Use of Stated Preference Methods to Value the Benefits of Ecological Risk Reductions: A Case Study of Exposure to Polychlorinated Biphenyls

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ABSTRACT: We report the results of a contingent valuation (CV) survey to develop willingness to pay (WTP) estimates to reduce environmental risks facing wildlife as a result of exposure to polychlorinated biphenyls (PCBs) in fish. Three surveys are developed: survey 1 asks respondents about potential ecological benefits in the first section, and a second section asks about the combined ecological and human (potential for developmental effects of *in utero* exposures to PCBs) WTP. A second survey, survey 2, (n=405) reverses the order, and a third survey, survey 3, asks only about the combined effects. We ask about two specific endpoints for each survey: the first is a risk reduction specifically to eagles, and the second is based on a "species sensitivity distribution" (SSD). For the human health endpoints, the first endpoint is a small reduction in IQ and the second endpoint a probability of a 7-month reduction in reading comprehension. Survey results show that WTP for SSD and eagles is similar. In addition, the risk reduction coefficient is negative for SSD, suggesting that respondents had difficulty interpreting the meaning of the risk reduction and associated graphics. Survey respondents were willing to pay incrementally more for human health endpoints in Survey 1 than they were for ecological endpoints in Survey 2. There are very few surveys that evaluate WTP for small risk reductions associated with exposure to chemicals in the environment specifically in terms of ecological benefits. The results presented here demonstrate the feasibility of evaluating benefits for ecological receptors.

JEL Codes: C34, Q50, Q51, Q57, Q58

1.0 Introduction

Risk assessment is the process of quantifying the probability of adverse health effects in humans and wildlife as a result of exposure to stressors, such as chemicals, in the environment. The risk assessment framework can be applied across a range of scales, from small, site-specific efforts, to larger sites, to evaluations of policy alternatives. Once the risk assessment model has been developed for a particular context, it is possible evaluate risk reductions across management alternatives. In many cases, it is beneficial, indeed necessary, to evaluate the potential benefits of risk reductions. This is not typically straightforward, particularly for ecological risk reductions (for which the benefits generally involve passive use values) and noncancer human health effects (e.g., developmental effects in children). There are hedonic methods available, such as cost-of-illness, but these are more difficult to apply in the case of children, and the uncertainty in projected benefits has the potential to be greater than the estimates themselves. For most ecological benefits, there are no revealed preference methods for quantifying benefits. Although benefits do not necessarily require monetization, there are distinct advantages for quantifying benefits in terms of money. In particular, money is a convenient common metric across disparate endpoints (e.g., human health and ecological), and allows for a direct comparison to predicted costs of the management alternatives.

In the absence of observable markets for the endpoints of interest, stated preference methods that rely on individuals making hypothetical choices would seem to offer an approach. Although there are legitimate criticisms of stated preference methods, in some cases they may offer the only reasonable alternative to capturing the monetary value of benefits of regulatory actions. We present the results of two contingent valuation (CV) surveys developed specifically to elicit values for risks and endpoints associated with exposure to polychlorinated biphenyls (PCBs) via fish ingestion. The surveys ask about both potential ecological and noncancer health effects. Exposure to PCBs has been strongly associated in both the animal toxicological and epidemiological literature with reproductive and developmental effects. For ecological receptors, particularly higher-order predators and keystone species, exposure to PCBs can cause reproductive impairment significant enough to impact population sustainability. In humans, exposure to PCBs to the developing fetus has been associated with developmental delays and statistically significant impacts on IQ, even at 11-years following exposure (Jacobson *et al.*, 2002; Schantz *et al*., 2003; Jacobson and Jacobson, 1996).

The case study is relevant to the many PCB-contaminated sites across the country, including the Fox River, Sheboygan River, Housatonic, Hudson, Passaic, and others. The case study incorporates an exposure model developed by the lead author and others under the Remedial Investigation/Feasibility Study (RI/FS) for the Hudson River. This model, *FishRand*, is a nested probabilistic Monte Carlo model that develops population-level predictions of PCB concentrations in fish tissue with associated uncertainty. It is important to distinguish between uncertainty and variability in risk models (Thompson and Graham, Stackelberg et al., 2002b). Variability reflects population heterogeneity, and identifies the distribution of risks across the population (e.g., subsistence anglers versus occasional recreational anglers). Uncertainty reflects unknown but measurable quantities, such as measurement error. There is a limit to how much variability can be reduced; in theory, enough data could be collected to eliminate uncertainty. The predicted fish concentrations are used as inputs to the human health and ecological risk models, which are also nested Monte Carlo models.

We use the risk assessment framework and the tools developed for the Hudson River RI/FS to demonstrate the feasibility of incorporating economic information on the benefits of risk reductions. In addition, we explore issues related to stated preference methods through the CV surveys. The first two surveys (n=400 each) are designed such that half the respondents answer questions on the ecological valuation first, and the other half respond to questions relating to noncancer developmental effects of *in utero* exposures. The next part of each survey asks respondents about the combined effects and benefits. Each arm of the survey (ecological and human) randomly asks respondents about two different endpoints. For human exposure, the endpoints include a probability of a 6-point reduction in IQ, and a 7-month delay in reading comprehension. There are two different probabilities for each endpoint to evaluate scope. For ecological exposures, the endpoints include a probability of effects to one particular species, the bald eagle, as well as the probability that a percentage of all species will be affected (e.g., species sensitivity distribution). Finally, a third survey (n=200) asks only about the combined effects.

The inherent complexity of ecological systems and the many subtle ways in which natural systems influence our daily lives makes valuation of ecological outcomes particularly difficult (EPA, 1999a). Most ecological benefits are not quantifiable in a market setting, and the largest source of benefits for ecological endpoints may well be attributable to passive use benefits (Chambers and Whitehead, 2003; Jakobsson and Dragun, 2001). Passive use (or nonuse) benefits arise from the knowledge that an ecological characteristic exists without direct use of that characteristic by the public. For example, there is value to individuals just knowing that particular endangered species are being preserved, or that suitable habitat is available to support a variety of species. This category of benefits includes value from the preservation of an ecological characteristic for future generations, or characteristics that contribute to ecological well-being in and of itself (*e.g.,* biodiversity).

The primary method available for evaluating nonmarket and passive use benefits involves stated preference techniques. Contingent valuation (CV) is primary among these. This technique involves eliciting or activating a set of personal norms that individuals possess relating internal values to a specific situation presented to them (Blamey, 1998) in terms of a willingness to pay (WTP) to avoid or reduce a particular outcome.

Ecological risk is often attributable to contaminants that are consumed rather than inhaled, such as hydrophobic organic contaminants (*e.g*., organochlorines and pesticides). This class of contaminants preferentially partition into the organic fraction of whatever media they are residing in, such as lipid in organisms or organic carbon in sediment. Because of this behavior, they typically bioaccumulate in organisms and are known to biomagnify in food webs, achieving higher concentrations at each increasing trophic level. While concentrations of these contaminants in lower trophic levels or sediment and water may not be directly detrimental, by the time humans and other predatory animals are exposed to them through consumption of exposed fish or game, concentrations are high enough to be associated with adverse effects. The existence of fish consumption advisories in virtually every state indicate that levels of certain contaminants are high enough to exert potential effects in humans that consume fish[1] (http://www.epa.gov/ost/fish/). Other piscivorous receptors are similarly affected, including eagles, otter, and mink (EPA, 2000b).

