C I N T R A F O R

Working Paper

109

A Meta Analysis of Willingness to Pay Studies

Adam Lewis

David Layton

John Perez-Garcia

November 2007

Center for International Trade in Forest Products

C I N T R A F O R

Working Paper 109

A Meta Analysis of Willingness to Pay Studies

Adam Lewis

David Layton

John Perez-Garcia

November 2007

Center for International Trade in Forest Products
College of Forest Resources
University of Washington
Box 352100
Seattle, WA 98195-2100

This material is based in part upon research supported by the USDA Cooperative State Research, Education and Extension Service. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the funding agencies.

Executive Summary

This study is a meta-analysis of contingent valuation studies of rare and endangered species. The study seeks to measure non-market benefits in order to inform the limits and allowances of environmental policies. It follows a similar analysis performed by Loomis and White (1996) and employs methods developed in Layton and Lee (2006) and Buckland et al. (1997). We estimated 38 different reasonably likely models using linear and loglinear specifications. The models were then weighted according to their relative statistical fits using two criteria: the small sample size corrected Akaike's Information Criterion (AICc) developed by Hurvich and Tsai (1989, 1995), and the Bayes Information Criterion (BIC). The models reflect how well they explain the variation in willingness to pay both WTP and model economy. Use of the model-averaging approach reflects the considerable uncertainty regarding which specific model to choose. The model-averaging approach effectively broadens and makes explicit the implicit model testing process that researchers commonly pursue when determining their final models for reporting. Monte Carlo simulations were used to simulate the confidence interval for the model-averaged expected willingness to pay (EWTP).

Overall, the two criteria using the linear specification allocate weight quite similarly. Both criteria place the majority of the weight on one model. All models selected by either criterion include a variable indicating whether the survey was administered in person, by mail or by phone. With the loglinear models, the AICc and BIC criteria again allocate model weight similarly, and both allocate the most weight to a single, but different model than under the linear specification. As was the case in the linear WTP models, the loglinear models selected by the AICc are essentially a subset of the models selected by the BIC. The R-squared results for the loglinear models are higher than those of their linear counterparts. Both specifications suggest a change in the values for WTP over time. Both specifications exhibit a positive and large coefficient for phone surveys. Both specifications resulted in a significant indicator of using taxes as a payment vehicle rather than a donation or membership.

The overall results of the models revealed a consistently significant positive effect on WTP for the linear model that conducted the survey by phone, used taxes as a payment vehicle, and included protection of multiple species. Conducting the survey by phone, focusing on charismatic megafauna, maintaining current land protections, using taxes as a payment vehicle, asking for a one time payment and protecting multiple species generally had a significant positive effect on WTP for the loglinear models. The most prominent difference between model classes is that the loglinear models consistently returned the fish species indicator as negatively significant and the megafauna indicator as positively significant, whereas none of the linear models found these variables to be significant.

Three scenarios were created in order to simulate a distribution of observations from which we can obtain an estimate and confidence interval for WTP. The 3 scenarios analyzed were: an increasing the population of Chinook salmon, preventing the extinction of Orca whales and preserving old-growth forest for the Northern Spotted owl. There was considerable variability in the estimates of WTP both within scenarios and between them for the linear models. The loglinear models also displayed considerable variability in the estimates of WTP both within and between scenarios. The AICc weighted confidence interval was tighter than that of the BIC in five of the six scenarios across the two model classes.

A comparison of WTP estimates with original study estimates revealed that the salmon estimate of the loglinear AICc was higher, the marine mammal estimate was very similar, and the spotted owl estimate was considerably lower than the results of their corresponding valuation studies. Overall the meta-analysis model results confirmed earlier findings that endangered species CV studies can provide estimates that are sensitive to frequency of payments and insensitive to WTP question format, and that respondents' value protection of multiple species more than that of a single species.

Table of Contents

List of Tables

Introduction

This meta-analysis of contingent valuation studies of rare and endangered species follows a similar analysis performed by Loomis and White (1996). This analysis seeks to build on that previous effort and to provide an overview of species valuation that reflects subsequent studies, the evolution of statistical methods, and the expansion of computational power.

This study is part of the continuous effort to improve our understanding of the value our environment and the natural landscape hold for us. Understanding that value may assist society in making decisions that accurately reflect the goals and priorities of its citizens.

Endangered Species Protection and Valuation Background

Endangered Species Act

Congress first passed the Endangered Species Protection Act in 1966. That law provided limited protection for species listed as endangered. In 1973, Congress passed the Endangered Species Act (ESA), which greatly strengthened protections for listed species and increased funding for protection activities. For example, it prohibited federal agencies from taking any action that would jeopardize the continued existence of an endangered species or damage the critical habitat of the species.[1] In 1978, the Supreme Court held in TVA v. Hill that the intent of the ESA was to "halt and reverse the trend towards species extinction, whatever the cost."[2] Since that time, Congress has had to provide specific exemptions for government projects that might detrimentally affect threatened or endangered species. Indeed, under the standard interpretation, the ESA implies that Congress generally considers protected species priceless (Salzman and Thompson, 2003).

There are, however, two areas of ESA implementation where economic costs and benefits are plainly important considerations. Costs and benefits play a key role in the process of choosing which species will be listed as protected, and they are important again in the designation of critical habitat. In the first case, economic considerations play an implicit, though prohibited, role, whereas in the second they are explicitly considered under the wording of the ESA.

Although the ESA discourages using economic and political considerations in the decision of whether to list a species, the Fish and Wildlife Service (FWS) often faces significant pressure not to list a species. The FWS can determine that it needs more information before it can make a decision, and even when it has found that listing of a species is warranted, the FWS can decide that listing must be delayed because there are other, higher listing priorities. There continues to be a significant backlog of such candidate species.

The ESA declares that the FWS must designate critical habitat, but it leaves it up to the agency to determine how much and which habitat will be designated. In fact, the ESA says that the FWS must consider "the economic impact, and any other relevant impact, of specifying any particular area as critical habitat."[3] The FWS may exclude any area if the economic costs outweigh the economic benefits unless that exclusion "will result in the extinction of the species concerned."[4]

Costs and Benefits

Determining whether the costs outweigh the benefits requires that the decision makers know what those costs and benefits are. The costs of protecting endangered species are in principle simple both to identify and to quantify. Beyond the direct costs of endangered species protection efforts, they are the foregone values of activities that are prohibited to protect endangered species and their habitat. Such foregone values lie in things like land development, economic activities that rely on water use, and natural resource extraction. Those values are readily measured and very immediate for the people who must sacrifice them for protection of threatened and endangered species.

Prohibiting economic activity in one region may indirectly promote it in another, so the cost of a regulation as viewed by an individual may not represent its actual cost to society. The transfer of activity

---

[1] ESA § 7(a)(2), 16 U.S.C. § 1533(a)(2).
[2] 437 U.S. 153 (1978).
[3] ESA § 4(b)(2), 16 U.S.C. § 1533(b)(2).
[4] Ibid.

due to regulation does, however, likely represent a shift to a less desirable or higher-cost location, which means it results in long-run higher costs or lost benefits for society.

The specific benefits of protecting endangered species, on the other hand, are very difficult to identify and, especially, to quantify. Some would argue that species have an inherent value and right to exist that is independent of human views and values. Whether they stem from religion or simply a biocentric outlook on the world, such views hold that the existence of a species has value beyond calculation. The reality, however, is that human society has to make decisions that affect whether or not species survive, and such decisions are made based on values deriving from human society. For those reasons, we seek to know specifically how much endangered species are worth to humans. There are no observable markets for endangered species protection we can observe. As a consequence, we cannot observe the prices at which people make exchanges, and moreover, we lack a market guide as to exactly what people would be exchanging. We must therefore first identify specifically what forms the value of endangered species takes, and then look to see how people can reveal them to us.

The values endangered species hold for humans are divided into two general types, use values and non-use values, each of which has multiple sub-types. With minor variations, most environmental value classifications resemble the following breakdown, based on Freeman (2003) and Salzman and Thompson (2003):

> Use values are present, tangible benefits that people derive from interactions with, or the activities of, species.
>
> Market use values lead to identifiable transactions and can therefore readily be quantified. They are further broken down into:

- Consumptive use values, which involve the harvest of the species, and thus sometimes contribute to the pressure on the population that leads to species being threatened or endangered in the first place. Consumptive use means that the species has direct commercial value, which can be quite significant. Salmon fisheries, for example, provide millions of dollars annually to the economy of the Pacific Northwest.
- Non-consumptive use values, which are those that are generated only by interaction with the species, but that do not require harvesting or consuming the species. Bird watching and tourism are good examples of non-consumptive uses.
- Non-market use values are tangible services species provide for society which are not captured in market transactions. For example, the combined existence of numerous species is necessary for biodiversity and highly functional natural ecosystems. Natural ecosystems purify air and water, limit erosion, provide flood control, pollinate agricultural crops, control pests, and provide aesthetic pleasures, to name a few of the services they offer.

> Non-use values are benefits that people derive from species without actually needing to interact with them in any way. Some examples of non-use values are:

- Existence values, which are those benefits people derive simply from knowing that a particular species exists.
- Bequest values, which are benefits people derive from believing that a species will survive to exist in the world of their descendants.
- Option values, which are benefits people derive from the continued existence of a species they believe may hold additional use value in the future. For example, the genetic information of a species may one day contribute to medicine, agriculture, or industry.

Contingent Valuation Method

The majority of the benefits of species outlined above are non-market benefits, making it difficult to assess accurately what value the continued existence of a species holds for society. There is no market in which we can observe prices. The creation and continued support of legislation such as the ESA and the Convention on International Trade in Endangered Species (CITES), are plain evidence that endangered species protection holds value for people both in the United States and in other countries, but they provide limited information about the magnitude of that value. Indeed, we seek to measure that value in order to inform the limits and allowances of those very policies. In the effort to measure that value more accurately, researchers have drawn on the contingent valuation (CV) method. In simple terms, the CV method measures the value of something by surveying a sample of the population and asking each of them how much they would be willing to pay for it. The first recorded CV study was done by Davis (1961), though that study and those of the next several years focused on use values. Randall, Ives and Eastman (1974) extended the use of CV methods to estimate non-use values. Initial efforts at measuring non-use values sought to measure their components individually, but the recent emphasis in CV research has been to measure the total economic value of the good in question. Not only is there reason to doubt that individuals can differentiate between the components of the non-use values comprised in their willingness to pay (WTP) (Cummings and Harrison, 1995), but total economic value is generally more relevant to decision making (Jakobsson and Dragun, 1996). See Mitchell and Carson (1989) for a complete discussion of the CV method.

In a CV survey focused on measuring values for endangered species protection, the researcher describes a hypothetical market which enables the respondent to reveal his or her WTP for that particular protection of that particular species in that particular place. As Loomis and White (1996) identified in their meta-analysis of endangered species valuation studies, key aspects of the hypothetical market for endangered species protection are:

- A description of the species in question, including a description of the threat to its existence,
- A description of the effect or program that is to be valued, including the consequences of choosing not to pay, and
- And the method and frequency of the payments to be made by the respondent.

The Meta-Analysis Method

A meta-analysis is a study of studies. The practice of gathering, combining, and analyzing the results of numerous studies has been used with increasing frequency in the agricultural and medical science fields since the early 20th century (van den Bergh et al., 1997). The term "meta-analysis" was first applied to the practice by Glass in 1976. In that paper, Glass provided a widely accepted definition:

> "Meta-analysis refers to the statistical analysis of a large collection of results from individual studies for the purpose of integrating the findings. It connotes a rigorous alternative to the casual, narrative discussions of research studies which typify our attempts to make sense of the rapidly expanding research literature."

Meta analysis allows the cumulative results of a body of research to be aggregated across studies. Meta-analysis can identify significant effects if they persist across studies, even if the smaller individual studies lack the power to establish the phenomenon. The application of meta-analysis techniques to non-market valuation has been a more recent extension of the technique (Loomis and White, 1996), but it is a highly suitable combination. There is ongoing debate as to the most appropriate methods of conducting CV studies. Meta-analysis can shed light on important effects the researchers' formulations of the original studies have on the results (Smith and Kaoru, 1990). Moreover, meta-analysis is recently gaining further popularity as a tool in generating benefits transfer functions, a tool decision-makers can use to translate existing valuation findings for application to their own areas of responsibility (Smith and Pattanayak, 2002).

In short, the theory of conducting a meta-analysis of contingent valuation studies of endangered species holds that the WTP in any specific study is a combination of the core, generalized WTP for endangered species and the specific characteristics of that study. As adapted from van den Bergh (1997), the formula is:

$$\beta_j = \mathrm{B} + \sum \alpha_k Z_{jk} + u_j \, (j = 1,2,...L)(k = 1,2,...M) \qquad (1)$$

where β_j is the reported WTP estimate of study *j,* B is the essential, general WTP for species protection, *L* is the total number of studies, Z_{jk} are *k* different variables that reflect the relevant characteristics of study j, α_k are the coefficients of the M different study characteristics, and u_j is the error term for study *j*.

Data

Overview of Included Studies

The studies used for analysis in this paper were located by searching an online bibliographic database of environmental studies,[5] through reference to Loomis and White's 1996 meta-analysis of endangered species valuation studies, and by following the references cited in the endangered species CV studies found. Because this analysis was seen as an opportunity to update both the methods and the literature used in the Loomis and White paper, it is worth noting the significant ways in which the studies used here differ from those they included.

As Loomis and White emphasized, they relied on several studies from the unpublished gray literature. In 2007, those studies are not readily available, and they do not appear in this analysis. This analysis includes some studies that reported WTP to protect multiple species. It should be noted that Loomis and White chose to exclude such studies. They are included here in the interest of maximizing the number of observations on which to base the analysis, and because there has been some debate as to whether CV studies show sensitivity to scope (Desvouges et al., 1992 and Carson and Mitchell, 1995). Some have claimed that a lack of sensitivity to scope shows that responses reflect the willingness to pay for the moral satisfaction of contributing to public goods rather than the economic value of those goods (Kahneman and Knetsch, 1992). Some researchers theorize that when respondents report WTP for endangered species protection, the endangered species is actually symbolic of all species or even ecosystem health in general (Loomis and White, 1996).[6] If asking respondents to value the protection of multiple species significantly increases WTP, it is evidence that endangered species CV studies are sensitive to scope.

Several studies reported multiple estimates of WTP. For example, some studies report WTP for different species, whereas others report different WTP for the same species when respondents are separated by sampling region. So as to retain as many observations as possible, all the models employed in this study include as parameters those characteristics that varied between distinct estimates from the same original study. In some cases, this means simply that respondents were asked to value two distinct species. Some studies, however, report different levels of WTP for observations that otherwise vary only in respondent pool attributes or the proposed method of payment. Such singular variation is also valuable to the analysis because it helps isolate the effects of changing the varying characteristic.

In total the data set included 46 observations taken from 21 studies. The earliest survey was conducted in 1983, and the most recent was conducted in 2001. Appendix A includes a table listing the examined characteristics and results of the studies included in the analysis and a table listing some details of observations omitted from this analysis.

