58 (1.74)	
AGE	**-0.013 (-2.14)	**-0.014 (-2.11)	
POL-IDEO	**-0.13 (-2.11)	**-0.13 (-1.94)	
IMPORT	***0.25 (4.74)	***0.25 (4.61)	
RECOG	***0.97 (3.05)	***0.97 (3.03)	
SM (SILVERY MINNOW)	***-0.62 (-3.23)	***-0.75 (-2.78)	**-0.43 (-2.62)
RM	0.17 (0.95)	-0.001 (-0.004)	0.13 (0.82)
INTERACT (SM*RM)		0.26 (0.70)	
AWARE		0.099 (0.49)	
BERN-CO.		-0.004 (-0.43)	
FISH-LIC		0.18 (0.91)	
ENVIR-ORG		0.27 (0.90)	
LLF	-335.52	-331.67	
LRT ($?^2$)	***114.69 [*df*=11]	***113.97 [*df*=16]	***51.25 [*df*=3]
McFadden R^2	0.15	0.15	0.06
% Correct Predict	68	70	0.63

Numbers in parentheses are asymptotic t-statistics; *, **, *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.

Table 4. Estimation Results for WTP Models.

Variables	WTP-1 n=567	WTP-2 n=567	WTP-3 n=567 SM=1	WTP-3 n=567 SM=0
INTERCEPT	*-126.34 (-1.91)	**-166.29 (-2.34)	-79.75 (-1.96)	*-240.60 (-1.86)
INC2	**53.43 (2.48)	**54.40 (2.36)	31.49 (1.35)	**78.35 (1.98)
INC3	***92.35 (3.67)	**85.98 (2.56)	*63.62 (1.88)	**138.67 (.2.64)
INC4	***131.98 (3.07)	***143.44 (2.76)	58.18 (1.09)	**200.85 (2.52)
INC5	**62.48 (2.62)	**73.63 (2.64)	52.03 (1.36)	*77.48 (1.95)
AGE	**-1.27 (-2.37)	**-1.29 (-2.33)	*-1.51 (-1.84)	-0.68 (-0.79)
POL-IDEO	**-12.60 (-2.51)	**-12.13 (-2.14)	*-14.09 (-1.87)	-9.51 (-1.04)
IMPORT	***23.67 (3.91)	***24.07 (4.03)	***19.34 (2.68)	***27.28 (2.66)
RECOG	***91.37 (3.43)	**94.37 (3.41)	49.86 (1.38)	**137.52 (2.49)
RM	16.72 (0.98)	19.71 (1.11)	22.62 (1.14)	3.80 (0.13)
SM (SILVERY MINNOW)	***-58.32 (-3.09)			
? (scale parameter)	***93.83 (5.73)	***98.85 (5.74)	***74.03 (4.14)	***112.77 (3.62)
Log-likelihood	-335.52	-340.92	-332.62	
LRT (?^{2})	***114.69 (*df*=11)	***103.89 (*df*=10)	***114.78 (*df*=20)	
McFadden R^2	0.15	0.13	0.15	

Numbers in parentheses are asymptotic t-statistics; *, **, *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5. Summary of Hypothesis Tests and Results.

Hypothesis Test #1: Split-sample test of scope (component sensitivity for nested goods)

	Non-Parametrics	Logit Models	WTP Models
Null	H_0: ~$P(W=1)_{SM=0}$ = ~$P(W=1)_{SM=1}$	H_0: $?_{SM} = 0$	H_0: $ß_{SM} = 0$ (H_0: $\mu_{WTP\mid X,SM=0} = \mu_{WTP\mid X,SM=1}$)
Alternative	H_a: ~$P(W=1)_{SM=0} \neq$ ~$P(W=1)_{SM=1}$	H_a: $?_{SM} \neq 0$	H_a: $ß_{SM} \neq 0$
Decision	Reject H_0	Reject H_0	Reject H_0
Signif. Level	≤ 0.02	≤ 0.01	≤ 0.01
Result: Evidence supports alternative in all models; mean contribution amount is sensitive to a change in the scope of the nested goods.			

Hypothesis Test #2: Split-sample test of group size reminder effect

	Non-Parametrics	Logit Models	WTP Models
Null	H_0: ~$P(W=1)_{RM=0}$ = ~$P(W=1)_{RM=1}$	H_0: $?_{RM} = 0$	H_0: $ß_{RM} = 0$ (H_0: $\mu_{WTP\mid X,RM=0} = \mu_{WTP\mid X,RM=1}$)
Alternative	H_a: ~$P(W=1)_{RM=0} \neq$ ~$P(W=1)_{RM=1}$	H_a: $?_{RM} \neq 0$	H_a: $ß_{RM} \neq 0$
Decision	Cannot Reject H_0	Cannot Reject H_0	Cannot Reject H_0
Result: Evidence supports the null in all models; there is no reminder effect.			