It has been argued that the impact of ecological effects are typically low in monetary terms relative to the value of preventing a statistical case of cancer, and even noncancer

[1] A complete list of all state, federal, and tribal issued fish consumption advisories can be found at an online database, the National Listing of Fish and Wildlife Advisories (NLFWA) at http://fish.rti.org/.

effects are likely to be very small relative to carcinogenic outcomes. This may be true for particular classes of contaminants, but it is less clear whether such an assumption holds for bioaccumulative and persistent contaminants for which health outcomes may be primarily systemic in humans and which may have significant ecological implications given the biomagnification of these contaminants through the food web.

The goal of this analysis is to develop WTP estimates for risk reductions associated with ecological (specifically avian) receptor exposure to polychlorinated biphenyls (PCBs) in the environment. A concurrent study develops WTP estimates for potential noncancer developmental effects in humans. An additional goal is to demonstrate the feasibility of integrating WTP data on risk reductions within the current established regulatory framework for risk assessment (EPA-SAB, 2000).

1.1 PCB Case Study

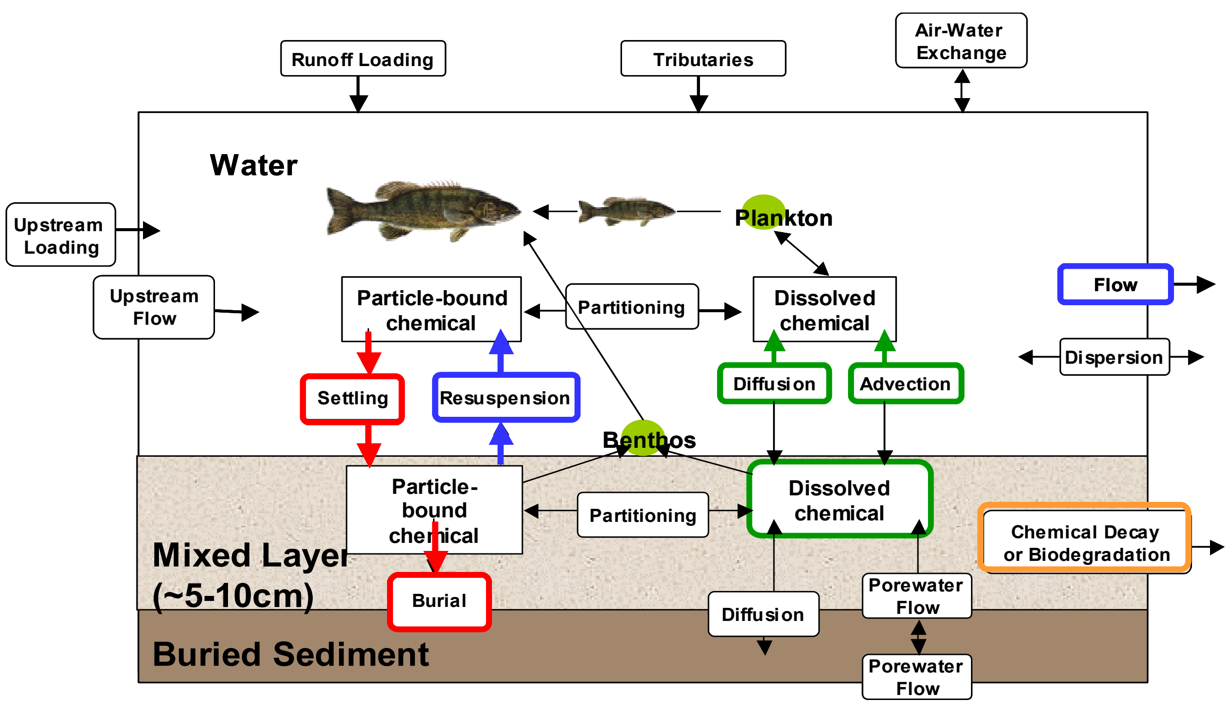
From the 1930's to the late 1970's, PCBs were manufactured and marketed under the trade name Aroclor for use in dielectric fluids, hydraulic fluids, solvent extenders, flame retardants, organic diluents, inks, dyes, paints and adhesives. PCBs are persistent in the environment and not very soluble in water. The oil-like PCBs were considered an ideal insulating fluid and they quickly replaced substances that easily caught on fire, and they were used in carbonless copy paper, newsprint and caulking compounds. PCB mixtures degrade once they are released into the environment, and in particular they slowly become dechlorinated. Consequently, the non-standard mixtures continually change, which makes assumptions about the components of the mixture tenuous at best. All the toxicological studies upon which ecological toxicity reference values or human toxicity values are based were conducted on laboratory-derived Aroclors rather than the mixture of PCBs found in the environment. This becomes important when quantifying benefits associated with risk reductions.

The CV is framed within a risk assessment case study involving PCB exposure via fish ingestion. There are numerous PCB-contaminated sites across the United States (and the world). In the US alone, there are at least 123 active remediation projects representing 103 contaminated sediment sites (http://www.hudsoninformation.com/mcss/index.htm), most of which have PCBs as a primary chemical of concern. Most of these sites will undergo a risk assessment at some point in order to quantify and evaluate the implications of exposures to measured concentrations.

The risk assessment consists of five steps. The first step involves developing a conceptual model and identifying the pathways, stressors (chemicals), and receptors of concern. The conceptual model provides the roadmap for the overall analysis, and describes the qualitative relationships between compartments or components in the analysis. It provides the basis for the equations and mathematical relationships that quantitatively link these compartments. The conceptual model for the case study that frames this CV is a sediment-based aquatic food web as shown in Figure 1. Ecological and human receptors are exposed to PCBs originating in the sediments by eating fish. Exposure doses in humans and animals are a function of the concentration of PCBs in the fish, the specific fish that the animal or human eats, the consumption rate, and the time period over which fish are consumed.

The CV that is developed here is based on a representative sample of the US population. However, the example of an application of WTP within a risk assessment is done in a site-specific context and will be the subject of a companion paper (von Stackelberg *et al.*, 2005) based on an actual site, the Hudson River (EPA, 2000a; 2000b). We only describe the selection of the specific endpoints as these are the focus of the valuation in this paper. Details of the risk modeling are found in the companion paper and associated references (EPA, 2000a; 2000b). The case study frames both the endpoints that are selected for valuation, as well as the context under which exposure and risk reduction occurs. Three versions of the survey are administered: Survey 1, which asks respondents about potential ecological effects of PCB exposure and elicits WTP for that endpoint, followed by a series of questions related to potential human health effects; Survey 2, which asks respondents exactly the same questions but in the opposite order (e.g., human health related WTP is elicited first); and Survey 3, which asks respondents only about the combined set of effects and potential benefits.

Figure 1: Conceptual Model for a Sediment-Based Foodweb in a Freshwater System



The next section discusses the survey procedure and data sources. Section 3 provides a description of the econometric models used to analyze the results, and the final section provides estimates of WTP for several different populations.