Data Issues

There were several variables it would have been interesting to include in the analysis that had to be omitted because they were not applicable to some studies. Correspondingly, some endangered species valuation studies had to be omitted because they did not report the information for several variables included in the analysis. This is sometimes referred to as the n vs. k dilemma (Moeltner, 2006). This study is the result of an effort to find a balance between retaining as many observations as possible and exploring variables of interest.

---

[5] http//www.evri.ca

[6] Loomis and White state that they dropped such studies because they could not be included in a "single-species meta-analysis". This study is not so specifically defined.

One intriguing area of study is how respondent WTP is affected by the level of certainty of the outcome to be valued—there is certainly a wide variation in the certainty with which real-world endangered species protection programs will deliver the desired results. Unfortunately, few studies actually addressed the certainty of the outcome, and it was not possible to create a meaningful variable measuring certainty of outcome.

It would be similarly interesting to examine the effect the size of the change offered in the valued program has on WTP, but again many of the studies did not identify the magnitude of the promised change, and many offered respondents no specific outcome beyond a funded preservation effort.
A prospective meta-analyst can hope that endangered species CV studies, all based on a similar protocol, will rapidly accumulate, but there are reasons the studies are both scarce and varied. As Smith and Pattanyak (2002) noted, non-market valuation studies must develop a new technique in order to be published; simply adding a new species valuation is not enough. This inherently limits the rate of growth of the body of valuation research, and studies explicitly aimed at varying from each other are unlikely to be readily standardized for systematic comparison. The push for creativity drives exploration of the CV method, but it limits the accumulation of CV results.

The Model-Averaging Approach

This analysis was conducted using a frequentist-based model-averaging approach, following Layton and Lee (2006) and Buckland et al. (1997). Rather than choosing just one model, two classes of 38 different reasonably likely models were estimated. The models were then weighted according to their relative statistical fits, which reflect both how well they explain the variation in WTP and model economy. Use of this method reflects that there was considerable uncertainty regarding which specific model to choose. Loomis and White (1996) presented some of the possible models, but there are numerous reasonable variables and specifications they omitted. While some research is driven by a specific hypothesis to a specific model specification, this is exploratory research, not based on fixed ideas of the factors that determine WTP results in CV studies. With the model-averaging approach, it is possible to explore multiple alternative specifications and to report on the relative performance of each one. The approach effectively broadens and makes explicit the implicit model testing process that researchers commonly pursue when determining their final models for reporting. Moreover, presentation of the full range of models considered and their weights provides the reader a clearer view of the criteria and process used in the analysis. The reader is better apprised of the range of possibilities and is even free to choose other models based on alternative assumptions.

This weighting approach is primarily employed within a Bayesian framework (see Koop and Tole, 2004 and Leon and Leon, 2003). As Layton and Lee (2006) note, however, a Bayesian multiple-choice alternative, discrete choice case, with covariates poses difficulties. Though this frequentist approach lacks the formal justification of that of the Bayesian framework (see Koop and Tole 2004), it makes weighted model-averaging available at a manageable complexity in this situation.

For weighting criteria, I will report the results of both the small sample size corrected Akaike's Information Criterion (AICc) developed by Hurvich and Tsai (1989, 1995) and the Bayes Information Criterion (BIC).

$$\text{AICc} = -2\ell + 2p + \frac{2p(p+1)}{n-p-1} \qquad (2)$$

$$\text{BIC} = -2\ell + p\ln(n)$$

where ℓ is the log-likelihood, p is the number of parameters in the model, and n is the sample size. These two criteria are well suited to this analysis because they include penalties for models that include large numbers of parameters relative to the number of observations. The data pool for this analysis holds 46 observations, and the models considered contain as many as 26 variables, so model economy is an important consideration in determining goodness of fit. As Layton and Lee (2006) explain, the $2p + \frac{2p(p+1)}{n-p-1}$ term in the AICc criterion and the p ln(n) term in the BIC criterion in (2) are penalties added to two times the log-likelihood. One chooses the model with the smallest criterion value, so these factors penalize additional parameters in any given model.

Under what conditions is one penalty greater than the other? Looking at the AICc term, $2p + \frac{2p(p+1)}{n-p-1}$, and the BIC term, $p\ln(n)$, we see that their penalties are the number of parameters, p, times a penalty factor, $2 + \frac{2(p+1)}{n-p-1}$ and ln(n), respectively. In this study all models have 46 observations. In absolute terms with n=46, the AICc criterion penalty is less than that of the BIC criterion for all $p < 21$.

It is important to remember, however, that the values of a particular criterion are compared only to the values of that same criterion for producing model weights. When thinking about how a criterion penalizes the marginal addition of model parameters, the comparison must also be based on how much greater the penalty is for *p+1* than for *p*. The marginal BIC penalty factor is ln(n), a constant when n is held constant. Looking at the AICc penalty factor, however, we see that as p increases, the numerator of the second term increases while the denominator decreases. That means that the AICc penalty factor increases with the numbers of parameters. Thus, relative to its own penalty, the AICc penalizes an increase in the number of parameters more severely than the BIC criterion does for a constant, equal sample size. This effect is greater at lower numbers for *p*, but it would still be substantial for models with a reasonable number of parameters.

Overall, the AICc seems to reward model economy a little more than the BIC does; however, it is still theoretically ambiguous which criterion will reward model economy more in this analysis. The AICc criterion penalizes the marginal addition of a parameter to a model more severely than the BIC does, but in absolute terms the BIC penalty is greater for all models with 20 or fewer parameters. Only 5 of the 38 models considered in this analysis have more than 20 parameters. The weighting results will depend on the absolute difference in log-likelihood between the particular models considered before the criterion penalties are added.

Model Weighting

Once the criteria values are calculated using the formulas in (2), those values determine model weight. Following Buckland et al. (1997) and Layton and Lee (2006), the weight for each model is calculated according to:

$$w_m = \frac{\exp\left(\frac{-crit_m}{2}\right)}{\sum_{i=1}^{M}\exp\left(\frac{-crit_i}{2}\right)} \tag{3}$$

where $crit_m$ and w_m are the criterion value and the weight allocated to model *m,* respectively, and *M* is the total number of models considered. Equation (3) guarantees that the weights lie between 0 and 1 (inclusive) and sum to 1. The form is motivated by Buckland et al. (1997) as an approximation of a Bayes factor for use in Bayesian model-averaging.

Model-Averaged WTP

The purpose of CV studies is to generate an estimate of WTP, and a central goal of this meta-analysis was to generate an EWTP for endangered species protection based on the included studies.

The estimate of model-averaged WTP for endangered species protection follows Layton and Lee (2006) and Buckland et al. (1997). The weighted estimate of model-averaged WTP is of the form:

$$EWTP_{Mavg} = \sum_{1}^{M} w_m EWTP_m \tag{4}$$

where M is the number of models, w_m and $EWTP_m$ are the weight and expected WTP, respectively, for model *m*. In simpler terms, the model-averaged EWTP is a weighted average of the EWP of all the models.

Under an assumption of normality, one could obtain closed forms for the confidence intervals; however, this analysis used Monte Carlo simulations to simulate the confidence interval for the model-averaged EWTP. Following Layton and Lee (2006) and Krinsky and Robb (1986), the coefficient estimates and covariance matrices for each model were used to create a model-averaged pool of 128,000 observations from which to draw a distribution of the estimated WTP. Individual model estimates are represented in the simulation results according to the weight the model received from the information criterion being examined. Expected value estimates and confidence intervals reported are the mean results of 50 rounds of simulations. Illustrative scenarios serve as the basis for specifying quantities for the variables used in these Monte Carlo simulations. A sample of the Matlab code used in the Monte Carlo simulations is included in Appendix B.

The reader may have concerns about how this approach handles covariance among the models themselves. That is an important limitation of this technique and worthy of further research. It is a limitation that must be kept in mind when interpreting the results.

Variables Examined

The dependent variable in all models was the stated WTP. Models were divided into two classes based on functional form. One class was linear in WTP and one was log-linear in WTP. The general form of the equation is:

$$\mathrm{F}[\mathrm{WTP}(\$2006)] = \alpha C + \mathrm{B}X + u \qquad (5)$$

Where F denotes a function that is either WTP or the natural log of WTP, X is a vector of variables that vary according to the specific model, and B is a vector of coefficients applied to the variables comprised in a given model. Loglinear models are most appropriate if the variable effects are proportional to the size of WTP, rather than purely linear. Loglinear models also constrain WTP estimates to positive numbers, which is reasonable given that all included observations report positive WTP. The full range of variables appearing in the models used is listed below in Table 1.

Table 1. Meta-analysis variable details

Variable	Full Name	Type	Description	Sub-variables
Prog I	Program variables suite I	Categorical	Indicates the most prominent focus of the program valued by respondents.	1. Avoid extinction 2. Avoid pop. decline 3. Increase pop. 4. Land management. 5. General program
Prog II	Program variables suite II	Categorical	Indicates the most prominent focus of the program valued by respondents.	1. Population focus 2. Land management 3. General program
Phone	Survey method	Categorical	Indicates the survey method used.	1. Phone 2. Mail 3. In-person
Species I	Species divisions	Categorical	Indicates the general class of the species valued.	1. Fish 2. Bird 3. Marine mammal 4. Other
Species II	Species divisions	Categorical	Indicates the general class of the species valued.	1. Fish 2. Bird 3. Marine mammal 4. Other mammal 5. Other
Species III	Species divisions	Categorical	Indicates the general class of the species valued.	1. Fish 2. Bird 3. Mammal 4. Other
Mega	Charismatic megafauna	Categorical	Indicates whether the species valued has particular charismatic or symbolic appeal.	
NOAA	Post-NOAA panel survey	Categorical	Indicates whether survey was conducted after the publishing of the findings of the NOAA panel.	
Year	Year of survey	Continuous	The year the survey was conducted.	
state_pc	Percentage of respondents from the state	Continuous	Percentage of respondents from within state of program implementation.	
rrate	Response rate	Continuous	Response rate, allowing for undeliverable surveys.	
new	New land preservation	Categorical	Program includes new land preservation or restrictions.	
maint	Maintain land preservation	Categorical	Program maintains current land preservation or restriction on activities.	

state*new	State percentage * new	Interaction	Combined effect of in-state respondents and new land preservation.	
state*maint	State percentage * maint	Interaction	Interaction of in-state respondents and maintain land preservation.	
rnum	Response number	Continuous	Indicates the number of respondents to the survey.	
tax	Payment vehicle	Categorical	Indicates the payment vehicle in the survey.	1. Tax 2. Donation or membership
one-time	One-time payment	Categorical	Indicates how often stated amount was to be paid.	1. One time only 2. Annual
multi	Multiple species indicator	Categorical	Indicates that WTP is for multiple species.	
users	Users indicator	Categorical	Indicates respondents were specifically those with use values for the species, e.g., hunters or birdwatchers.	
local	Local respondent indicator	Categorical	Indicates the respondent pool was from the immediate area of program implementation.	
DC	DC flag	Categorical	Indicates the survey question format was dichotomous choice.	

Models

Each of the models considered comprised some combination of the numerous possible variables considered. Table 2 shows the variables included in each of the 38 models considered. Inclusion of a variable is indicated by an I. An exhaustive representation of all the possible model variations using the component variables identified would be prohibitively large. Instead, this selection of models is meant to represent a significant number of reasonable combinations of variables. Specific combinations of interest not represented here could readily be constructed for comparison to the models chosen.

Models 1 through 13 all include a Program I, a suite of variables indicating the specific emphasis of the program that respondents were asked to value. The programs valued in studies were focused on avoiding extinction, avoiding a decrease in population, increasing population, changing land management practices, or on a general program to promote the species in question.

Models 27 through 37 include Program II, a reduced form of the above-mentioned suite of program variables. In these models, programs were identified as focusing on population effects, land management effects, or simply on a general program with no specific effects. Models 14 through 26 had no program-focus variables. Model 38 is a minimal specification, using only those variables necessary to make the observation matrix maintain full rank in the analysis, which sets a baseline for explanatory power.

Table 2. Model variable matrix

	Model																																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Prog I	I	I	I	I	I	I	I	I	I	I	I	I													I													
Prog II																											I	I	I	I	I	I	I	I	I	I	I	
Phone							I	I	I	I	I	I	I	I	I	I	I	I							I	I							I	I	I	I	I	
Species I	I	I									I	I	I	I									I	I			I	I									I	
Species II			I	I					I	I					I	I					I	I							I	I					I	I		
Species III					I	I	I	I									I	I	I	I											I	I	I	I				
Mega	I		I		I		I		I		I		I		I		I		I		I		I		I	I	I		I		I		I		I		I	
NOAA			I	I	I	I					I	I			I	I			I	I	I	I				I			I	I	I	I					I	
Year	I	I					I	I	I	I			I	I			I	I					I	I	I		I	I					I	I	I	I		
state %	I	I			I	I			I	I			I	I			I	I			I	I				I	I	I			I	I			I	I		
rrate	I	I	I				I	I	I				I	I	I				I	I	I				I		I	I	I				I	I	I			
state* new			I	I	I				I	I	I				I	I	I				I	I	I			I			I	I	I				I	I	I	
state*maint			I	I	I				I	I	I				I	I	I				I	I	I			I			I	I	I				I	I	I	
new		I	I	I				I	I	I				I	I	I				I	I	I				I		I	I	I				I	I	I		
maint		I	I	I				I	I	I				I	I	I				I	I	I				I		I	I	I				I	I	I		
rnum	I	I	I	I					I	I	I	I					I	I	I	I					I		I	I	I	I					I	I	I	
tax	I	I					I	I	I	I					I	I	I	I					I	I		I	I	I					I	I	I	I		
one time	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
multi	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
users	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
local	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
DC	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I

I Indicates that the variable was included in that model.

Although we have some intuition as to how people distinguish value among different types of species, it is reasonable to say that we do not know specifically how people draw their distinctions or, indeed, whether the general class of species to be valued has a clear effect on the respondents' WTP. The models examined therefore include three different reasonable approaches to classifying species, as well as some models that do not include any variable for the type of species. The suite Species I divides species into fish, birds, marine mammals, and others, following the specification chosen by Loomis and White (1996). Species II explores the value of a more detailed division of species types by dividing species into fish, birds, marine mammals, other mammals, and others. And Species III eschews classification schemes containing ad-hoc sub-class divisions in favor of more classical biological categories of fish, birds, mammals, and others. Models that omit any species suite variable but do include an indicator for charismatic megafauna are based on the premise that people do not have strong feelings about the specific class of a species, but simply draw a distinction between prominent, charismatic species and others.

Results

Linear WTP Models

Table 3 lists model fits and weights based on linear WTP. The model weights are calculated using equations (3) and (4) from the model-averaging discussion. Although every model receives some weight in principle, the weight of most models is infinitesimally small. The weights are rounded to three decimal places, so any model receiving less than 0.05 percent of the weight is disregarded. The AICc criterion allocates non-zero weight to models 15,16,17,18, and 26. The BIC criterion spreads the weight among models 9, 10, 15, 16, 18, 26, and 36.

Overall, the two models allocate weight quite similarly. The AICc divides the weight among fewer models than the BIC does, and nearly every model chosen by the AICc is also chosen by the BIC. The exception, model 17, receives only 0.1 percent of the weight from the AICc, so the AICc model set is essentially contained within that of the BIC. The AICc does seems to reward model economy more than the BIC does, which provides further insight into the criterion characteristics identified in section IV. Models 9, 10, and 36, the models selected by the BIC but not the AICc, are the models with the highest raw explanatory power, but they also have the greatest number of parameters.