2.0 Survey Design and Development

Respondents to the survey are first told that government officials in their State are responsible for allocating resources and are interested in individual opinions to inform potential policies. The first question asks respondents to rate the importance of several issues, including reducing crime, cleaning up the environment, improving education, reducing taxes, protecting State waterways, improving library services, reducing air pollution, and providing additional security at public events. The second question asks respondents to consider whether current State budget allocations should be reduced or increased, keeping in mind that overall expenditures cannot be increased without an increase in revenue. Respondents are reminded that State policy makers are responsible for allocating resources, and that people may feel differently about these allocations depending on their own beliefs and knowledge. State policy makers are interested in learning how taxpayers feel about specific issues.

At that point, respondents are informed that the survey is asking specifically about a program involving the potential effects of chemicals in the environment on animals for Survey 1, humans for Survey 2, and humans and animals combined for Survey 3. The survey provides some background information on PCBs, how they influence the food web and human and animal exposures (including graphics) and a brief description of the potential reproductive effects on ecological receptors such as birds. Respondents are informed that historical practices, together with a lack of knowledge of the potential effects of PCBs, resulted in the current contamination situation, and that most of the companies responsible for the contamination are no longer in business. Respondents are informed that there are known deposits of PCBs in some freshwater systems in their State, and that State policy makers are considering cleanup efforts to reduce exposure to the PCBs.

The endpoints selected for valuation in survey are based on the risk models from the case study. Two different endpoints were selected based on the evidence for potential reproductive effects in ecological receptors that could influence population viability and these are described in more detail in Section 2.1. The questions are framed in terms of WTP for a cleanup that would reduce, although not eliminate, potential risks associated with exposure to PCBs. The cleanup would be funded by a one-time additional increase in the income tax, which would go into a special fund specifically for this purpose. The cleanup is expected to take a year or two, and the full benefits of the cleanup would take at least five years. If there is no cleanup, respondents are informed that sediment levels will decline over time, but that it would take closer to 75 years rather than five years to achieve the stated risk reductions.

The next section describes the selection of specific endpoints for valuation. The survey questions respondents about two different risk levels to test for scope (Section 2.2), and three different versions of the survey are administered to evaluate potential embedding effects (Section 2.3).

2.1 Endpoint Selection

There are two distinct ways in which ecosystem structure and function are typically evaluated within a risk assessment context and these are used as the basis for developing the CV questions. The first focuses the analysis on a set of single species that have been selected to represent high-end exposure and sensitivity. Within the ecological risk assessment framework, the assessment endpoints (that which is being protected) generally do not define specific species (e.g., a typical assessment endpoint is the protection and sustainability of wildlife populations). The associated measurement endpoint(s) for that assessment endpoint might include comparing predicted doses to the selected species with doses from the toxicological literature associated with specific effects. This deterministic analysis can be expanded to include a joint probability model that quantifies the probability of an increasing magnitude of effect using a dose-response model for a single species (*e.g*., reduction in fecundity). Alternatively, the probability of exceeding a threshold value can also be modeled. Under this approach, a valuation for a single “high-profile” species will implicitly value those aspects of the ecosystem that support this species (Loomis and White, 1996). The valuation questions respondents on their willingness to pay to reduce the probability of an effect on a single species. Management actions are designed to reduce risks for the presumed highest risk species.

The second approach is slightly different. Rather than relying on a single dose-response relationship for one species, the analysis develops species sensitivity distributions. These distributions quantify the probability of the proportion of species that will be affected (e.g., there is a 20% probability that 80% of the species will experience adverse reproductive effects). Under this approach, the analysis does not focus on one particular species but rather considers the probability of impacting multiple species.

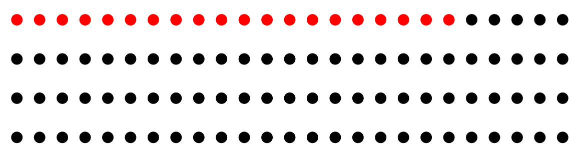
The specific endpoints for this analysis are based on the potential reproductive effects of PCBs on ecological receptors. The survey tool contains questions on the willingness to pay to decrease the risk of reductions in fecundity for eagles. The lead author was the technical lead for the development of a joint probability model (EPA, 2000b) that evaluates the impact of PCB exposure to bald eagles by estimating the probability of reductions in fecundity (e.g., the probability of a percentage reduction in fecundity), which is interpreted relative to the reproductive potential of the population. A second arm of the survey contains questions on the willingness to pay to decrease the probability of reproductive effects across all avian receptors using a species sensitivity distribution (Suter, 2003) based on predicted concentrations in avian eggs. The specific risk reduction is based on the risk model and is discussed in the next subsection.

2.2 Risk Reduction and Scope Tests

The survey asks respondents about two potential risk reductions for each endpoint. Sensitivity of estimated WTP to the magnitude of the risk reduction is one technique used as a diagnostic test of the performance of the survey instrument (Arrow *et al*., 1993; Hammitt and Graham, 1999). Figure 1 provides a sample from the survey for effects to eagles, and Figure 2 shows a sample for the species sensitivity distribution. The values in brackets are the final risks, thus, the risk reductions in each case are 0.15 and 0.10 for eagles, and 0.25 and 0.4 for SSD.

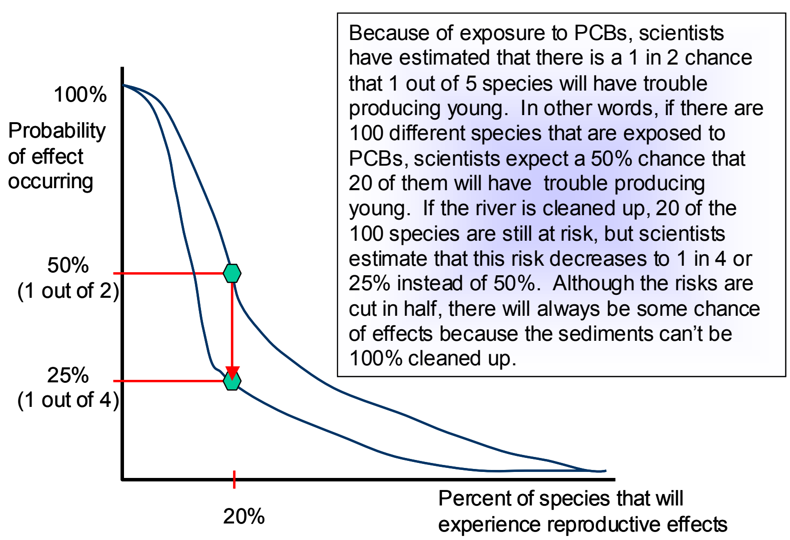
Figure 2: Sample from Survey for Potential Effects to Eagles

D.1. Scientists predict that eagles will have a 20 in 100 (or 1 in 5) chance of failing to produce young if exposed to PCBs. Put another way, out of 100 exposed eagles, scientists predict that 20 will be unable to produce young. Each dot below represents one eagle. The red dots represent the eagles that won't be able to reproduce.



If the sediments are cleaned up, scientists predict that the risk will decrease to **[**1 in 10 / 1 in 20**],** or that **[**10 out of 100 / 5 out of 100**]** eagles will still be affected. There will always be some chance that eagles will have trouble reproducing because the sediments can't be totally cleaned up. Each dot below represents one eagle: the red dots represent the eagles that will still have trouble reproducing after the sediments are cleaned up.

Figure 3: Species Sensitivity Distribution Risk Reduction Graphic from Survey



This graphic was used to visually describe the risk reduction for the species sensitivity distribution (SSD). The choice of percent of species that will experience reproductive effects is not a science-based decision but rather policy. Ecologists do not quantitatively know the significance of the fraction of species affected. However, from a management perspective, it would seem to offer greater ecological integrity to manage ecosystems on a species-wide basis as opposed to the "receptor species" approach that ecological risk assessment has favored for many years.

2.3 Embedding and Order Effects

The valuation questions are framed in terms of a cleanup of a fairly large, unnamed, contaminated freshwater system in the respondents' state. Should this cleanup occur, risks to ecological receptors (and humans) that consume fish will decrease. Clearly, there are a bundle of benefits associated with cleaning up the source of the PCBs and any cleanup designed for one endpoint will influence all the endpoints. There has been increasing discussion in the CV literature concerning the effect of the placement of a particular good or endpoint within a valuation sequence and the influence that has on respondent valuation (Carson and Mitchell, 1995; Diamond, 1996; Bateman and Willis, 2001). Different WTP estimates are obtained depending on the order in which the benefits are presented, and additionally, the summation of the individual WTP values is often not the same as the overall WTP obtained without specifying individual endpoints.

One study (Veisten *et al.,* 2004) elicited WTP in a Norwegian population to protect specific subsamples of endangered species. Respondents were informed that changes in forest management practices to increase the area of protected habitats funded through an environmental tax on wood products would protect all species versus individual species. They administered four different versions of the survey and found that the built-up sequence of additional increments towards the overall benefit bundle (e.g., all endangered plants and animals) gave similar WTP estimates as the direct valuation.

We evaluate the implications of embedding effects by administering three different versions of the survey. Two versions ask exactly the same set of questions except in opposite order, and one survey asks only about the combined set of potential effects and risk reductions (e.g., human and ecological) to evaluate adding-up properties.

2.4 Motivation Questions

The survey contains a number of questions related to respondents' knowledge and beliefs regarding chemicals in the environment, PCBs in the environment, potential effects of PCBs, and trust in different sources of information (*e.g*., industry scientists, media, academia, etc.). Another set of questions elicits the importance of various nonuse values as shown in Figure 4.

Figure 4: Questions Related to Motivation

ALTR I think it's important to preserve **[EAGLES / WILDLIFE]** not just for my enjoyment but for everyone

BEQUEST I would like my children to have the opportunity to have **[EAGLES / WILDLIFE]** in their environment

EXIST I think it's important to protect **[EAGLES / WILDLIFE]** – it's important to me know that they are ok even if I don't see them directly

OPTION It's not very important to me right now if see **[EAGLES / WILDLIFE]**, but I would like the option of doing so in the future

ENV I support a cleanup no matter what the risk might be (I don't like the idea of chemicals in the environment generally)

2.5 Survey Administration

A professional survey firm, Knowledge Networks (KN), administered the survey to a panel representative of the US general population via a web-based survey mechanism during February of 2005. The Knowledge Networks panel-based approach provides core capabilities for multimedia interviewing, cost-effective access to small or special subpopulations, longitudinal research, and rapid delivery of survey data. The statistical foundation of the research panel stems from the application of probability-based sample selection methodologies to recruit panel members. The KN web-enabled panel is the only available method for conducting Internet-based survey research with a nationally representative probability sample (Couper, 2001; Krotki and Dennis, 2001).

The Knowledge Networks Panel, recruited randomly through Random Digit Dialing, represents the broad diversity and key demographic dimensions of the U.S. population. The web-enabled panel tracks closely the U.S. population on age, race, ethnicity, geographical region, employment status, and other demographic elements. The differences that do exist are small and are corrected statistically in survey data (i.e., by non-response adjustments). The web-enabled panel is comprised of both Internet and non-Internet households, all of which are provided the same equipment for participation in Internet surveys. Internet-based surveys are increasingly showing favorable comparisons to mail and telephone survey methods (Berrens *et al*., 2003).

There are four main factors responsible for the representativeness of the web-enabled research panel. First, the panel sample is selected using list-assisted random digit dialing telephone methodology, providing a probability-based starting sample of U.S. telephone households. Second, the panel sample weights are adjusted to U.S. Census demographic benchmarks to reduce error due to non-coverage of non-telephone households and to reduce bias due to nonresponse and other non-sampling errors. Third, samples selected from the panel for individual studies are selected using probability methods. Appropriate sample design weights for each study are calculated based on specific design parameters. Fourth, nonresponse and poststratification weighting adjustments are applied to the final survey data to reduce the effects of non-sampling error (variance and bias).

WTP is elicited using double-bounded binary-choice questions (Alberini, 1995). Each respondent is randomly assigned one of five bid vectors, as shown below. The initial amount is the first amount show in the parentheses. If the respondent indicates "yes" to this amount, they are shown the second value. If the response to the initial bid is "no", respondents are shown the lower amount, or final value in the parentheses below.

A ($25, $50, $10)
B ($50, $100, $25)
C ($100, $200, $50)
D ($200, $400, $100)
E ($400, $800, $200)
F ($800, $1000, $400)

The endpoint selection, specific risk reduction, and follow up human health questions are all randomized across the respondents. There are two endpoints, two risk reductions, two human health endpoints and associated risk reductions, and two quality adjusted life year questions. Survey 1 is included as Appendix A.

In the next section, we report the results of the first ecological survey and an example of how these results can be incorporated into a risk assessment model. Finally, we explore the regulatory implications of quantifying and monetizing risk reductions.

3.0 Survey Results

The statistical model for CV responses must satisfy both statistical and economic criteria (Hanemann and Kaninnen, 1999). CV responses are discrete dependent variables with binary responses since respondents can either state "yes" or "no" to a particular bid value. There are a number of statistical model formats designed to evaluate such data. In economic terms, the statistical model for CV responses must be consistent with the theory of utility maximization inherent in economic models. Briefly, individuals show preferences for market commodities (x) and nonmarket amenities (q) as represented by a utility function $u(x,q)$ which is continuous and non-decreasing (Hanemann, 2001). Individuals face budget constraints based on income (y) and prices of the market commodities (p). Individuals are assumed to be utility-maximizers given a budget constraint (e.g., disposal income). Willingness to pay, or the compensating variation (C) is the maximum an individual is willing to pay to secure a change in the risk to reproductive capacity of wildlife (or specific species such as eagles):

$$v(p, q_1, y\text{-}C) = v(p, q_0, y) \qquad (1)$$

where C = the amount of money at which the individual is indifferent between a higher probability that eagles and/or wildlife will prosper and higher income, and q_0 and q_1 are different levels of reproductive risk to eagles or wildlife

In this case, a smaller risk to wildlife (under the SSD model) or specifically to eagles (under the eagle model) leads to a decrease in income. We assume that expected utility is roughly proportional to the risk of reproductive impairment to wildlife and/or eagles and consequently WTP should be proportional to risk. As individuals spend more money, the utility loss increases. However, WTP is likely small with respect to income and so an income effect is likely to be small.