Table 3. Selected results and weights for linear WTP models

Model	Params	Adj R Sq	LL	AICc	Weight	BIC	Weight	Sig. Vars
1	19	0.603	-247.94	563.11	0.000	568.63	0.000	1
2	20	0.628	-245.56	564.73	0.000	567.70	0.000	1
3	22	0.657	-241.92	571.83	0.000	568.06	0.000	1
4	20	0.657	-243.74	561.08	0.000	564.06	0.000	1
5	18	0.679	-243.88	549.10	0.000	556.68	0.000	3
6	15	0.588	-251.99	549.97	0.000	561.40	0.000	2
7	19	0.686	-242.54	552.31	0.000	557.82	0.000	2
8	20	0.682	-241.96	557.52	0.000	560.49	0.000	2
9	26	0.854	-217.98	561.85	0.000	535.50	0.027	7
10	24	0.858	-219.65	544.44	0.000	531.19	0.237	7
11	20	0.744	-236.98	547.55	0.000	550.53	0.000	6
12	17	0.689	-243.99	543.83	0.000	553.06	0.000	2
13	15	0.663	-247.34	540.68	0.000	552.11	0.000	5
14	16	0.677	-245.62	542.00	0.000	552.50	0.000	5
15	20	0.823	-228.50	530.59	0.009	533.57	0.072	8
16	18	0.823	-230.18	521.68	0.813	529.27	0.620	6
17	18	0.758	-237.36	536.06	0.001	543.64	0.000	6
18	15	0.744	-241.03	528.05	0.034	539.48	0.004	6
19	13	0.458	-259.73	556.83	0.000	569.22	0.000	2
20	14	0.602	-251.94	545.42	0.000	557.47	0.000	4
21	18	0.590	-249.55	560.43	0.000	568.01	0.000	2
22	16	0.581	-251.60	553.96	0.000	564.46	0.000	3
23	14	0.618	-250.97	543.50	0.000	555.55	0.000	4
24	11	0.599	-254.18	538.11	0.000	550.47	0.000	4
25	16	0.633	-248.60	547.95	0.000	558.45	0.000	1
26	16	0.776	-237.21	525.17	0.142	535.67	0.025	4
27	17	0.591	-250.28	556.43	0.000	565.66	0.000	2
28	18	0.607	-248.53	558.39	0.000	565.97	0.000	2
29	20	0.593	-247.69	568.97	0.000	571.95	0.000	2
30	18	0.588	-249.65	560.63	0.000	568.21	0.000	2
31	16	0.575	-251.92	554.60	0.000	565.10	0.000	3
32	12	0.436	-261.33	556.12	0.000	568.61	0.000	3
33	17	0.687	-244.15	544.15	0.000	553.38	0.000	2
34	18	0.677	-244.03	549.39	0.000	556.97	0.000	2
35	24	0.814	-225.84	556.83	0.000	543.58	0.000	5
36	22	0.825	-226.40	540.80	0.000	537.03	0.013	5
37	18	0.735	-239.53	540.40	0.000	547.98	0.000	7
38	6	0.382	-267.16	548.47	0.000	557.29	0.000	2

Both criteria place the majority of the weight on model 16, 81.3 percent by the AICc and 62.0 percent by the BIC. Model 16 has 18 independent variables and an adjusted R-squared of 0.823. The AICc assigns the second most weight (14.2 percent) to model 26, which also receives 2.5 percent of the weight from the BIC. The BIC assigns the second most weight (23.7%) to model 10, which has the highest adjusted R-squared of all the models (0.858) but has 24 independent variables. Model 10 does not receive any weight from the AICc.

There are few obvious traits that distinguish the selected models from those that did not receive any weight, but one can make some general observations. All models selected by either criterion include a variable indicating whether the survey was administered in person, by mail, or by phone. The AICc selected no models that included a Program suite of variables, describing specifically what effects were guaranteed to respondents in the valued preservation program. One model selected by both criteria, model 26, included no variable indicating what type of species was to be protected in the valued program.

Loglinear WTP Models

The fits and weights for each model based on loglinear WTP appear in Table 4. The AICc spreads the weight among models 16, 17, 18, 23, 24, 26, 33, and 34. The BIC criterion spreads the weight among models 9, 10, 15, 16, 17, 18, 23, 24, 26, 27, 33, 34, 35, and 36. The AICc and the BIC criteria again allocate model weight similarly, and both allocate the most weight to model 18. As was the case in the linear WTP models, the models selected by the AICc are essentially a subset of the models selected by the BIC.

The BIC criterion places 49.7 percent of the weight on model 18, and each of models 9, 17, 35, and 36 receive more than 5 percent of the weight. The set of models receiving non-zero weight from the BIC criterion in this set includes all of those that received non-zero weight in the linear WTP models, but it also includes models 17, 23, 24, 27, 33, 34, and 35. The AICc criterion allocates comparatively more of the weight, 87.7 percent, to model 18, and it allocates 4.8 percent, 3.7 percent, and 2 percent to models 23, 17, and 24, respectively.

Although they are two entirely different classes of models, by comparing the results of the linear WTP models to those of the loglinear WTP models, we can gain some insight into how the models behave. Although the results for the two model types are fairly similar, we see some distinct differences. The log likelihoods of loglinear models are based on a completely different scale from those of the linear models, so the basis of comparison is the adjusted R-squared results. In 35 of the 38 model types, the R-squared results for the logarithmic models are higher than those of their linear counterparts. This gives reason to believe that the effects of at least some of the included variables are proportional rather than linear. The linear version of model 16 is given the most weight by both criteria, but it is among those models that have a lower adjusted R-squared in the loglinear form. Thus, the loglinear form of model 16 is allocated only a minuscule amount of weight by either criterion.

Table 4. Selected results and weights for loglinear WTP models

Model	Params	Adj R Sq	LL	AICc	Weight	BIC	Weight	Sig. Vars
1	19	0.673	-34.39	136.01	0.000	141.52	0.000	6
2	20	0.646	-35.29	144.19	0.000	147.16	0.000	2
3	22	0.686	-30.75	149.49	0.000	145.72	0.000	6
4	20	0.613	-37.34	148.28	0.000	151.26	0.000	5
5	18	0.679	-34.77	130.87	0.000	138.45	0.000	5
6	15	0.479	-48.26	142.52	0.000	153.95	0.000	2
7	19	0.702	-32.25	131.73	0.000	137.25	0.000	4
8	20	0.690	-32.25	138.10	0.000	141.07	0.000	4
9	26	0.816	-14.20	154.30	0.000	127.95	0.052	7
10	24	0.801	-18.21	141.56	0.000	128.31	0.044	10
11	20	0.639	-35.74	145.09	0.000	148.06	0.000	2
12	17	0.556	-43.04	141.93	0.000	151.16	0.000	3
13	15	0.610	-41.58	129.16	0.000	140.58	0.000	5
14	16	0.650	-38.34	127.43	0.000	137.93	0.000	5
15	20	0.738	-28.37	130.34	0.000	133.32	0.004	7
16	18	0.710	-32.40	126.14	0.001	133.72	0.003	8
17	18	0.755	-28.50	118.34	0.037	125.92	0.143	8
18	15	0.731	-33.01	112.01	0.877	123.44	0.497	7
19	13	0.430	-51.75	140.87	0.000	153.26	0.000	3
20	14	0.588	-43.56	128.66	0.000	140.71	0.000	5
21	18	0.600	-39.81	140.95	0.000	148.54	0.000	3
22	16	0.536	-44.83	140.42	0.000	150.92	0.000	4
23	14	0.675	-38.13	117.82	0.048	129.87	0.020	6
24	11	0.601	-44.89	119.54	0.020	131.89	0.007	6
25	16	0.554	-43.93	138.61	0.000	149.11	0.000	1
26	16	0.673	-36.75	124.26	0.002	134.76	0.002	4
27	17	0.673	-35.98	127.82	0.000	137.05	0.001	5
28	18	0.654	-36.51	134.35	0.000	141.93	0.000	4
29	20	0.644	-35.45	144.50	0.000	147.48	0.000	5
30	18	0.567	-41.65	144.63	0.000	152.22	0.000	5
31	16	0.561	-43.54	137.83	0.000	148.33	0.000	5
32	12	0.305	-56.99	147.44	0.000	159.93	0.000	2
33	17	0.722	-32.28	120.42	0.013	129.65	0.022	4
34	18	0.711	-32.33	126.00	0.001	133.58	0.003	4
35	24	0.809	-17.24	139.62	0.000	126.37	0.115	10
36	22	0.791	-21.36	130.72	0.000	126.95	0.086	12
37	18	0.566	-41.68	144.70	0.000	152.29	0.000	2
38	6	0.243	-62.71	139.57	0.000	148.39	0.000	2

Estimation Coefficients

Table 5 shows detailed results of models 16 and 18, the models chosen first by both criteria in the linear and loglinear model classes, respectively. Looking at the variables with significant coefficients, we can see which survey attributes mattered most in the best-fitting models.

Table 5. Detailed results of most-heavily weighted models

	Linear Model 16			Loglinear Model 18		
Variable	**beta**	**s.e**	**p-value**	**beta**	**s.e**	**p-value**
C	36.62	54.24	0.505	6.468	0.836	0.000**
DC	-5.05	22.62	0.825	-0.451	0.316	0.164
Local	49.53	27.73	0.085	0.177	0.350	0.616
Users	35.95	29.70	0.236	0.776	0.389	0.055
Multi	73.26	27.98	0.014**	0.443	0.357	0.224
One-time	84.17	29.07	0.007**	0.704	0.346	0.050
Fish	-59.04	39.56	0.147	-1.896	0.522	0.001**
Bird	-33.96	37.90	0.379	-1.350	0.521	0.015*
Marine	52.58	45.41	0.257			
Mammal				-0.403	0.563	0.480
Other mammal	20.31	55.37	0.717			
NOAA	-127.52	24.17	0.000**			
Survey Year				-0.125	0.032	0.001**
Phone	188.51	52.58	0.001**	1.513	0.653	0.027*
Mail	29.06	42.82	0.503	0.135	0.585	0.819
Land New	56.89	49.16	0.257			
Land Maint	171.23	38.46	0.0001**			
State %				-1.269	0.419	0.005**
State %*Land Maint	-31.87	56.54	0.578			
State %*Land New	-234.34	52.88	0.0001**			
Tax	75.76	26.65	0.008**	1.432	0.345	0.0002**
No. of Respondents				0.000	0.001	0.729

* Denotes significant at the 5% significance level

** Denotes significant at the 1% significance level

The significant variables for model 16, the most heavily weighted linear model, are those indicating multiple species valued, a one-time payment, survey occurring after the NOAA panel convened, a phone survey, maintaining current land protections in the valued program, an interaction of the percentage of in-state respondents with new land protections, and taxes as the payment vehicle. The positive and significant coefficient for the one-time payment indicator is a sensible result. Intuition suggests that, all else being equal, people would have a higher WTP if they need pay only once rather than annually. Multi and One-time are not significant in model 18. That may be due to multi-collinearity masking the effects of certain attributes, especially in a small sample study such as this one.

The coefficients in model 16 of both Land New and Land Maint are positive, while their interaction with the percentage of in-state respondents is negative. This suggests that people nationwide value land preservation in protecting endangered species, but those who live within the more narrow political boundaries that include the area of focus, whom one might expect to be more directly affected by the land policies, value it less. It is not clear how this interacts with the intuition and prior research (see Pate and Loomis, 1997) showing that WTP declines with distance from the preserved species. The in-state respondents variable might be considered a proxy for distance, as in-state respondents almost certainly live closer to the area of focus, on average, than the nationwide population. States vary widely in size, however, and one can easily imagine a respondent living just across the state border from the area of focus. Moreover, in-state residence connotes other differences besides distance.

The significant variables for model 18, the most heavily weighted loglinear model, are those indicating the constant, fish species, bird species, the year of the survey, a phone survey, the percentage of in-state respondents, and taxes as the payment vehicle. The fish and bird species indicators both have negative coefficients. That contrasts with the results of Loomis and White (1996), who found positive effects for fish, birds and marine mammals relative to omitted species. Though they used a slightly different structure of species variables than that in model 16, the contrast is instructive. The Bird and Fish variables were not significant in every model that contained them, but they were negative when they were. The variation of which variables were significant among models indicates that the results are arbitrary to a degree: the choice of model decides which conclusions one is left to draw. There is likely enough multi-collinearity in the variables that different models assign effects differently, especially with the small sample size.

It is interesting to note that the coefficient for Mammal is also negative (though not significant), which suggests model 18 estimates a lower WTP for fish, birds, and mammals compared to species in Other, the omitted variable. In this meta-analysis, Other includes two studies of sea turtles and wood turtles. Perhaps people truly value turtles more than other endangered species, but the popular press suggests that people value most those species that resemble ours. Loomis and White (1996) found that protecting birds and marine mammals elicited greater WTP relative to Other. In light of the small sample for this study, there is reason to consider the result an anomaly of the data, but further research is required to draw firm conclusions.

In model 16, the coefficient of -127.52 on the NOAA variable indicates that WTP was expected to be $127.52 lower if the survey occurred after 1992. The -0.125 coefficient on survey year in loglinear model 18 indicates that the WTP estimate is reduced by 0.13 percent for each year between 1982 and the year the survey took place. One possible explanation of this trend is that the publication of the NOAA panel findings standardized and tightened survey methods. Another possibility is that people's attitudes toward endangered species evolved negatively over this period as issues related to ESA enforcement and land policy disputes become more prominent in the news. I have encountered no studies of the change in values for environmental goods over this period, and the subject invites further research.

Both studies exhibit a positive and large coefficient for phone surveys. This suggests that respondents tend to state a larger WTP when surveyed over the phone rather than through in-person interviews. Linear model 16 estimates that a phone survey returns WTP $188.51 higher, and loglinear model 18 estimates WTP approximately 151% higher. It should be noted that this study database included few observations based on in-person interviews, and nearly all of those were conducted on-site with wildlife watchers. The effects of such interviews would be difficult to extract from that of surveying users. The Users variable was rarely significant in any model. The coefficients for Mail in both models are also positive, but they are insignificant and much smaller. The intuitive explanation for phone surveys leading to larger WTP estimates relative to mail surveys is that respondents may feel social pressure to report a higher WTP when interacting directly with someone on the phone. That intuition is somewhat confounded here, because in-person interviews would presumably have the same effect of creating social pressure to increase stated WTP, yet in-person interviews are estimated to produce the lowest WTP. The NOAA panel indicated that in-person interviews and phone surveys are preferred to mail surveys due to doubts that mail surveys would elicit reliable estimates (Arrow et al., 1993). It is unclear how these results relate to that recommendation.

The third variable that is significant in both studies is an indicator of using taxes as a payment vehicle rather than a donation or membership. Although it may seem counter-intuitive for people to prefer paying taxes to an alternative, this may have a sensible explanation. People are loath to give toward the public good when they suspect that free riders are likely to enjoy the benefits of the good without themselves giving. Moreover, people may not want to give generously toward a cause they fear will not get strong overall support, imagining themselves as a central benefactor of a minuscule fund that stands no chance of achieving the desired effect. Taxes are, of course, mandatory, and respondents are likely indicating their WTP if everyone does it, and if that means the goal can actually be achieved.

Table 6. Coefficient details for linear models

	Model																																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
C	~	~	~	~	~	~	~	~	~	~	X	~	X	~	~	~	X	X	~	~	~	~	X	X	~	~	~	~	~	~	~	~	~	~	~	~	X	X
Extinct	~	~	~	~	~	~	~	~	~	~	N	~													~													
Increase	~	~	~	~	~	~	~	~	~	~	~	~													~													
Decrease	~	~	~	~	~	~	~	~	~	~	~	~													~													
Pop																											~	~	~	~	~	~	~	~	~	~	N	
Land	~	~	~	~	~	~	~	~	N	N	~	~													~		~	~	~	~	~	~	~	~	N	N	~	
Phone							~	~	X	X	X	~	X	~	X	X	X	X							~	X							~	~	X	X	X	
Mail							~	~	~	~	~	~	~	~	~	~	~	~							~	~							~	~	~	~	~	
Fish	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~			~	~	~		~	~	~	~	~	~	~	
Bird	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~			~	~	~		~	~	~	~	~	~	N	
Marine Mam	~	~			~	~	~	~			~	~	~	~			~	~	~	~			~	~			~	~			~	~	~	~			~	
Mammal					~	~	~	~									~	~	~	~											~	~	~	~				
Othmam			~	~					~	~					~	~					~	~							~	~					~	~		
Mega	~		~		~		~		~		~		~		~		~		~		~		~		~	~	~		~		~		~		~		~	
NOAA			~	~	N	N					N	N			N	N			~	N	N	N				N			~	~	N	N					~	
Year	~	~					~	~	~	~			N	N			N	N					N	N	~		~	~					~	~	~	~		
State %	~	~			~	~			~	~			N	N			N	N			~	~				~	~	~			~	~			~	~		
Rrate	~	~	~				~	~	~				~	~	~				~	~	~				~		~	~	~				~	~	~			
State*New			~	~	X				~	~	~				~	~	~				~	~	~			~			~	~	X				~	~	~	
State*Maint			~	~	~				N	N	N				N	N	~				~	~	~			N			~	~	~				N	N	N	
New		~	~	~				~	~	~				~	~	~				X	~	~				~		~	~	~				~	~	~		
Maint		~	~	~				~	~	~				~	X	~				X	~	~				~		X	X	X				~	X	X		
Responses	~	~	~	~					N	N	~	~					~	~	~	~					~		~	~	~	~					N	N	~	
Tax	X	~					X	X	X	X					X	X	X	X					X	X		~	X	X					X	X	~	~		
One-time	~	~	~	~	~	~	~	~	~	~	~	~	~	X	X	X	~	~	~	~	~	X	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Multi	~	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Users	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Local	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	X	~	~	~	~	~	~	~	~	~	~	~	~	X	~	~	~	~	X	~
DC	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~

~ Indicates that the variable was present in the model and was not significant.

X Indicates that the variable was present and significant in the model with a positive coefficient.

N Indicates that the variable was present and significant in the model with a negative coefficient.

Table 7. Coefficient details for loglinear models

	Model																																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
C	X	X	X	X	X	X	X	X	X	X	X	X	~	X	X	X	X	X	X	X	X	X	X	X	~	X	X	X	X	X	X	X	X	X	X	X	X	X
Extinct	~	~	~	~	~	~	~	~	~	~	~	~													~													
Increase	~	~	~	~	~	~	~	~	~	N	~	~													~													
Decrease	~	~	~	~	~	~	~	~	~	~	~	~													~													
Pop																											~	~	~	~	~	~	~	~	~	~	~	
Land	~	~	~	~	~	~	~	~	N	N	~	~													~		~	~	~	~	~	~	~	~	N	N	~	
Phone							~	~	X	X	~	~	X	~	~	X	X	X							~	~							~	~	X	X	~	
Mail							~	~	~	~	~	~	~	~	~	~	~	~							~	~							~	~	~	~	~	
Fish	N	~	~	~	~	~	N	N	N	N	~	N	N	~	N	N	N	N	~	~	~	~	~	N			N	N	~		~	~	N	N	N	N	~	
Bird	~	~	~	~	~	~	~	~	~	N	~	~	~	~	~	~	N	N	~	~	~	~	~	~			~	~	~		~	~	N	~	N	N	~	
Marine Mam	~	~			~	~	~	~			~	~	~	~			~	~	~	~			~	~			~	~			~	~	~	~			~	
Mammal					~	~	~	~									~	~	~	~											~	~	~	~				
Othmam			~	~					~	~					~	~					~	~							~	~					N	N		
Mega	X		X		X		~		~		~		~		~		X		X		~		X		~	X	X		X		X		~		~		~	
NOAA			~	~	~	~					~	~			N	N			~	~	~	~				~			~	~	~	~					~	
Year	N	N					N	~	~	~			~	N			N	N					N	N	~		~	N					N	N	~	N		
State %	~	~			N	~			~	~			N	~			N	N			~	~				~	~	~			~	~			~	~		
Rrate	~	~	~				~	~	~				~	~	~				~	~	~				~		~	~	~				~	~	~			
State*New			~	~	X				~	~	~				~	~	~				~	~	~			~			~	~	X				~	~	~	
State*Maint			N	~	~				N	N	~				N	N	~				~	~	~			~			N	~	X				N	N	~	
New		~	X	X				~	~	~				X	~	~				X	~	~				~		~	X	X				~	~	~		
Maint		~	X	X				~	X	X				X	X	X				X	~	X				~		X	X	X				~	X	X		
Responses	~	~	~	~					~	~	~	~					~	~	~	~					~		~	~	~	~					~	~	~	
Tax	X	~					X	X	X	X					X	X	X	X					X	X		X	X	X					X	X	X	X		
One-time	~	~	~	X	X	X	~	~	~	~	~	X	X	X	X	X	~	~	~	X	X	X	~	~	~	~	~	~	~	X	~	~	~	~	~	X	~	~
Multi	X	~	X	~	X	~	~	~	~	~	X	~	X	~	~	~	X	~	X	X	X	X	X	X	X	X	X	~	X	X	X	X	~	~	~	~	X	X
Users	~	~	~	X	~	~	~	~	X	X	~	~	~	~	~	X	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	X	X	~	~
Local	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
DC	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	N	N	~	~	N	~	~	~	~	~	~	~	~	~	~	~

~ Indicates that the variable was present in the model and was not significant.

X Indicates that the variable was present and significant in the model with a positive coefficient.

N Indicates that the variable was present and significant in the model with a negative coefficient.

The analysis above is based on a look at the single best model in each model class. One can gain further understanding of the data trends by looking at the overall results of the models. Table 6 presents an overview of the coefficient estimations for the linear models, and Table 7 presents the estimations for the loglinear models.

Several of the models were allocated essentially zero weight in the weighted model, but their results add to the impression created by the chosen models.

Looking at the results for the linear models in table 6, we see that conducting the survey by phone, using taxes as a payment vehicle, and including protection of multiple species consistently had a significant positive effect on WTP. To a lesser degree, this was true of maintaining current land protections and asking for a one-time payment. Conducting the survey later in time, especially after the convening of the NOAA panel, and the interaction of in-state respondents with maintaining current land protections generally had a significant negative effect on WTP. To a lesser degree this is true of having the focus of the valued program be land protection, having more in-state respondents in general, and obtaining a higher number of responses to the survey.

Looking at the results for the loglinear models in table 7, we see that conducting the survey by phone, focusing on charismatic megafauna, maintaining current land protections, using taxes as a payment vehicle, asking for a one-time payment, and protecting multiple species generally had a significant positive effect on WTP. To a lesser degree, that is true of including new land protections and surveying those who have obvious use value for the species being protected. Protecting a fish species, conducting the survey later in time, and the interaction of in-state respondents with maintaining current land protections generally had a significant negative effect on WTP. That is true to a lesser degree of focusing on land protection, focusing on a bird species, surveying after the convening of the NOAA panel, and including more in-state respondents.

Significant variables generally maintained the same sign both within and between model classes. The only exception occurs in loglinear model 31, where the interaction of in-state respondents with maintaining current land protections was returned positive and significant. That model lacks the Maint variable, which was commonly positive, and the result is likely a consequence of the omitted variable. It is worth noting that model 31 was not allocated any weight by either information criterion.

Both classes of models returned the phone survey, multiple species, and tax payment vehicle indicators consistently positive and significant. The model classes intermittently returned the indicators for creating new land protections, maintaining current land protections, and asking for a one-time payment as significant and positive. Both classes of models consistently returned indicators for later surveys as significant and negative. The indicator for having a land protection focus, the in-state respondents variable, and the interaction of in-state respondents with maintaining current land protections were intermittently significant and negative in both model classes. Few models in either class found the question format to impact WTP significantly; only three of the less-weighted loglinear models found the DC indicator to be negatively significant.

The two classes of models return some of the same variables consistently significant, but there are some notable differences. The most prominent difference between the model classes is that the loglinear models consistently returned the fish species indicator as negatively significant and the megafauna indicator as positively significant, whereas none of the linear models found these variables to be significant.

It is somewhat surprising that neither program variables nor species variables were frequently significant. Of all of those, the fish species indicator was the only one to turn up significant frequently, and that only in one class of models. The most preferred models in both classes did not include program variables, and model 26, which was selected by both criteria for both model classes, lacked any species variables. As a group, those insignificant results suggest that respondents' WTP was insensitive to most details of the preservation program offered.

EWTP Scenarios

Three scenarios were created in order to simulate a distribution of observations from which we can obtain an estimate and confidence interval for WTP following the methods described. In all these scenarios the variables related to study execution are set to the same values. These values could be varied for the purpose of exploring how study execution affects the resultant WTP, but we focus here on how variation in the species protection program to be valued affects WTP. Therefore, in all scenarios the hypothetical payment is to be made annually, 50 percent of the respondent pool comprises residents of the state where the program would be implemented and 50 percent is drawn nationally, the survey uses discrete choice methods, the response rate is set to 57.8 percent and the response number to 322, the mean values for the sample. The year of the survey is set at 2001, the latest year any survey included in the data was conducted. Overall, the baseline attribute values are well within the range of the experimental design.

Scenario 1: Increase the Population of Chinook Salmon

In scenario 1, survey respondents are asked to value a program with the primary promised result being to increase the population of Northwest Chinook salmon from its current level. Although it is not the primary focus of the study, it is explicitly stated in the program description that one use of funds generated by the program will be maintenance of current protective land use restrictions.

Scenario 2: Prevent the Extinction of Orca Whales

In scenario 2, survey respondents are asked to value a program with the primary promised result being to prevent the extinction of Orca whales. The program includes no explicit references to land (or sea) use restrictions or policies.

Scenario 3: Preserve Old-Growth Forest for the Northern Spotted Owl

In scenario 3, survey respondents are asked to value a program aimed at protecting the Northern spotted owl by imposing new restrictions and protections on old-growth forests in order to maintain habitat. The program description does not offer explicit population outcomes, but instead focuses on the nature of the preservation efforts.

Scenario Results

For each scenario and each selection criterion, the model-averaged EWTP was calculated for both the linear and loglinear classes of models. Each model was represented among the total pool of observations according to the weight it received under that model criterion. For example, a simulation based on Model 16 provided 81.3 percent of the observations used to generate the EWTP confidence interval for the linear models under the AICc criterion. Table 8 shows the EWTP's and confidence intervals for the linear models, and Table 9 shows the results of the loglinear models. The tables show the EWTP's and confidence intervals for the models that were allocated weight by either criterion. The last two rows in each table show the weighted EWTP for the AICc and the BIC.

Linear Model EWTP

Looking at the collective linear model results in table 8, we see generally sensible point estimates of WTP, though several models estimate a negative WTP for scenarios 1 and 3. The AICc and BIC weighted estimates are fairly similar. Both criteria provide a negative WTP estimate for scenario 1. The BIC provides a tighter confidence interval for scenario 1 (S), and the AICc provides a tighter interval for scenarios 2 (O) and 3 (N). There is considerable variability in the estimates of WTP both within scenarios and between them. Given the relatively small number of studies and observations for this meta-analysis, such variability is not surprising.

Table 8. Linear model WTP for selected models

Model	**S**	S-95%	S+95%	**O**	O-95%	O+95%	**N**	N-95%	N+95%
9	**47.78**	-83.76	179.87	**686.74**	388.55	977.11	**-69.57**	-194.31	55.46
10	**-3.14**	-101.19	95.41	**586.89**	347.63	825.69	**-89.96**	-209.75	30.04
15	**-27.75**	-99.82	44.26	**129.79**	54.83	204.44	**47.81**	-22.09	117.83
16*	**-24.92**	-88.87	39.06	**140.73**	67.40	213.88	**41.05**	-26.14	108.18
17	**63.04**	-30.57	146.22	**93.61**	27.65	148.42	**74.71**	-6.04	159.06
18	**46.56**	-37.01	129.65	**116.07**	60.56	170.14	**50.24**	-25.88	126.74
26	**56.08**	-22.57	134.46	**88.73**	29.48	147.70	**106.60**	50.97	162.29
36	**22.99**	-78.45	125.86	**326.60**	164.66	489.60	**-32.66**	-156.37	91.19
AICc weighted	**-16.78**	-75.59	78.30	**132.22**	65.02	198.53	**48.41**	-12.59	122.21
BIC weighted	**-21.87**	-88.86	73.10	**143.85**	65.14	675.04	**38.57**	-110.47	114.27

Notes: The bold columns are the expected values for the S (Salmon), O (Orca), and N (Northern spotted owl) scenarios. The -95% column is the value greater than 5% of the results of the Monte Carlo simulation, and the +95% column is the value greater than 95% of the Monte Carlo simulation results.

* Denotes preferred model under both criteria.

Both criteria allocate the vast majority of the weight to model 16, which provides one of the tighter estimates of WTP of any model for each of the three scenarios. The AICc criterion also allocates significant weight to model 26. While model 26 provides relatively tight confidence intervals, those intervals only partially overlap with the corresponding confidence intervals of model 16. The AICc weighted confidence interval is therefore in all cases larger than that of either model 16 or model 26 although together they account for 95.5 percent of the AICc estimate weight. The BIC criterion allocates nearly a quarter of the weight to its second choice, model 10 one of the most variable of the models. Moreover, the BIC spreads the weight among more models, and the BIC weighted confidence interval is correspondingly larger than that of the AICc.

The EWTP results for scenario 2 are greater than those of both the other scenarios. This is not a surprising result, as the coefficient for marine mammals is large and positive in most models, whereas the coefficients for birds and fish are negative in most models. Furthermore, the program valued in scenario 2 indicates it will prevent the extinction of the species, which also carries a positive coefficient. As a result, the confidence intervals for scenario 2 are all greater than zero, and both weighted estimates predict a significantly positive WTP.