Under the double-bounded dichotomous choice framework, it is not possible to observe the actual amount at which the individual is indifferent but rather an interval censored value. The actual bid P_i that the respondent is willing to pay is somewhere between the upper and lower bids or $P_L < P_i < P_U$. Thus, for any given underlying WTP distribution specified as $G_c(\bullet)$, the probability of the responses is given by:

$$\begin{aligned} &\Pr\{\text{yes/yes}\} \equiv P^{yy} = 1 - G_C(P_U) \\ &\Pr\{\text{yes/no}\} \equiv P^{yn} = G_C(P_U) - G_C(P) \\ &\Pr\{\text{no/yes}\} \equiv P^{ny} = G_C(P) - G_C(P_L) \\ &\Pr\{\text{no/no}\} \equiv P^{nn} = G_C(P_L) \end{aligned} \qquad (2)$$

Where:
P = initial bid for that question
PU = next bid up
PL = next bid down

The bid vector for the second part of Survey 2 (the ecological component) takes as its starting point the next highest bid that was agreed to in the first part of the survey. Table 1 shows the relationship between the bid amounts in the first part of the survey and the bid amounts in the second part.

Table 1: Initial Bid Vectors and Followup Bids for Surveys 1 and 2

	Bid vectors based on final response in first section:			
Initial Bid from HH Questions in Survey 2	Y-Y[1]	Y-N[1]	N-Y[1]	N-N
\$25	\$100, \$200, \$50	B (\$50, \$100, \$25)	A (\$25, \$50, \$10)	random
\$50	\$200, \$400, \$100	C (\$100, \$200, \$50)	B (\$50, \$100, \$25)	random
\$100	\$400, \$800, \$200	D (\$200, \$400, \$100)	C (\$100, \$200, \$50)	random
\$200	\$800, \$1000, \$400	E (\$400, \$800,	D (\$200, \$400,	random

		$200)	$100)	
$400	$1000, $1500, $800	F ($800, $1000, $400)	E ($400, $800, $200)	random

Notes:
1 – It is possible, in the followup, to respond "no" to a value for the total that had already been agreed to in the previous section. In that case, respondents are shown the following prompt: "You already agreed you'd be willing to pay this amount for *ecological* benefits alone. Now we're asking about the *total* you'd be willing to pay"

All analyses are conducted using S-Plus 6.2 (Insightful Corporation, 2004) and Microsoft Excel.

3.1 Descriptive Statistics

Table 2 presents the frequencies of each response to the bid vectors.

Table 2: Frequency of Response to Bid Vectors

	EAGLE (n=193)					**SSD (n=210)**				
Bid Amount	n	Y-Y	Y-N	N-Y	N-N	n	Y-Y	Y-N	N-Y	N-N
A ($25, $50, $10)	36	12%	3%	3%	1%	37	11%	1%	1%	4%
B ($50, $100, $25)	38	10%	3%	3%	4%	36	9%	4%	1%	3%
C ($100, $200, $50)	22	2%	7%	1%	2%	30	3%	4%	1%	6%
D ($200, $400, $100)	32	5%	6%	2%	5%	34	3%	6%	1%	6%
E ($400, $800, $200)	33	2%	4%	3%	9%	39	4%	5%	2%	8%
F ($800, $1000, $400)	32	3%	4%	2%	8%	34	4%	1%	2%	9%

Table 3 provides a summary of the demographic characteristics of the sample, and for comparison purposes, data from the 2000 census. This table shows that the sample is representative of the US population. The median income differs, but this is primarily attributable to the fact that income was provided in terms of ranges, and the median income was estimated from the midpoint of the range provided for each individual. If one compares the income distribution (shown in the table below the median and mean income), it shows that the sample is very close to the US population.

The sample also shows a lower proportion of individuals with less than a high school education as compared to the general public, and a higher proportion of individuals with at least an associates degree. However, it is not clear that more traditional survey methods (e.g., direct mail and/or telephone) would have reached a higher proportion of this fraction of the population.

Table 3: Demographic Characteristics of Survey 1 and US Census

Demographic	Eagle (n=193)	SSD (n=210)	US Census Data[1]
Some high school, no diploma	7%	8%	20%
High school	29%	30%	29%
Some college, no degree	23%	20%	21%
Associate degree (AA, AS)	15%	12%	6%
Bachelor's degree	17%	19%	16%
Master's degree	4%	7%	6%
Other	5%	4%	3%
Black, Non-Hispanic	10%	12%	12%
Hispanic	9%	15%	13%
Other, Non-Hispanic	5%	5%	0%
White, Non-Hispanic	76%	68%	75%
Female	57%	50%	51%
Male	43%	50%	49%
Median Income	$ 32,500	$ 37,500	$ 41,994.00
Mean Income	$ 43,860	$ 46,854	$ 56,644.00
Less than $10,000	12%	10%	10%
$10,000 to $14,999	11%	5%	6%
$15,000 to $19,999	5%	4%	6%
$20,000 to $24,999	8%	10%	7%
$25,000 to $29,999	8%	7%	6%
$30,000 to $34,999	7%	7%	6%
$35,000 to $39,999	4%	10%	6%
$40,000 to $49,999	9%	11%	11%
$50,000 to $59,999	10%	9%	9%
$60,000 to $74,999	10%	9%	10%
$75,000 to $99,999	11%	9%	10%
$100,000 to $124,999	2%	3%	5%
$125,000 to $149,999	1%	2%	3%
$150,000 to $174,999	1%	1%	2%
$175,000 or more	2%	2%	2%
Divorced	12%	15%	10%
Married	52%	50%	54%
Separated	2%	2%	2%
Single (never married)	26%	28%	27%
Widowed	7%	5%	7%

1: Data provided for males and females combined (except gender); thereore, percentages may not equal 100 due to combining. Data from: factfinder.census.gov, 2000 Census

Table 4: Summary of Model Variables and Means

		Eagle (n=193)		SSD (n=210)	
Parameter	Parameter Name	Mean	Stdev	Mean	Stdev
Education (1 for college and above, 0 otherwise)	EDUCAT	0.53	0.50	0.61	0.49
White (1 for yes, 0 otherwise)	WHITE	0.76	0.43	0.68	0.47
Black (1 for yes, 0 otherwise)	BLACK	0.09	0.29	0.12	0.33
Hispanic (1 for yes, 0 otherwise)	HISPANIC	0.09	0.29	0.15	0.35
Gender (1 if Female, 0 if Male)	MALE	0.57	0.50	0.50	0.50
Natural log of income	LNInc	10.36	0.86	10.46	0.83
Married (1 if yes, 0 otherwise)	MARRIED	0.52	0.50	0.50	0.50
Live in a metropolitan area (1 if yes, 0 if no)	METRO	0.83	0.38	0.82	0.38
Natural log of risk reduction	LNEcoRR	-2.09	0.20	-1.17	0.23
Have you ever heard of PCBs (1 if yes, 0 otherwise)	PCBs	0.48	0.50	0.50	0.50
Confidence in eco response (scale of 1 to 5 where 1 is not confident and 5 is very confident)	ConfWildlife	4.39	1.39	4.16	1.64
Confidence in total	ConfTotal	4.55	1.19	4.06	1.71
Are you able to think about ecological endpoints separately from human (1 if yes, 0 if no)	eco.sep	0.78	0.41	0.72	0.45
Are you able to think about ecological benefits separately from human health benefits? (1 if yes, 0 otherwise)	eco.ben.sep	0.62	0.49	0.63	0.48
Concerned about chemicals in the environment (1 if yes, 0 otherwise)	ChemConcern	3.12	0.84	2.96	0.87
Concerned about PCBs in the environment (1 if yes, 0 otherwise)	PCBConcern	2.96	0.87	2.77	0.87
Do you believe PCBs can cause reproductive effects in wildlife? (1 if yes, 0 otherwise)	PCBWildlife	0.66	0.48	0.59	0.49
Do you believe PCBs can cause developmental effects in children exposed *in utero*? (1 if yes, 0 otherwise)	PCBChild	0.61	0.49	0.54	0.50

Rate the risks facing eagles in this state (0 = not sure, 1 = not serious, 2 = somewhat serious, 3 = very serious, 4 = extremely serious)	risk.wldlf	2.14	1.17	2.04	1.20
Rate the risks facing unborn babies in this state (0 = not sure, 1 = not serious, 2 = somewhat serious, 3 = very serious, 4 = extremely serious)	risk.baby	2.22	1.27	2.01	1.28
How often do you watch programs on television about wildlife (1 = never, 2 = rarely, 3 = sometimes, 4 = often)	tv.wldlf	2.99	0.88	2.91	0.97
Do you live near freshwater (1 = yes, 0 = no)	live.fw	0.69	0.46	0.64	0.48
How much time do you spend on a river, lake, or stream? (1 = never, 2 = rarely, 3 = sometimes, 4 = often)	time.fw	2.60	1.03	2.65	1.02
How often do you eat recreationally caught fish (0 = never, 1 = a few times a year, 2 = a few times a month, 3 = a few times a week)	eat.fish	2.50	0.81	2.53	0.85
How much confidence do you have in information you receive from government sources (1 = none, 2 = some, 3 = a lot)	conf.gov	1.85	0.56	1.78	0.49
How much confidence do you have in information you receive from industry scientists (1 = none, 2 = some, 3 = a lot)	conf.sci.ind	1.88	0.58	1.82	0.54
How much confidence do you have in information you receive from university scientists (1 = none, 2 = some, 3 = a lot)	conf.sci.univ	2.25	0.59	2.27	0.60
How much confidence do you have in information you receive from television sources (1 = none, 2 = some, 3 = a lot)	conf.tv	1.70	0.58	1.68	0.54
How much confidence do you have in information you receive from government web sites (1 = none, 2 = some, 3 = a lot)	conf.gov.web	1.87	0.50	1.78	0.53
How much confidence do you have in information you receive from commercial web sites (1 = none, 2 = some, 3 = a lot)	conf.comm.web	1.69	0.52	1.62	0.52

How much confidence do you have in information you receive from nonprofit web sites (1 = none, 2 = some, 3 = a lot)	conf.np.web	2.10	0.62	2.09	0.58
How much confidence do you have in information you receive from university web sites (1 = none, 2 = some, 3 = a lot)	conf.uni.web	2.21	0.59	2.20	0.54
How much confidence do you have in information you receive from print media (1 = none, 2 = some, 3 = a lot)	conf.print	1.86	0.56	1.88	0.40

3.2 Statistical Models

The double-bounded dichotomous choice elicitation format used here is analogous to interval-censored survival data in medical and engineering settings in which time to illness or failure of a component is modeled. In this case, we know the interval within which WTP for any individual respondent lies; for example, for the yes-yes response, it is known that the interval lies somewhere between the highest amount the respondent agreed to and infinity. Table 5 shows the intervals for each bid vector based on the initial bids for each survey.

Table 5: Bid Vectors Based on Initial Bids

BID VECTOR	NO-NO	NO-YES	YES-NO	YES-YES
A ($25, $50, $10)	$0 - $10	$10 - $25	$25 - $50	$50 - □
B ($50, $100, $25)	$0 - $25	$25 - $50	$50 - $100	$100 - □
C ($100, $200, $50)	$0 - $50	$50 - $100	$100 - $200	$200 - □
D ($200, $400, $100)	$0 - $100	$100 - $200	$200 - $400	$400 - □
E ($400, $800, $200)	$0 - $200	$200 - $400	$400 - $800	$800 - □
F ($800, $1000, $400)	$0 - $400	$400 - $800	$800 - $1000	$1000 - □

The WTP model takes the form:

$$WTP_i = \beta_0 * \Delta Risk^{\beta_1} * I^{\beta_2} * \exp^{\beta_x x + \varepsilon} \quad (3)$$

Taking the natural log of both sides results in:

$$LNWTP_i = \beta_0 + \beta_1 LN\Delta Risk + \beta_2 LNIncome + \beta_x X + \varepsilon \quad (4)$$

where

WTP for the i^{th} individual in the interval given in Table 5
ΔRisk – is the risk reduction (0.1 or 0.15 for Eagle; 0.25 or 0.4 for SSD)
Income – respondent household income
X – vector of respondent-specific attributes as given in Table 4
ε – error term

The log likelihood function can be maximized assuming a particular parametric distribution (e.g, lognormal) or by using the Turnbull nonparametric modification of the Kaplan-Meier estimator, which makes no assumptions about the shape of the underlying WTP distribution (Carson *et al*., 2003; Hanemann and Kanninen, 2001).

Parameter estimation is accomplished through maximum likelihood methods. The goal of maximum likelihood estimation (MLE) is to obtain the values of unknown statistical parameters that are most likely to have generated the observed data. In this case, the data are in the form of yes/no responses from survey respondents. If y_i is the response of the y^{th} individual, then $y_1 = 1$ if 'yes' and $y_1 = 0$ if 'no'. Each respondent provides a vector of explanatory variables including bid amount (P_i), income (I), age, other sociodemographic variables, knowledge about chemicals and/or PCBs in the environment, and other attitudinal and demographic variables unique to each respondent.

Average WTP for a set of benefits is quantified as the area under a demand curve, where the demand curve represents the proportion of individuals willing to pay a specified bid. One can use the results from the regression models to predict mean WTP by using the sample mean for each of the covariates.

Tables 6 through 9 show the results of the regression analyses.

In the full model for the eagle (Table 6), significant predictors for WTP are shown in bold (PCBWildlife, ChemConcern, conf.gov.web and conf.print). PCBWildlife and ChemConcern indicate whether respondents believe that PCBs could cause effects in wildlife, and whether they are concerned about chemicals in the environment generally. The other two variables indicate the level of confidence respondents have concerning the source of information they receive. Conf.gov.web is information contained on government-hosted websites, and conf.print is any kind of print media.

The estimated coefficient for risk reduction (EcoLNRR) is not significant, and estimated WTP is not proportional to the magnitude of the risk reduction.