Loglinear Model EWTP

Looking at the results from the loglinear models in Table 9, it is important to note that the results of this loglinear estimation are constrained to be greater than zero. This constraint is justified by the assumption that people's WTP for endangered species protection by itself is zero or greater. Experience shows us that many people have values that conflict with endangered species survival in some cases. We can justifiably assume that they are not opposed to the survival of the species when those conflicts are otherwise accounted for, but these results are WTP estimates for programs complete with their human consequences. Respondents who would be directly impacted by programs might have a negative WTP for them, meaning that they would need to be compensated to restore them to their original level of utility. It is reasonable, however, to expect the WTP estimates of this meta-analysis to be positive for most scenarios, considering that all studied observations report positive WTP.

Table 9. Loglinear model WTP for selected models

Model	S	S-95%	S+95%	O	O-95%	O+95%	N	N-95%	N+95%
9	**13.96**	2.92	66.55	**4948.86**	150.95	1.586 e5	**11.19**	2.48	49.97
10	**6.41**	1.86	22.03	**2926.29**	144.30	57581.00	**10.16**	2.25	45.12
15	**22.58**	9.05	55.90	**142.21**	53.62	371.55	**91.91**	36.68	223.53
16	**16.90**	7.21	40.12	**164.76**	62.11	447.72	**70.70**	27.11	176.45
17	**20.97**	2.82	156.38	**109.92**	26.03	462.64	**40.00**	7.18	226.78
18*	**19.90**	8.01	49.33	**88.37**	48.71	161.16	**34.37**	14.97	78.74
23	**34.40**	15.60	75.58	**112.65**	48.15	263.38	**69.41**	33.71	143.93
24	**21.02**	9.87	44.36	**88.63**	38.75	202.18	**40.36**	20.05	80.78
26	**54.89**	19.84	144.79	**103.37**	49.50	229.29	**118.90**	58.99	214.87
27	**36.07**	8.06	167.67	**109.35**	28.64	459.72	**62.32**	21.52	182.93
33	**10.99**	2.06	56.83	**40.02**	13.49	117.30	**57.60**	18.97	179.29
34	**7.57**	1.86	32.41	**41.70**	12.90	133.59	**52.87**	15.67	169.73
35	**19.20**	4.48	82.79	**1124.20**	160.53	1117.70	**15.19**	3.48	66.58
36	**9.24**	2.82	30.40	**613.77**	94.56	4053.00	**15.10**	3.57	64.69
AICc weighted	**20.35**	7.41	55.55	**89.04**	44.67	182.09	**35.72**	14.74	97.29
BIC weighted	**18.62**	4.34	70.57	**107.50**	38.41	3026.50	**34.27**	6.05	132.92

Notes: The bold columns are the median values for the S (Salmon), O (Orca), and N (Northern spotted owl) scenarios. The -95% is the value greater than 5% of the results of the Monte Carlo simulation, and the +95% is the value greater than 95% of the Monte Carlo simulation results. Note that loglinear models are constrained to positive numbers.

* Denotes preferred model under both criteria

The loglinear models also display considerable variability in the estimates of WTP both within and between scenarios. The estimates for scenario 2 are generally larger than those of the other scenarios, though there is considerable overlap between the results. The lower bound of the AICc weighted confidence interval for scenario 2 is greater than the higher bound of the confidence interval for scenario 1, which means that criterion predicts a significantly greater WTP for scenario 2.

Table 10. Model-averaged EWTP of linear and loglinear models

Model Type	Criterion	S	S-95%	S+95%	O	O-95%	O+95%	N	N-95%	N+95%
Linear	AICc	**-16.78**	-75.59	78.30	**132.22**	65.02	198.53	**48.41**	-12.59	122.21
Log	AICc	**20.35**	8.91	46.69	**89.04**	51.17	157.98	**35.72**	17.08	80.69
Linear	BIC	**-21.87**	-78.09	49.41	**143.85**	77.68	550.95	**38.57**	-62.98	101.34
Log	BIC	**18.62**	5.83	53.11	**107.50**	48.65	1823.40	**34.27**	8.38	105.00

Notes: The bold columns are the expected values for the S (Salmon), O (Orca), and N (Northern spotted owl) scenarios. The “-95%” and the “+95%” are the lower and upper bounds of the confidence interval, respectively. Note that loglinear models are constrained to positive numbers.

Table 10 compares the model-averaged estimates and confidence intervals of the linear and loglinear models. Loglinear estimation has the potential for explosive estimates of variance after the results are exponentiated to get linear translations, and thus the very largest loglinear confidence interval estimates we encounter are much larger than those of the linear models. While the weighted loglinear confidence intervals for scenarios 1 and 3 are tighter than those of the linear models under both criteria, the loglinear BIC weighted confidence interval for scenario 2 is much larger than that of the linear version. The loglinear AICc weighted confidence interval for scenario 2 is tighter than that of the linear version. The wide confidence interval of the loglinear BIC occurs because the loglinear confidence intervals for models 9, 10, 35, and 36 on scenario 2 are much larger than those of their linear counterparts. Those models are allocated weight only by the BIC criterion, so the loglinear BIC weighted confidence interval is much larger.

Preferred Criterion and Model Class

The AICc criterion allocated weight to fewer models than the BIC in both the linear and loglinear model classes. Those models selected by the AICc also tended to provide tighter confidence intervals of EWTP than those selected only by the BIC. As a result, the AICc weighted confidence interval was tighter than that of the BIC in five of the six scenarios across the two model classes. In this analysis, the AICc is therefore the preferred information criterion. This contrasts with the evaluation of the Layton and Lee model-averaging study (2006). The most likely explanation is that this study is based on a small dataset, whereas theirs was based on a much larger one. Other explanations may exist, but that is a matter for future analysis.

Overall, the loglinear models seem to outperform the linear ones. The average adjusted R-squared is higher for the linear models, but the weighted estimate of the AICc, the preferred criterion, provides tighter confidence intervals for the loglinear models in all three scenarios. The loglinear models produce sensible WTP estimates in each of the three scenarios examined here, though it is worth noting again that such models constrain WTP to be greater than zero.

Discussion and Conclusion

Pursuing the model-averaging approach enabled the examination of a broad range of models in this meta-analysis. Furthermore, it offered an effective way of handling the research quandary of seeking a good fitting model that also yields “sensible” estimates of WTP (Layton and Lee, 2006). Traditional exploration for a single model would likely have led through several of the models examined here before settling on one or two for presentation. Models 9 and 10 generated the highest adjusted R-squared numbers (and the lowest log-likelihoods) of all models, but they included more variables and generated broader confidence intervals of EWTP. Models 16 and 18, the preferred models among the linear and loglinear classes, respectively, offered less overall explanatory power, but they were more parsimonious and provided tighter estimates of WTP. The model-averaging approach was a systematic method for arriving at those observations, and it makes the model selection process evident to the reader.

Comparison of WTP Estimates with Original Study Estimates

We can get some sense of how the loglinear AICc weighted model performs by comparing the EWTP results to those of contingent valuation studies of the species used for these scenarios, with all values in 2006 dollars. The loglinear AICc weighted EWTP’s for the salmon, orca, and Northern spotted owl scenarios were $20.35, $80.94, and $35.72, respectively. Stevens et al. (1991) found that Massachusetts residents were willing to pay approximately $10 to prevent Atlantic salmon from going extinct in the state. Samples et al. (1986) found the WTP of students in Hawaii for a program to protect humpback whales to be $80, and Giraud et al. (2002) showed that an even mixture of Alaskan and nationwide residents would value new programs and restrictions to protect the Steller sea lion at $77. Loomis and Gonzalez-Caban (1998) found a WTP of $76 to protect spotted owl habitat from fire, and Rubin et al. (1991) found the WTP of Washington households to ensure continued survival of the Northern spotted owl to be $88.

The salmon estimate of the loglinear AICc is higher, the marine mammal estimate is very similar, and the spotted owl estimate is considerably lower than the results of their corresponding valuation studies. It is interesting to note that the experimental results for the spotted owl are higher relative to the WTP results for other charismatic species than one might expect from a small bird that is rarely seen. One could speculate that the spotted owl valuation is inextricably tied to values of the old-growth forest habitat it has come to symbolize, and it is not surprising that a general system would produce a lower estimate than specific experimental results. The weighted model confidence intervals for the scenario EWTP’s are larger than those of the corresponding original studies, which was to be expected. Firstly, a general equation is intuitively going to be less exact than a specific one. Secondly, these estimates are based on the small sample of existing contingent valuation studies, not hundreds of survey responses.

Comparing Results with Loomis and White

Overall, these meta-analysis model results confirm earlier findings that endangered species CV studies can provide estimates that are sensitive to frequency of payment and insensitive to WTP question format (Loomis and White, 1996) and that respondents value protection of multiple species more than that of a single species (Giraud et al., 1999).

The model results also indicate that WTP results decreased significantly over the period represented by the studies in the sample. That would also result in studies produced over the convening of the NOAA panel to find lower WTP than those conducted before it; however, rolling window regressions of these studies indicate that drawing a line between studies produced before and after the three year period spanning the convening of the NOAA panel and the publication of its findings best explained WTP, which suggests its recommendations had a significant effect. Some of these findings contrast with those of Loomis and White (1996). They found that the year of the CV study had no significant effect on WTP.

One possible explanation of the differing findings is that their meta-analysis was conducted soon after the publishing of the NOAA panel findings and thus included almost exclusively studies that pre-dated its recommendations. The subject merits further research. Also in contrast, these results rarely found that focusing on those studies with a use value for the species had a significant effect on WTP. Few of the included studies focused on users, however, and one should hesitate to draw conclusions about the effects of use values on overall WTP.

Policy Implications

Focus on Equity

If the positive effect of using taxes as a payment vehicle on WTP is indeed explained by respondents' desire to avoid being the only one to pay for protection of the species, it strongly reinforces what policy makers already know: equity of burdens and benefits is a central issue in policy acceptance. People indicate that they are willing to pay for species protection, both in CV study responses and in ongoing political support for the ESA. We must acknowledge, however, that if the WTP of every respondents to a survey about a hypothetical situation is significantly affected by concerns about bearing an equitable share of the burden, then the passions that arise in real-world situations are understandable and perhaps unavoidable. Those who face land-use restrictions if endangered species are discovered on their property face real, and potentially large, economic costs. The lost income hurts, but perhaps the perceived unfairness of the outcome adds insult to injury.

Numerous programs exist that seek to distribute across society the burdens on private landowners of protecting endangered species (Wagner et al., 1997). Chambers and Whitehead (2003) examine the example of the Wolf Damage Management Plan in Minnesota. In their study, respondents indicated a similar WTP for reimbursing landowners who suffered wolf damages and for general efforts to protect wolves. The federal government also sought to ease the burden of ESA-driven logging restrictions on rural communities through the Secure Rural Schools funding initiative (Omnibus Budget Reconciliation Act, 1993). Taxpayers reasonably expect such assistance to end as people have time to adjust, however, and recent issues with the sunsetting of the Secure Rural Schools funding hint that such programs may simply delay the pain. The issue defies simple solution. These findings confirm that equity concerns should continue to be central to the search for effective, accepted policies.

Species Symbolism and the Coarse-Filter Approach

A survey of these studies reveals plainly different types of protection programs that are all grouped together under species protection. Simply creating a fund to promote the protection of a species is quite different from guaranteeing its survival, doubling its population, or specifically creating new land restrictions in the name of protecting it. Despite those differences, we speak of such studies as if they are measuring the same core value, and these results suggest that is an acceptable generalization.

Program focus variables rarely turned out significant, and the best-fitting models omitted program variables entirely. One explanation for this is that people are not that sensitive to program details when reporting their WTP. These results also suggest that WTP is relatively insensitive to the type of species being protected. Loomis and White (1996) found that CV respondents were sensitive to the size of change described in the survey. A review of the available studies used in their analysis, however, reveals a collection of vaguely stated outcomes of distinctly varying types. The Loomis and White change size variable was based on numerous different effects, such as odds of surviving, species population numbers, or area of preserved habitat, as well as others that included no clear effect from which to measure size of change. The most similar variable in this study to Loomis and White's change size is the indicator for protection of multiple species, which was consistently significant and positive. One might interpret that as further evidence that respondents are sensitive to the scale of the promised effects.

Each of us occupies a subjective universe, and people are stating their WTP for an internal representation that lies at some degree of abstraction from the specific program described in the CV study survey. Based on these results, we can generally say that internal representation is sensitive to the scale of the effects, but is relatively insensitive to the specific species and the specific program. It is therefore quite understandable that disputes over endangered species protection have so often served as proxies for other issues.

As the spotted owl controversy has illustrated, species protection ends up being the focus of much broader sentiments and a tool for ulterior motives. Across the United States, conservationists pushed for the protection of the previously little-known bird. It was commonly understood that the fight was really over disappearing old-growth forest ecosystems, but old-growth forest does not qualify for ESA protection. The coarse filter approach to conservation takes a larger-scale view of ecosystem health. That view acknowledges the interrelated nature of ecology. Based on the idea that a species cannot be considered in isolation from the relationships that form its role in the ecosystem, and species protection is best achieved by focusing on biodiversity and maintenance of ecological processes (Hunter, 1991).

Using species protection as a proxy for broader conservation causes is inherent to the power and specific focus of the ESA. Species population stability is just one measure of ecosystem health, and the ESA represents a fine filter aimed at preserving that one (admittedly essential) aspect. A coarse filter focused on overall ecosystem health might more accurately reflect the environmental values behind people's stated values for species preservation. A coarse filter is reflective of the holistic nature of ecology and does not require us to understand precisely what we value in the survival of a species. It also makes explicit that we value ecosystem health rather than species in isolation.

Few species listed under the ESA have gone extinct, but many experts agree that recovery efforts have had disappointing results despite enormous expenses (Skoloff, 2007). Coarse filter advocates have argued that the fine-filter, single-species recovery approach embodied by the ESA is doomed to fail, and that a larger-scale focus on maintaining ecosystems within the natural range of variability should replace it (Franklin, 1993). Within such an approach, species are indicators of ecosystem health rather than the central focus of management efforts (Haufler, 1996). Recognizing the ironic tragedy of sacrificing species to extinction along the path to improved ecosystem health, some have proposed that fine filter approaches such as the ESA complement coarse filter approaches by acting as a safety net to species that slip through more broadly-focused management efforts (Tracy and Brussard, 1994). The challenge to pursuing any of these approaches is that the ESA is the primary driving force behind so many ecosystem management imperatives, and it mandates a fine filter approach.

Policy changes must obviously be feasible in the current setting. The ESA is a high-water mark for environmental protection, and conservationists recognize that a similar level of protection would not likely result from the replacement of the ESA with legislation aimed at broader ecosystem health (Tracy and Brussard, 1994). There is little reason to expect coarse filter environmental legislation to replace the ESA anytime soon. These results suggest, however, that the coarse filter approach reflects people's environmental values more than might be inferred from its absence from prominent conservation legislation.

The Benefits of Model-Averaged Meta-Analysis

The model-averaging approach was effective at handling the uncertainty regarding the best model for this meta-analysis. The full range of models examined is presented for the reader. The reader thus has considerable insight into the analysis process of this study and is now free to accept the preferred weighted estimate, the loglinear AICc, or to choose one of the constituent models. Moreover, the full picture of the coefficient results lends added confidence to the identification of significant variables. It is in a sense a meta-meta-analysis. Variables that are significant in numerous, significantly different models are more convincingly significant. While any conclusions drawn are plainly a product of the small sample of original studies, one can feel confident that numerous approaches to these studies would produce similar results.