Income has a negative coefficient, although insignificant, counter to the expectation that higher income is associated with a higher WTP. However, the effect is small – a 1% decrease in income leads to an approximately 0.1% increase in WTP. Respondents with at least some college education are estimated to have a WTP 20% less than those respondents with less than a college education. Those respondents who live near freshwater are estimated to have a 14% lower WTP than those who do not.

Conf.gov.web shows a negative coefficient – those respondents who trust information contained on government websites have a lower WTP. By contrast, those respondents who trust information obtained from print media (e.g., newspapers and magazines) had a higher WTP.

Table 6: Valuation Function Results for the Eagle Subset (Full Model)

```
Distribution:  Lognormal

 Standardized Residuals:
             Min    Max
Uncensored     NA     NA
  Censored  0.067 13.736

Coefficients:
                 Est. Std.Err. 95% LCL 95% UCL z-value  p-value
 (Intercept)  3.5912    2.388 -1.0893   8.272   1.504 0.132627
     married  0.2010    0.266 -0.3208   0.723   0.755 0.450208
        Male  0.0542    0.256 -0.4480   0.556   0.212 0.832403
       White -0.6245    0.547 -1.6959   0.447  -1.142 0.253266
    Hispanic  0.2424    0.662 -1.0541   1.539   0.366 0.714039
       Black -0.5592    0.657 -1.8468   0.728  -0.851 0.394667
     EcoLNRR  0.1631    0.609 -1.0306   1.357   0.268 0.788849
       LNInc -0.1142    0.161 -0.4304   0.202  -0.708 0.478869
       Metro -0.0965    0.354 -0.7895   0.597  -0.273 0.784957
 PCBWildlife  0.9621    0.296  0.3815   1.543   3.248 0.001164
        PCBs  0.2441    0.265 -0.2756   0.764   0.921 0.357294
 ChemConcern  0.5931    0.167  0.2661   0.920   3.555 0.000378
      Educat -0.2286    0.256 -0.7311   0.274  -0.891 0.372694
  risk.wldlf  0.0423    0.124 -0.1999   0.285   0.343 0.731909
    tv.wldlf  0.1816    0.157 -0.1271   0.490   1.153 0.248936
     live.fw -0.1510    0.298 -0.7345   0.432  -0.507 0.611938
     time.fw  0.0276    0.133 -0.2334   0.289   0.208 0.835519
     confgov  0.4434    0.323 -0.1899   1.077   1.372 0.169969
conf.gov.web -0.9216    0.353 -1.6129  -0.230  -2.613 0.008985
  conf.print  0.6098    0.267  0.0869   1.133   2.286 0.022271
conf.sci.ind -0.1192    0.237 -0.5830   0.345  -0.504 0.614505
conf.sci.uni  0.1400    0.257 -0.3636   0.644   0.545 0.585921

Gaussian distribution: Dispersion (scale) = 1.326698
Observations: 193 Total; 193 Censored
-2*Log-Likelihood: 447
```

In Table 7, we remove respondent characteristics with a p-level less than 0.15 stepwise except for risk reduction, and find that the estimated coefficients change slightly. The coefficient for risk reduction (EcoLNRR) is still not significant, and still less than proportional with respect to WTP.

Table 7: Valuation Function Results for Eagle (Reduced Model)

```
Distribution:  Lognormal

Standardized Residuals:
              Min    Max
Uncensored     NA     NA
  Censored  0.071 10.575

Coefficients:
               Est. Std.Err. 95% LCL 95% UCL z-value   p-value
 (Intercept)  2.586    1.408  -0.174 5.34570   1.836 0.0663056
     EcoLNRR  0.233    0.597  -0.937 1.40336   0.391 0.6959917
 PCBWildlife  1.060    0.267   0.537 1.58270   3.973 0.0000711
 ChemConcern  0.657    0.151   0.361 0.95273   4.349 0.0000137
conf.gov.web -0.509    0.265  -1.028 0.00918  -1.925 0.0541947
  conf.print  0.605    0.249   0.117 1.09228   2.432 0.0150280

Gaussian distribution: Dispersion (scale) = 1.368229
Observations: 193 Total; 193 Censored
-2*Log-Likelihood: 458
```

The full model for SSD, presented in Table 8, shows a nonsignificant negative coefficient for the magnitude of risk reduction. Although the survey format did not specifically test for the effects of the graphical representation, it is likely that respondents had difficulty comprehending the probability plots shown to them. A negative coefficient indicates that respondents are willing to pay more for a lower risk reduction – in this case, a 1% increase in risk leads to a 40% increase in WTP. Again, as with the eagle survey, income is negatively associated with WTP, another counterintuitive result. However, unlike the eagle survey, education shows a positive coefficient and some college education leads to an increase in WTP.

Significant predictors in the full SSD model are shown in bold in Table 8. This model shows slightly different predictors than the Eagle model. A general concern for chemicals in the environment is still significant, but for the SSD model, respondents who live near freshwater and/or who watch programs on television concerning wildlife are also significant. Living near freshwater is negatively associated with WTP. Those who live near freshwater have a 40% lower WTP than those who do not. The SSD model also shows a significant predictor for confidence in information received from scientists who work at universities (conf.sci.univ).

Table 8: Valuation Function Results for SSD (Full Model)

Distribution: Lognormal

Standardized Residuals:

	Min	Max
Uncensored	NA	NA
Censored	0.097	10.661

Coefficients:

	Est.	Std.Err.	95% LCL	95% UCL	z-value	p-value
(Intercept)	1.5668	2.793	-3.9065	7.040	0.5611	0.57475
married	0.1775	0.346	-0.5004	0.855	0.5131	0.60786
Male	-0.1180	0.332	-0.7681	0.532	-0.3558	0.72196
White	0.0320	0.714	-1.3683	1.432	0.0448	0.96425
Hispanic	0.3433	0.796	-1.2174	1.904	0.4311	0.66639
Black	-0.5334	0.828	-2.1564	1.090	-0.6441	0.51950
EcoLNRR	-0.5688	0.696	-1.9325	0.795	-0.8175	0.41362
LNInc	-0.2548	0.231	-0.7081	0.198	-1.1019	0.27051
Metro	-0.0186	0.424	-0.8487	0.811	-0.0440	0.96493
PCBWildlife	0.4770	0.376	-0.2599	1.214	1.2687	0.20455
PCBs	0.0407	0.360	-0.6649	0.746	0.1131	0.90993
ChemConcern	**0.6757**	**0.230**	**0.2242**	**1.127**	**2.9335**	**0.00335**
Educat	0.4095	0.354	-0.2845	1.103	1.1565	0.24749
risk.wldlf	0.1646	0.164	-0.1567	0.486	1.0039	0.31544
tv.wldlf	**0.3105**	**0.181**	**-0.0445**	**0.666**	**1.7145**	**0.08644**
live.fw	**-0.5756**	**0.358**	**-1.2782**	**0.127**	**-1.6057**	**0.10835**
time.fw	-0.1505	0.174	-0.4925	0.191	-0.8626	0.38835
confgov	**1.0410**	**0.430**	**0.1988**	**1.883**	**2.4226**	**0.01541**
conf.gov.web	**-0.5547**	**0.380**	**-1.3003**	**0.191**	**-1.4582**	**0.14479**
conf.print	-0.2145	0.354	-0.9091	0.480	-0.6053	0.54497
conf.sci.ind	0.3040	0.330	-0.3436	0.952	0.9200	0.35756
conf.sci.uni	**0.5616**	**0.314**	**-0.0547**	**1.178**	**1.7860**	**0.07409**

Gaussian distribution: Dispersion (scale) = 1.821803
Observations: 209 Total; 209 Censored
-2*Log-Likelihood: 484

Table 9 presents the results for the reduced model for SSD in which non-significant predictors are removed. Conf.gov.web becomes strongly non-significant and is also removed.