Opportunities for Further Research

This exploratory research suggests several questions for further inquiry. The negative time trend in WTP observed across these studies merits further investigation into its causes—survey techniques, economic conditions, and public attitudes have all changed significantly during that time. It would also be interesting to examine how perceptions of equity affect WTP, both as regards species protection and more generally. Lastly, the field of ecosystem conservation might benefit from research into public preferences regarding the coarse filter approach. Debate about the approach's merits continues among experts, and the views of the general public merit recognition.

References

Adamowicz, Wiktor, et al. “Stated preference approaches for measuring passive use values: Choice experiments and contingent valuation.” *Amer. J. Agr. Econ*. 80 (February 1998): 64-75.

Arrow, K., et al. “Report of the NOAA panel on contingent valuation.” *Federal Register* 58, no. 10 (1993): 4602-14.

Bishop, Richard C., et al. “Toward total economic valuation of Great Lakes fisher resources.” *Transactions of the American Fisheries Society* 116 (1987): 339-345.

Bowker, J. M., and J. R. Stoll. “Use of dichotomous choice nonmarket methods to value the whooping crane resource.” *American Journal of Agricultural Economics* 70, no. 2 (May 1988): 372-381.

Boyle, Kevin J., and R. C. Bishop. “Valuing wildlife in benefit-cost analyses: a case study involving endangered species.” *Water Resources Research* 23, no. 5 (May 1987): 943-950.

Brookshire, David S. et al. “Estimating option prices and existence values for wildlife resources.” *Land Economics* 59, no. 1 (1983): 1-15.

Buckland, S. T., et al. “Model selection: an integral part of inference.” *Biometrics* 53, no. 2 (June 1997): 603-618.

Carson, Richard T., and R. C. Mitchell. “Sequencing and nesting in contingent valuation surveys.” *Journal of Environmental Economics and Management* 28 (1995): 155-173.

Carson, Richard T., et al. “Temporal reliability of estimates from contingent valuation.” *Land Economics* 73, no. 2 (May 1997): 151-163.

Chambers, Catherine M., and J. C. Whitehead. “A contingent valuation estimate of the benefits of wolves in Minnesota.” *Environmental and Resource Economics* 26 (2003): 249-267.

Coursey, Don L. “The revealed demand for a public good: evidence from endangered and threatened species.” University of Chicago Working Paper Series 94.2 (January 1994).

Cummings, Ronald G., et al. “Substitution effects in CVM values.” *Amer. J. Agr. Econ.* 76 (May 1994): 205-214.

Cummings, Ronald G., et al. “Homegrown values and hypothetical surveys: is the dichotomous choice approach incentive compatible?” *The American Economic Review* (1995).

Davis, Robert K. “Recreation planning as an economic problem.” *Nat. Resources J.* 3 (1963): 239:249.

Ekstrand, Earl R., and J. Loomis. “Incorporating respondent uncertainty when estimating willingness to pay for protecting critical habitat for threatened and endangered fish.” *Water Resources Research* 34, no. 11 (1998): 3149-3155.

Frederick, Shane, and B. Fischhoff. “Scope (in)sensitivity in elicited valuations.” *Risk Decision and Policy* 3, no. 2 (1998): 109-123.

Franklin, Jerry F. “Preserving biodiversity: species, ecosystems, or landscapes?” *Ecological Applications* 3 (1993): 202-205.

Freeman, A. Myrick, III. <u>The Measurement of Environmental and Resource Values</u>. Washington, DC: RFF Press, 2003.

Garber-Yonts, B., et al. “Public values for biodiversity conservation in the Oregon Coast Range.” *Forest Science* 50, no. 5 (2003): 589-601.

Giraud, K. L. et al. “Internal and external scope in willingness-to-pay estimates for threatened and endangered wildlife.” *Journal of Environmental Management* 56 (1999): 221-229.

Giraud, K. L., et al. "A comparison of willingness to pay estimation techniques from referendum questions." *Environmental and Resource Economics* 20 (2001): 331-346.

Giraud, K. L., et al. "Economic benefit of the protection program for the Steller sea lion." *Marine Policy* 26 (2002): 451-458.

Glass, G. V. "Primary, secondary, and meta-analysis of research." *Educational Research* 5 (1976): 3-8.

Greene, William H. Econometric Analysis. India: Dorling Kindersley (India) Pvt. Ltd., 2003.

Hagen, Daniel A. et al., "Benefits of preserving old-growth forests and the spotted owl." *Contemporary Policy Issues* X (April 1992): 13-26.

Hailu, Atakelty, et al. "Complements, substitutes, budget constraints and valuation." *Environmental and Resource Economics* 16 (2000): 51-68.

Haufler, J. B. et al. "Using a coarse-filter approach with species assessment for ecosystem management." *Wildlife Society Bulletin* 24 (1996): 200-208.

Hunter, M. L. "Coping with ignorance: the coarse filter strategy for maintaining biodiversity." Balancing on the Brink of Extinction, K. A. Kohm, K ed. Washington DC: Island Press, 1991.

Hurvich, Clifford M., and C. Tsai. "Regression and time series model selection in small samples." *Biometrika* 76, no. 2 (June 1989): 297-307.

Jakobsson, Kristin M., and A. K. Dragun. Contingent Valuation and Endangered Species: Methodological Issues and Applications. Brookfield, VT: Edward Elgar Publishing Company, 1996.

Jakobsson, Kristin M., and A. K. Dragun. "The worth of a possum: valuing species with the contingent valuation method." *Environmental and Resource Economics* 19 (2001): 211-227.

Kay, David L. et al. "The economic benefits of the restoration of Atlantic salmon to New England Rivers." Draft report, Department of Natural Resources, NY State College of Agriculture and Life Sciences, Cornell University, NY (1987).

Kahneman, D. and J. L. Knetsch. "Valuing public goods: the purchase of moral satisfaction." *Journal of Environmental Economics and Management* 22 (1992): 57-70.

Koop, Gary, and L. Tole. "Measuring the health effects of air pollution: to what extent can we really say that people are dying from bad air?" *Journal of Environmental Economics and Management* 47 (2004): 30-54.

Kotchen, Matthew J., and S. D. Reiling. "Environmental attitudes, motivations, and contingent valuation of nonuse values: a case study involving endangered species." *Ecological Economics* 32 (2000): 93-107.

Krinsky, Itzhak, and A. L. Robb. "On approximating the statistical properties of elasticities." *The Review of Economics and Statistics* 68, no. 4 (November 1986): 715-719.

Kroeger, Timm, et al. "Reintroduction of the Mexican wolf (Canis lupus baileyi) to the Southwestern United States: an economic perspective." Paper presented at *18th Annual North American Wolf Conference* (April 2006): Chico Hot Springs, MT.

Layton, David F., and S. T. Lee. "Embracing model uncertainty: strategies for response pooling and model averaging." *Environmental and Resource Economics* 34 (2006): 51-85.

Leon, R., and C. J. Leon. "Single or double bounded contingent valuation? A Bayesian test." *Scottish Journal of Political Economy* 50, no. 2 (2003): 174-188.

Loomis, John B. "Vertically summing public good demand curves: an empirical comparison of economic versus political jurisdictions." *Land Economics* 76, no. 2 (May 2000): 312-321.

Loomis, John B., and A. Gonzalez-Caban. "A willingness-to-pay function for protecting acres of spotted owl habitat from fire." *Ecological Economics* 25 (1998): 315-322.

Loomis, John B., et al. "Willingness to pay to protect wetlands and reduce wildlife contamination from agricultural drainage." The Economics and Management of Water and Drainage. A. Dinar and D. Zilberman Eds. Kluwer Academic, 2003.

Loomis, John B., and D. S. White. "Economic benefits of rare and endangered species: summary and meta-analysis." *Ecological Economics* 18 (1996): 197-206.

Mitchell, R. and R. Carson. Using Surveys to Value Public Goods: The Contingent Valuation Method. Washington, DC: Resources for the Future, 1989.

Moeltner, Klaus, et al. "Meta-analysis and benefit transfer for resource valuation: addressing classical challenges with Bayesian modeling." *Journal of Environmental Economics and Management* 53, no. 2 (2007): 250-269.

Montgomery, Claire, and G. M. Brown, Jr. "Economics of species preservation: the spotted owl case." *Contemporary Policy Issues* X (April 1992): 1-12.

Olsen, Daryll, et al. "Existence and sport values for doubling the size of Columbia River Basin salmon and steelhead runs." *Rivers* 2 (1991): 44-56.

Pate, Jennifer, and J. Loomis. "The effect of distance on willingness to pay values: a case study of wetlands and salmon in California." *Ecological Economics* 20 (1997): 199-207.

Payne, John W., et al. "Valuation of multiple environmental programs." *Journal of Risk and Uncertainty* 21, no. 1 (2000): 95-115.

Randall, Alan, and J. R. Stoll. "Existence value in a total valuation framework." Managing Air Quality and Scenic Resources at National Parks and Wilderness Areas. R. D. Rowe and L. G. Chestnut, eds. Boulder, CO: Westview Press, 1983.

Randall, Alan, et al. "Bidding games for valuation of aesthetic environmental improvements." *Journal of Environmental Economics and Management* 1, no. 2 (1974): 132-149.

Rubin, J., et al. "A benefit-cost analysis of the Northern spotted owl." *Journal of Forestry* 89 (1991): 25-30.

Salzman, James and B. H. Thompson, Jr., Environmental Law and Policy. New York: Foundation Press, 2003.

Samples, K. C., and J. R. Hollyer. "Contingent valuation of wildlife resources in the presence of substitutes and complements." Economic Valuation of Natural Resources: Issues, Theory, and Application. R. L. Johnson and G. V. Johnson eds. Boulder, CO: Westview Press, 1989.

Samples, K. C., et al. "Information disclosure and endangered species valuation." *Land Economics* 62, no. 3 (August 1986): 306-312.

Simon, Carl P., and L. Blume. Mathematics for Economists. New York: W. W. Norton & Company, 1994.

Skoloff, Brian. "Endangered Species Act working, but broken, experts say." *Miami Herald* (August 11, 2007). Retrieved August 16, 2007 from http://www.miamiherald.com/.

Smith, V. Kerry, and Y. Kaoru. "Signals or noise? Explaining the variation in recreation benefit estimates." *American Journal of Agricultural Economics* 72, no. 2 (May 1990): 419-433.

Smith, V. Kerry, and S. K. Pattanayak. "Is meta-analysis a Noah's Ark for non-market valuation?" *Environmental and Resource Economics* 22 (2002): 271-296.

Solomon, Barry D., et al. "The Florida manatee and eco-tourism: toward a safe minimum standard." *Ecological Economics* 50 (2004): 101-115.

Stevens, Thomas H., et al. "Measuring the existence value of wildlife: What do CVM estimates really show?" *Land Economics* 67(4) (1991): 390-400.

Stevens, Thomas H., et al. "Comparison of contingent valuation and conjoint analysis in ecosystem management." *Ecological Economics* 32 (2000): 63-74.

Tracy, C. Richard, and P. F. Brussard. "Preserving biodiversity: species in landscapes." *Ecological Applications* 4, no. 2 (May 1994): 205-207.

Van den Bergh, J. C. J. M., et al. Meta-Analysis in Environmental Economics. Netherlands: Kluwer Academic Publishers, 1997.

Venkatachalam, L. "The contingent valuation method: a review." *Environmental Impact Assessment Review* 24 (2004): 89-124.

Vig, Norman J., and M. E. Kraft. Environmental Policy: New Directions for the Twenty-First Century. Washington, DC: CQ Press, 2003.

Watts Reaves, Dixie, et al. "Does question format matter? Valuing an endangered species." *Environmental and Resource Economics* 14 (1999): 365-383.

Whitehead, John C. "Ex ante willingness to pay with supply and demand uncertainty: implications for valuing a sea turtle protection programme." *Applied Economics* 24 (1992): 981-988.

Appendix A. Details of Included and Excluded Observations

Table A1. Details of included studies

Study	Species	Mega	Multi	Model type	WTP	2006 WTP	Rrate	Rnum	Survey method	Survey year	Region	Certainty	Chgsize Abs	Chgsize Prop.	One time	Pmt. Veh.	Users	Status	Land Use Change	Focus
Adamowicz et al. (1998)	Woodland caribou	1	0	DC	$141.80	$187.58	65%	402	Phone	1995	Canada	"small risk"	400 to 600	50	0	Tax	0	Thrt.	wilderness reserve	Increase
Bishop et al. (1987)	Bald eagle	1	0	DC	$75.31	$146.13	89%	220*	Mail	1984	Midwest	certain	vague	100	0	Memb.	1	Endng.	None stated	Extinction
Bishop et al. (1987)	Bald eagle	1	0	DC	$18.02	$34.96	89%	220*	Mail	1984	Midwest	certain	vague	100	0	Memb.	0	Endng.	None stated	Extinction
Bishop et al. (1987)	Bald eagle	1	0	DC	$11.84	$22.97	73%	176*	Mail	1984	Midwest	certain	vague	100	0	Memb.	0	Endng.	None stated	Extinction
Bishop et al. (1987)	Bald eagle	1	0	DC	$28.38	$55.07	89%	220*	Mail	1984	Midwest	certain	vague	100	0	Memb.	1	Endng.	None stated	Extinction
Bishop et al. (1987)	Bald eagle	1	0	DC	$30.78	$59.72	89%	220*	Mail	1984	Midwest	certain	vague	100	0	Memb.	0	Endng.	None stated	Extinction
Bishop et al. (1987)	Bald eagle	1	0	DC	$25.97	$50.39	73%	176*	Mail	1984	Midwest	certain	vague	100	0	Memb.	1	Endng.	None stated	Extinction
Bishop et al. (1987)	Bald eagle	1	0	DC	$10.62	$20.61	73%	176*	Mail	1984	Midwest	certain	vague	100	0	Memb.	0	Endng.	None stated	Extinction
Bishop et al. (1987)	Bald eagle	0	0	DC	$5.66	$10.98	89%	435	Mail	1984	Midwest	certain	vague	100	0	Memb.	0	Endng.	None stated	Extinction
Bishop et al. (1987)	Bald eagle	0	0	DC	$4.16	$8.07	73%	365*	Mail	1984	Midwest	certain	vague	100	0	Memb.	0	Endng.	None stated	Extinction
Bowker & Stoll (1988)	Whooping crane	1	0	DC	$21.93	$44.39	67%	536*	On-site	1983	TX	certain	vague	100	0	Memb.	1	Endng.	New refuge land	Extinction
Bowker & Stoll (1988)	Whooping crane	1	0	DC	$34.41	$69.65	36%	495*	Mail	1983	US	certain	vague	100	0	Memb.	0	Endng.	New refuge land	Extinction
Chambers & Whitehead (2003)	Gray wolf	1	0	DC	$67.00	$76.31	56%	352	Mail	2001*	Midwest	certain	1600	vague	1	Tax	0	Endng.	Land maint	Program
Giraud et al. (1999)	Mexican spotted owl	0	0	DC	$48.01*	$60.30	54*%	385	Mail	1997	SW	vague	unstated	unstated	0	Tax	0	Thrt.	None stated	Program
Giraud et al. (1999)	62 species, incl. MSO & 39 plants	0	1	DC	117.84*	$148.02	54*%	369	Mail	1997	SW	vague	unstated	unstated	1	Tax	0	Thrt.	None stated	Program
Giraud et al. (2002)	Steller sea lion	1	0	DC	$40.41	$47.31	70%	387*	Mail	2000	AK	Vague	unstated	unstated	0	Tax	0	Endng.	New fishing restrictions	Land
Giraud et al. (2002)	Steller sea lion	1	0	DC	$100.22	$117.33	51%	282*	Mail	2000	US	Vague	unstated	unstated	0	Tax	0	Endng.	New fishing restrictions	Land
Giraud et al. (2001)	9 species of fish	0	1	DC	$164.19	$210.97	54%	715	Mail	1996	US	Vague	vague	vague	0	Tax	0	Endng.	Maintain CHUs	Land
Kotchen & Reiling (2000)	Peregrine falcon	1	0	DC	$25.79	$32.39	63%	317*	Mail	1997	NE	Vague	unstated	unstated	1	Tax	0	Endng.	None stated	Extinction
Kotchen & Reiling (2000)	Shortnose sturgeon	0	0	DC	$26.63	$33.45	63%	317*	Mail	1997	NE	Vague	unstated	unstated	1	Tax	0	Endng.	None stated	Extinction
Loomis & Gonzalez-Caban (1998)	Northern spotted owl	1	0	DC	$56.00	$70.34	47%	672	Phone	1997*	W, NE	Vague	unstated	unstated	0	Donate	0	Endng.	Land new	Land

Continued on next page

Table A1 cont. Details of included studies

Study	Species	Mega	Multi	Model type	WTP	2006 WTP	Rrate	Rnum	Survey method	Survey year	Region	Certainty	Chgsize Abs	Chgsize Prop.	One time	Pmt. Veh.	Users	Status	Land Use Change	Focus
Watts Reaves et al. (1999)	Red cockaded woodpecker	0	0	Open ended	$8.42	$12.10	51%	188	Mail	1992	SE, US	50 to 99%	n/a	n/a	0	Donate	0	Endng.	None stated	Extinction
Watts Reaves et al. (1999)	Red cockaded woodpecker	0	0	DC	$10.29	$14.79	51%	168	Mail	1992	SE, US	50 to 99%	n/a	n/a	0	Donate	0	Endng.	None stated	Extinction
Watts Reaves et al. (1999)	Red cockaded woodpecker	0	0	Pay card	$7.57	$10.88	51%	203	Mail	1992	SE, US	50 to 99%	n/a	n/a	0	Donate	0	Endng.	None stated	Extinction
Samples et al. (1986)	Humpback whale	1	0	Open ended	$42.84	$80.27	100%	115	On-site	1985	HI	Vague	unstated	unstated	0	Donate	0	Endng.	None stated	Increase
Solomon et al. (2004)	Florida manatee	1	0	Open ended	$10.25	$11.67	36%	297	Mail	2001	SE	Vague	unstated	unstated	0	Donate	0	Endng.	None stated	Program
Stevens et al. (1991)	Wood turtle	0	0	DC	$86.00	$104.07	67%	581	Mail	1999	NE	Certain	unstated	11	0	Costs	0	"special concern"	Increased buffer zone	Land
Whitehead (1992)	Loggerhead sea turtle	1	0	DC	$27.02*	$39.99	35%	225	Mail	1991	SE	Certain	n/a	46.6	0	Donate	0	Thrt.	None stated	Extinction
Stevens et al. (1991)	Bald eagle	1	0	DC	$28.25	$43.57	30%	169	Mail	1990	NE	Certain	unstated	unstated	0	Donate	0	Reintro	None stated	Extinction
Stevens et al. (1991)	Wild turkey	0	0	DC	$7.11	$10.97	30%	339	Mail	1990	NE	Certain	unstated	unstated	0	Donate	0	Reintro	None stated	Extinction
Stevens et al. (1991)	Atlantic salmon	1	0	DC	$6.25	$9.64	30%	339	Mail	1990	NE	Certain	unstated	unstated	0	Donate	0	Reintro	None stated	Extinction
Stevens et al. (1991)	Bald eagle	1	0	Open ended	$19.28	$29.74	30%	169	Mail	1990	NE	Certain	unstated	unstated	0	Donate	0	Reintro	None stated	Extinction
Stevens et al. (1991)	Wild turkey	0	0	Open ended	$11.86	$18.02	30%	339	Mail	1990	NE	Certain	unstated	unstated	0	Donate	0	Reintro	None stated	Extinction
Stevens et al. (1991)	Atlantic salmon	1	0	Open ended	$7.93	$12.23	30%	339	Mail	1990	NE	Certain	unstated	unstated	0	Donate	0	Reintro	None stated	Extinction
Rubin et al. (1991)	Northern spotted owl	1	0	Pay card	$49.72	$88.24	23%	249	Mail	1987	W	Certain	existence certainty	unstated	0	Donate	0	Endng.	Land new	Extinction
Cummings et al. (1994)	Colorado squawfish	0	0	Open ended	$8.49	$13.10	53%	104	Mail	1990	SW	Vague	unstated	unstated	0	Tax	0	Thrt.	None stated	Increase
Loomis et al. (2003)	Numerous migrating bird species	0	1	DC	$174.00	$268.39	51%	227	Mail and Phone	2001*	W	Certain	unstated	avoid 70% loss	0	Tax	0	Unclear	Land maint	Land
Loomis et al. (2003)	Numerous migrating bird species	0	1	DC	$286.00	$441.14	51%	227	Mail and Phone	2001*	W	Certain	unstated	40% increase	0	Tax	0	Unclear	Land New	Land
Loomis et al. (2003)	Numerous migrating bird species	0	1	DC	$152.00	$234.45	51%	576	Mail and Phone	2001*	W	Certain	unstated	avoid 70% loss	0	Tax	0	Unclear	Land Maint	Land
Loomis et al. (2003)	Numerous migrating bird species	0	1	DC	$251.00	$387.16	51%	576	Mail and Phone	2001*	W	Certain	unstated	40% increase	0	Tax	0	Unclear	Land New	Land
Loomis et al. (2003)	Chinook salmon	1	0	DC	$202.00	$311.58	51%	227	Mail and Phone	2001*	W	Certain	unstated	avoid 70% loss	0	Tax	0	Unclear	Land Maint	Land
Loomis et al. (2003)	Chinook salmon	1	0	DC	$181.00	$279.19	51%	576	Mail and Phone	2001*	W	Certain	unstated	40% increase	0	Tax	0	Unclear	Land New	Land
Samples et al. (1989)	Humpback Whale	1	0	DC	$125.00	$229.93	100%	80	On-site	1986	HI	Certain	n/a	100%	1	Donate	0	Endng.	None stated	Extinction
Samples et al. (1989)	Hawaiian Monk Seal	1	0	DC	$103.00	$189.46	100%	80	On-site	1986	HI	Certain	n/a	100%	1	Donate	0	Endng.	None stated	Extinction
Kay et al. (1987)	Atlantic salmon	1	0	DC	$40.44	$74.39	42%	559	Mail	1986	NE	Certain	14 new rivers	unclear	1	Tax	0	Endng.	None stated	Extinction

* Denotes imputed values

Appendix B. Sample Matlab Code for Monte Carlo Simulations

```
clc
ntrials=128000;
nrounds=50;

weight4=.001*ntrials;
weight5=.037*ntrials;
weight6=.877*ntrials;
weight7=.048*ntrials;
weight8=.02*ntrials;
weight9=.002*ntrials;
weight11=.013*ntrials;
weight12=.001*ntrials;

total5=weight4+weight5;
total6=total5+weight6;
total7=total6+weight7;
total8=total7+weight8;
total9=total8+weight9;
total11=total9+weight11;
total=total11+weight12;

results = zeros(total,nrounds);
stats=zeros(2,nrounds);

mwtp16=zeros(5,nrounds);
mwtp17=zeros(5,nrounds);
mwtp18=zeros(5,nrounds);
mwtp23=zeros(5,nrounds);
mwtp24=zeros(5,nrounds);
mwtp26=zeros(5,nrounds);
mwtp33=zeros(5,nrounds);
mwtp34=zeros(5,nrounds);

scen116=[1 1 0 0 0 0 1 0 0 0 1 1 .174 .739 0 0 0 0];
scen117=[1 1 0 0 0 0 1 0 0 19 1 .174 .739 1 .5 0 0 322];
scen118=[1 1 0 0 0 0 1 0 0 19 1 .174 .739 .5 332];
scen123=[1 1 0 0 0 0 1 0 0 19 0 0 1 1];
scen124=[1 1 0 0 0 0 1 0 0 19 1];
scen126=[1 1 0 0 0 0 1 1 .174 .739 1 .5 0 0 0 0];
scen133=[1 1 0 1 0 0 19 .578 1 0 0 0 0 1 .174 .739 1];
scen134=[1 1 0 1 0 0 19 .578 1 0 0 0 0 1 .174 .739 0 0];

b16=transpose(chol(logchol16));
b17=transpose(chol(logchol17));
b18=transpose(chol(logchol18));
b23=transpose(chol(logchol23));
b24=transpose(chol(logchol24));
b26=transpose(chol(logchol26));
b33=transpose(chol(logchol33));
```

```
b34=transpose(chol(logchol34));

range=zeros(3,nrounds);
ptile=[2.5 50 97.5];
for j=1:nrounds;


   for i=1:weight4;
      run16=logcoeffs16+b16*randn(length(logcoeffs16),1);
      ewtp16=scen116*run16;
      results(i,j)=exp(ewtp16);
   end
   mwtp16(1,j)=mean(results(1:weight4,j));
   mwtp16(2,j)=std(results(1:weight4,j));
   mwtp16(3:5,j)=prctile(results(1:weight4,j),ptile);

   for i=weight4+1:total5;
      run17=logcoeffs17+b17*randn(length(logcoeffs17),1);
      ewtp17=scen117*run17;
      results(i,j)=exp(ewtp17);
   end
   mwtp17(1,j)=mean(results(weight4+1:total5,j));
   mwtp17(2,j)=std(results(weight4+1:total5,j));
   mwtp17(3:5,j)=prctile(results(weight4+1:total5,j),ptile);

   for i=total5+1:total6;
      run18=logcoeffs18+b18*randn(length(logcoeffs18),1);
      ewtp18=scen118*run18;
      results(i,j)=exp(ewtp18);
   end
   mwtp18(1,j)=mean(results(total5+1:total6,j));
   mwtp18(2,j)=std(results(total5+1:total6,j));
   mwtp18(3:5,j)=prctile(results(total5+1:total6,j),ptile);

   for i=total6+1:total7;
      run23=logcoeffs23+b23*randn(length(logcoeffs23),1);
      ewtp23=scen123*run23;
      results(i,j)=exp(ewtp23);

   end
   mwtp23(1,j)=mean(results(total6+1:total7,j));
   mwtp23(2,j)=std(results(total6+1:total7,j));
   mwtp23(3:5,j)=prctile(results(total6+1:total7,j),ptile);

   for i=total7+1:total8;
      run24=logcoeffs24+b24*randn(length(logcoeffs24),1);
      ewtp24=scen124*run24;
      results(i,j)=exp(ewtp24);

   end
   mwtp24(1,j)=mean(results(total7+1:total8,j));
```

```
    mwtp24(2,j)=std(results(total7+1:total8,j));
    mwtp24(3:5,j)=prctile(results(total7+1:total8,j),ptile);

    for i=total8+1:total9;
        run26=logcoeffs26+b26*randn(length(logcoeffs26),1);
        ewtp26=scen126*run26;
        results(i,j)=exp(ewtp26);

    end
    mwtp26(1,j)=mean(results(total8+1:total9,j));
    mwtp26(2,j)=std(results(total8+1:total9,j));
    mwtp26(3:5,j)=prctile(results(total8+1:total9,j),ptile);

    for i=total9+1:total11;
        run33=logcoeffs33+b33*randn(length(logcoeffs33),1);
        ewtp33=scen133*run33;
        results(i,j)=exp(ewtp33);

    end
    mwtp33(1,j)=mean(results(total9+1:total11,j));
    mwtp33(2,j)=std(results(total9+1:total11,j));
    mwtp33(3:5,j)=prctile(results(total9+1:total11,j),ptile);

    for i=total11+1:total;
        run34=logcoeffs34+b34*randn(length(logcoeffs34),1);
        ewtp34=scen134*run34;
        results(i,j)=exp(ewtp34);

    end
    mwtp34(1,j)=mean(results(total11+1:total,j));
    mwtp34(2,j)=std(results(total11+1:total,j));
    mwtp34(3:5,j)=prctile(results(total11+1:total,j),ptile);


    range(1,j)=prctile(results(:,j),2.5);
    range(2,j)=prctile(results(:,j),50);
    range(3,j)=prctile(results(:,j),97.5);
end

fifth16=mean(mwtp16(3,:))
ffifth16=mean(mwtp16(4,:))
nfifth16=mean(mwtp16(5,:))

fifth17=mean(mwtp17(3,:))
ffifth17=mean(mwtp17(4,:))
nfifth17=mean(mwtp17(5,:))

fifth18=mean(mwtp18(3,:))
ffifth18=mean(mwtp18(4,:))
nfifth18=mean(mwtp18(5,:))
```

```
fifth23=mean(mwtp23(3,:))
ffifth23=mean(mwtp23(4,:))
nfifth23=mean(mwtp23(5,:))

fifth24=mean(mwtp24(3,:))
ffifth24=mean(mwtp24(4,:))
nfifth24=mean(mwtp24(5,:))

fifth26=mean(mwtp26(3,:))
ffifth26=mean(mwtp26(4,:))
nfifth26=mean(mwtp26(5,:))

fifth33=mean(mwtp33(3,:))
ffifth33=mean(mwtp33(4,:))
nfifth33=mean(mwtp33(5,:))

fifth34=mean(mwtp34(3,:))
ffifth34=mean(mwtp34(4,:))
nfifth34=mean(mwtp34(5,:))

aic5th=mean(range(1,:))
aic50th=mean(range(2,:))
aic95th=mean(range(3,:))
```

Appendix C. Detailed Results for Selected Models

Table C1. Coefficients, standard errors, and weights for linear AICc models

	Model 15		Model 16		Model 17		Model 18		Model 26	
Weight	0.009		0.813		0.001		0.034		0.142	
Variable	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**
C	-18.647	67.701	36.616	54.250	17401.670	6052.646	19759.760	5916.529	82.249	61.016
DC	-16.460	24.577	-5.052	22.627	-24.195	29.327	-25.774	29.107	-10.100	26.214
Local	60.197	29.282	49.534	27.730	52.841	34.095	45.242	32.214	50.852	29.791
Users	22.479	32.054	35.953	29.699	13.854	35.628	20.020	35.776	9.900	32.177
Multi	78.204	32.933	73.264	27.981	105.949	37.232	84.054	32.840	87.335	34.629
One-Time	83.855	30.310	84.176	29.065	53.612	33.521	37.105	31.803	62.533	32.959
Increase										
Extinct										
Decline										
Pop										
Land										
Fish	-54.471	40.194	-59.046	39.564	-58.777	48.741	-80.468	48.080		
Bird	-30.919	38.303	-33.960	37.992	-67.013	47.121	-76.787	47.977		
Marine	45.071	45.761	52.577	45.411						
Mam					-11.520	50.982	-11.638	51.808		
Othmam	21.063	55.406	20.306	55.371						
Survey					-8.642	3.048	-9.821	2.981		
NOAA	-128.63	24.876	-127.52	24.174					-85.421	23.313
Rrate	63.505	45.558								
Tax	74.882	26.867	75.764	26.652	76.798	34.929	95.291	31.713	70.228	29.346
Phone	204.598	54.619	188.507	52.578	180.149	63.555	160.462	60.094	101.950	49.525
Mail	53.556	46.265	29.064	42.816	17.993	52.887	4.907	53.847	-40.801	37.900
Land-New	72.752	52.004	56.892	49.164					67.664	77.062
Land-Maint	174.958	40.927	171.233	38.464					114.333	66.736
Mega	3.803	20.257			19.713	22.705			21.628	23.236
State-PC					-129.108	42.316	-114.022	38.588	-20.132	59.482
State*New	-40.610	57.894	-31.866	56.541	38.051	37.038			-34.310	84.615
State*Maint	-234.13	53.837	-234.34	52.876	-37.369	44.428			-163.42	78.150
Rnum					-0.119	0.077	-0.073	0.069		

Table C2. Coefficients and standard errors for linear BIC models

	Model 9		Model 10		Model 15		Model 16		Model 18		Model 26		Model 36		Model 24	
Weight	0.027		0.237		0.072		0.62		0.004		0.025		0.013		0.007	
Variable	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S.E.**
C	-704.46	9998.311	7873.35	6965.76	-18.64	67.701	36.616	54.250	19759.76	5916.529	82.249	61.016	12691.390	7449.585	5.199	0.579
DC	-20.695	24.840	-14.138	23.959	-16.46	24.577	-5.052	22.627	-25.774	29.107	-10.100	26.214	-8.039	26.323	-0.727	0.329
Local	14.467	32.672	15.348	32.233	60.19	29.282	49.534	27.730	45.242	32.214	50.852	29.791	3.027	34.769	0.172	0.356
Users	30.733	29.859	42.416	27.942	22.47	32.054	35.953	29.699	20.020	35.776	9.900	32.177	40.598	30.967	0.621	0.454
Multi	65.491	30.744	59.144	26.699	78.24	32.933	73.264	27.981	84.054	32.840	87.335	34.629	63.816	29.340	0.950	0.411
One-Time	-22.955	42.091	-7.606	39.717	83.85	30.310	84.176	29.065	37.105	31.803	62.533	32.959	65.504	32.588	-0.019	0.337
Increase	-73.334	63.516	-98.167	59.533												
Extinct	77.168	62.060	33.638	48.812												
Decline	-150.76	74.948	-137.511	71.711												
Pop													-10.349	49.401		
Land	-333.59	87.770	-296.970	81.582									-164.573	72.140		
Fish	-66.233	47.029	-79.556	44.656	-54.47	40.194	-59.046	39.564	-80.468	48.080			-58.398	43.350	-1.422	0.474
Bird	-63.159	45.861	-77.891	43.606	-30.91	38.303	-33.960	37.992	-76.787	47.977			-58.994	44.266	-0.765	0.457
Marine	121.265	58.721	126.637	57.486	45.07	45.761	52.577	45.411					68.127	54.625	0.021	0.504
Mam									-11.638	51.808						
Othmam	-173.18	75.326	-134.393	66.571	21.06	55.406	20.306	55.371					-92.756	58.737		
Survey	0.328	4.981	-3.928	3.485					-9.821	2.981			-6.325	3.729	-0.111	0.029
NOAA					-128.64	24.876	-127.52	24.174			-85.421	23.313				
Rrate	75.300	64.529			63.50	45.558										
Tax	158.784	45.548	143.345	42.448	74.88	26.867	75.764	26.652	95.291	31.713	70.228	29.346	60.720	30.812	2.103	0.374
Phone	275.520	63.382	287.624	61.784	204.59	54.619	188.507	52.578	160.462	60.094	101.950	49.525	242.767	65.177		
Mail	57.409	50.140	57.172	49.196	53.55	46.265	29.064	42.816	4.907	53.847	-40.801	37.900	65.743	54.420		
Land-New	179.433	93.966	132.969	77.343	72.75	52.004	56.892	49.164			67.664	77.062	101.390	84.424		
Land-Maint	513.235	114.278	457.209	98.148	174.95	40.927	171.233	38.464			114.333	66.736	330.930	95.048		
Mega	13.030	21.230			3.80	20.257					21.628	23.236				
State-PC	6.324	63.050	-10.474	56.266					-114.022	38.588	-20.132	59.482	-54.143	59.435		
State*New	-79.218	92.819	-45.301	80.121	-40.61	57.894	-31.866	56.541			-34.310	84.615	-4.444	87.072		
State*Maint	-424.55	109.299	-410.339	105.477	-234.13	53.837	-234.34	52.876			-163.42	78.150	-307.695	93.335		
Rnum	-0.161	0.067	-0.169	0.066					-0.073	0.069			-0.183	0.072		

Table C3. Coefficients, standard errors, and weights for loglinear AICc models

	Model 16		Model 17		Model 18		Model 23		Model 24		Model 26		Model 33		Model 34	
Weight	0.001		0.037		0.877		0.048		0.02		0.002		0.013		0.001	
Variable	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**
C	4.292	0.737	6.014	0.866	6.468	0.836	4.085	0.640	5.199	0.579	3.768	0.781	6.181	0.485	6.164	1.527
DC	-0.048	0.307	-0.473	0.313	-0.451	0.316	-0.680	0.311	-0.727	0.329	-0.254	0.336	-0.539	0.336	-0.451	0.340
Local	-0.200	0.376	0.227	0.364	0.177	0.350	0.177	0.368	0.172	0.356	0.106	0.382	0.280	0.377	0.101	0.414
Users	0.939	0.403	0.586	0.380	0.776	0.389	0.369	0.420	0.621	0.454	0.585	0.412	0.542	0.414	0.599	0.413
Multi	0.394	0.380	0.935	0.397	0.443	0.357	1.416	0.420	0.950	0.411	1.062	0.444	0.863	0.430	0.610	0.374
One-Time	1.028	0.395	0.689	0.358	0.704	0.346	0.015	0.323	-0.019	0.337	0.606	0.422	0.417	0.429	0.617	0.431
Increase																
Extinct																
Decline																
Pop													-0.544	0.674	-0.500	0.706
Land													0.553	0.573	0.498	0.601
Fish	-1.452	0.537	-1.563	0.520	-1.896	0.522	-0.882	0.479	-1.422	0.474			-1.860	0.596	-1.855	0.613
Bird	-0.879	0.516	-1.187	0.503	-1.350	0.521	-0.378	0.443	-0.765	0.457			-1.301	0.599	-1.301	0.612
Marine	-0.246	0.617					0.142	0.488	0.021	0.504						
Mam			-0.519	0.544	-0.403	0.563							-0.568	0.553	-0.545	0.564
Othmam	-0.823	0.752														
Survey			-0.101	0.033	-0.125	0.032	-0.075	0.028	-0.111	0.029			-0.133	0.052	-0.137	0.052
NOAA	-0.810	0.328									-0.366	0.299				
Rrate													-0.408	0.664	-0.294	0.719
Tax	0.874	0.362	1.224	0.373	1.432	0.345	1.679	0.391	2.103	0.374	0.791	0.376	1.417	0.360	1.239	0.403
Phone	1.077	0.714	1.235	0.678	1.513	0.653					0.213	0.634	1.083	0.708	1.057	0.745
Mail	-0.290	0.581	0.154	0.564	0.135	0.585					-0.645	0.485	0.001	0.609	0.024	0.624
Land-New	1.150	0.667									0.873	0.987			0.384	0.389
Land-Maint	1.917	0.522									1.039	0.855			0.451	0.485
Mega			0.540	0.242			0.768	0.267			0.645	0.298	0.324	0.295		
State-PC			-1.345	0.451	-1.269	0.419					-0.280	0.762				
State*New	-0.586	0.768	0.437	0.395			0.398	0.356			-0.193	1.084				
State*Maint	-1.693	0.718	0.136	0.474			0.326	0.458			-0.810	1.001				
Rnum			0.000	0.001	0.000	0.001										

Table C4. Coefficients, standard errors, and weights for loglinear BIC models

	Model 9		Model 10		Model 15		Model 16		Model 17		Model 18		Model 23		Model 24	
Weight	0.052		0.044		0.004		0.003		0.143		0.497		0.02		0.007	
Variable	**Coeffs**	**S. E.**	**Coeffs**	**S. E.**	**Coeffs**	**S.E.**	**Coeffs**	**S.E.**	**Coeffs**	**S.E.**	**Coeffs**	**S.E.**	**Coeffs**	**S. E.**	**Coeffs**	**S.E.**
C	4.280	1.833	5.141	1.211	3.272	0.873	4.292	0.737	6.012	0.866	6.468	0.836	4.085	0.640	5.199	0.579
DC	-0.436	0.296	-0.348	0.300	-0.319	0.317	-0.048	0.307	-0.473	0.313	-0.451	0.316	-0.680	0.311	-0.727	0.329
Local	-0.216	0.389	-0.249	0.404	0.068	0.378	-0.200	0.376	0.227	0.364	0.177	0.350	0.177	0.368	0.172	0.356
Users	0.808	0.356	0.954	0.350	0.594	0.413	0.939	0.403	0.586	0.380	0.776	0.389	0.369	0.420	0.621	0.454
Multi	0.633	0.366	0.296	0.335	0.797	0.425	0.394	0.380	0.935	0.397	0.443	0.357	1.416	0.420	0.950	0.411
One-Time	0.151	0.502	0.273	0.498	0.858	0.391	1.028	0.395	0.689	0.358	0.704	0.346	0.015	0.323	-0.019	0.337
Increase	-1.321	0.757	-1.574	0.746												
Extinct	-0.362	0.739	-0.537	0.612												
Decline	-0.967	0.893	-1.147	0.899												
Pop																
Land	-3.182	1.046	-2.878	1.023												
Fish	-1.441	0.560	-1.718	0.560	-1.263	0.518	-1.452	0.537	-1.563	0.520	-1.896	0.522	-0.882	0.479	-1.422	0.474
Bird	-1.100	0.546	-1.319	0.547	-0.752	0.494	-0.879	0.516	-1.187	0.503	-1.350	0.521	-0.378	0.443	-0.765	0.457
Marine	1.010	0.700	0.923	0.721	-0.379	0.590	-0.246	0.617					0.142	0.488	0.021	0.504
Mam									-0.519	0.544	-0.403	0.563				
Othmam	-1.490	0.898	-1.351	0.835	-0.817	0.715	-0.823	0.752								
Survey	-0.061	0.059	-0.090	0.044					-0.101	0.033	-0.125	0.032	-0.075	0.028	-0.111	0.029
NOAA					-0.716	0.321	-0.810	0.328								
Rrate	0.334	0.769			0.867	0.588										
Tax	1.371	0.543	1.391	0.532	0.922	0.347	0.874	0.362	1.224	0.373	1.432	0.345	1.679	0.391	2.103	0.374
Phone	2.519	0.755	2.716	0.775	1.145	0.705	1.077	0.714	1.235	0.678	1.513	0.653				
Mail	0.843	0.597	0.717	0.617	0.094	0.597	-0.290	0.581	0.154	0.564	0.135	0.585				
Land-New	1.475	1.120	1.733	0.970	1.150	0.671	1.150	0.667								
Land-Maint	4.361	1.362	4.482	1.230	1.710	0.528	1.917	0.522								
Mega	0.494	0.253			0.446	0.261			0.540	0.242			0.768	0.267		
State-PC	-0.297	0.751	0.006	0.705					-1.345	0.451	-1.269	0.419				
State*New	-0.354	1.106	-0.737	1.004	-0.515	0.747	-0.586	0.768	0.437	0.395			0.398	0.356		
State*Maint	-3.799	1.302	-4.075	1.322	-1.497	0.694	-1.693	0.718	0.136	0.474			0.326	0.458		
Rnum	-0.001	0.001	-0.001	0.001					0.000	0.001	0.000	0.001				

Table C4 cont. Coefficients, standard errors, and weights for loglinear BIC models

	Model 26		Model 27		Model 33		Model 34		Model 35		Model 36	
Weight	0.002		0.001		0.022		0.003		0.115		0.086	
Variable	**Coeff**	**S. E.**	**Coeff**	**S. E.**	**Coeff**	**S. E.**	**Coeff**	**S. E.**	**Coeff**	**S. E.**	**Coeff**	**S. E.**
C	3.768	0.781	4.601	1.558	6.181	1.485	6.164	1.527	4.988	1.608	5.705	1.196
DC	-0.254	0.336	-0.762	0.308	-0.539	0.336	-0.451	0.340	-0.425	0.295	-0.337	0.305
Local	0.106	0.382	0.503	0.363	0.280	0.377	0.101	0.414	-0.210	0.391	-0.257	0.403
Users	0.585	0.412	0.313	0.444	0.542	0.414	0.599	0.413	0.799	0.358	0.935	0.359
Multi	1.062	0.444	1.299	0.427	0.863	0.430	0.610	0.374	0.653	0.370	0.289	0.340
One-Time	0.606	0.422	0.123	0.450	0.417	0.429	0.617	0.431	0.610	0.370	0.783	0.378
Increase												
Extinct												
Decline												
Pop			0.150	0.682	-0.544	0.674	-0.500	0.706	-0.553	0.598	-0.685	0.573
Land			0.101	0.739	0.553	0.573	0.498	0.601	-2.254	0.825	-1.860	0.836
Fish			-1.240	0.514	-1.860	0.596	-1.855	0.613	-1.554	0.540	-1.830	0.503
Bird			-0.632	0.518	-1.301	0.599	-1.301	0.612	-1.189	0.542	-1.396	0.513
Marine			-0.104	0.549					0.445	0.616	0.265	0.633
Mam					-0.568	0.553	-0.545	0.564				
Othmam									-1.628	0.656	-1.542	0.681
Survey			-0.097	0.048	-0.133	0.052	-0.137	0.052	-0.084	0.053	-0.110	0.043
NOAA	-0.366	0.299										
Rrate			0.157	0.720	-0.408	0.664	-0.294	0.719	0.205	0.646		
Tax	0.791	0.376	1.813	0.357	1.417	0.360	1.239	0.403	0.983	0.346	0.969	0.357
Phone	0.213	0.634			1.083	0.708	1.057	0.745	2.141	0.733	2.288	0.756
Mail	-0.645	0.485			0.001	0.609	0.024	0.624	0.924	0.606	0.790	0.631
Land-New	0.873	0.987					0.384	0.389	1.061	1.057	1.428	0.979
Land-Maint	1.039	0.855					0.451	0.485	3.326	1.119	3.464	1.102
Mega	0.645	0.298	0.757	0.298	0.324	0.295			0.531	0.257		
State-PC	-0.280	0.762	-0.584	0.528					-0.707	0.698	-0.369	0.689
State*New	-0.193	1.084							0.082	1.048	-0.390	1.009
State*Maint	-0.810	1.001							-2.509	1.068	-2.726	1.082
Rnum			0.001	0.001					-0.001	0.001	-0.001	0.001