Table 9: Valuation Function Results for SSD (Reduced Model)

```
Distribution:  Lognormal

Standardized Residuals:
              Min    Max
Uncensored     NA     NA
  Censored  0.156 13.006

Coefficients:
               Est. Std.Err. 95% LCL 95% UCL z-value   p-value
 (Intercept) -2.034    1.394 -4.7658  0.6974   -1.46 0.1444159
     EcoLNRR -0.852    0.701 -2.2261  0.5216   -1.22 0.2240293
 ChemConcern  0.844    0.204  0.4452  1.2436    4.15 0.0000339
    tv.wldlf  0.390    0.171  0.0560  0.7247    2.29 0.0221255
     live.fw -0.594    0.344 -1.2674  0.0796   -1.73 0.0839292
     confgov  0.722    0.346  0.0438  1.4011    2.09 0.0369276
conf.sci.uni  0.606    0.297  0.0243  1.1886    2.04 0.0411634

Gaussian distribution: Dispersion (scale) = 1.904002
Observations: 209 Total; 209 Censored
-2*Log-Likelihood: 496
```

We evaluated several distributional forms and found the lognormal provided the best fit (model specification not shown) using a likelihood ratio test.

We estimated models using Survey 2, human health endpoints first, as well. These are shown in Appendix B.

3.3 Median Household WTP

Median WTP per household is estimated from the regression models at the sample mean of the covariates. Median WTP is typically quite stable at the covariate means and is reasonable to estimate even if individual coefficients are not significant.

Table 10 presents the results of the median WTP estimates for the individual and total models from Surveys 1 and 2. The procedure to estimate the values shown in Table 10 was as follows. We first estimated a WTP model for the first endpoint (Survey 1 – ecological, Survey 2 – human) and specified each endpoint as a categorical variable (Survey 1 – 1 if eagle, 0 if SSD; Survey 2 – 1 if IQ, 0 if reading comprehension (RC)). We then developed a model for the second part of the survey (human health and ecological endpoints combined). In the model for the total, we retained all significant predictors from the individual model (whether significant or not in the total model) and added in significant predictors specific to the second set of endpoints.

Table 10: Median WTP Estimates from the Valuation Functions

	Survey 1 Eco First	Survey 1 Total	Survey 2 Human First	Survey 2 Total
Eagle/IQ	$9.94	$148.63	$1.77	$124.18
Eagle/RC	$68.82	$207.51	($13.21)	$130.15
SSD/IQ	$78.44	$235.21	$25.90	$148.31
SSD/RC	$171.62	$328.38	$12.09	$155.45
IQ			$122.41	
RC			$143.36	
Eagle	$138.69			
SSD	$156.77			

These results show that for Survey 2 (human health endpoints shown first), respondents were not willing to pay much more than what they had already agreed to in the first part of the survey for the eagle endpoint, but were willing to pay slightly more for the SSD endpoint. This is consistent with a number of open-ended responses in which survey takers indicated that they had difficulty understanding why the second set of endpoints hadn't just been included in the first set. However, for Survey 1, in which respondents addressed ecological effects first and potential developmental effects second, respondents showed a higher WTP for the total bundle of endpoints than for the ecological endpoints alone.

4.0 DISCUSSION

A number of the coefficients for both sets of models are counterintuitive to what is expected from economic theory and what previous CV studies have shown. However, the majority of these CV studies relate to human health effects, particularly mortality, rather than ecological effects. It may be that survey takers respond differently to potential ecological risks than they do to risks that they themselves or someone in their household might face. Further, these coefficients are not significant (e.g., income) and their effect is likely small relative to estimated WTP (e.g., WTP is small enough that there isn't an income effect).

Risk – the probability of an adverse effect – is a difficult concept for individuals to grasp under any circumstances. In this case, respondents were asked to consider risks to ecological receptors (species-wide or specifically to eagles). Moreover, they were not asked to consider extinction but rather a more nebulous impact on population viability. Respondents were informed that species would have "trouble reproducing" as opposed to being in any particular danger of extinction.

For those respondents who had a stated WTP (e.g., Y-Y, Y-N, or N-Y), we asked them to rate on a scale of 1 to 5 (not important to extremely important) their motivation for agreeing to a particular bid. The exact questions are provided in Figure 2. These results are shown in Table 11.

Table 11: Descriptive Statistics Underlying Motivation for Y-Y, Y-N and N-Y Respondents

	<<--		Eagle (n=139)			-->>	<<--		SSD (n=135)			-->>
	Altruism	Bequest	Nonuse	Use	Option	Cleanup	Altruism	Bequest	Nonuse	Use	Option	Cleanup
Not Important (1)	1%	2%	1%	4%	5%	1%	2%	0%	1%	1%	8%	1%
Somewhat Important (2)	4%	4%	3%	8%	7%	2%	0%	1%	1%	1%	8%	6%
Quite Important (3)	25%	21%	29%	27%	32%	19%	22%	14%	18%	16%	31%	16%
Very Important (4)	30%	28%	27%	28%	24%	25%	23%	32%	32%	28%	20%	25%
Extremely Important (5)	40%	45%	40%	32%	32%	52%	53%	53%	49%	53%	33%	52%

In both surveys, 52% of respondents with a positive WTP indicated that they supported a cleanup of the environment on principle as opposed to in relation to any specific risk reduction. 53% of respondents rated seeing wildlife as extremely important as compared 32% who rated seeing eagles in particular as extremely important. More respondents in the SSD survey rated bequest value as extremely important than in the eagle survey (53% versus 45%). Option value was lowest across both surveys.

For those respondents who did not have a stated WTP (e.g., N-N), we asked them why they didn't agree to any bid amount. These results are presented in Table 12:

Table 12: Descriptive Statistics for N-N Respondents

	Eagle (n=54)	SSD (n=76)
Isn't worth the money	20%	12%
Difficult for my household to pay	46%	32%
Don't believe the cleanup would work	22%	26%
Percentages do not sum to 100; respondents could choose more than one category		

Respondents were also allowed an "open ended" response in which they could type in their thoughts as to why they did or didn't agree to any bid amount. Approximately 25% of respondents chose to type in a response. Overwhelmingly, these typed-in responses indicated a level of distrust that the government would "spend the resources wisely." Some felt that the "one-time tax" referendum was merely a ruse and that the government would find other ways to keep the tax year after year. A typical open ended response was: "The government wants to do things only if we pay for it, this should be done and that's it. I think the government already receives enough revenue to do this clean up. The have plenty of money to go to war!!!!!!!!!!!!!!"

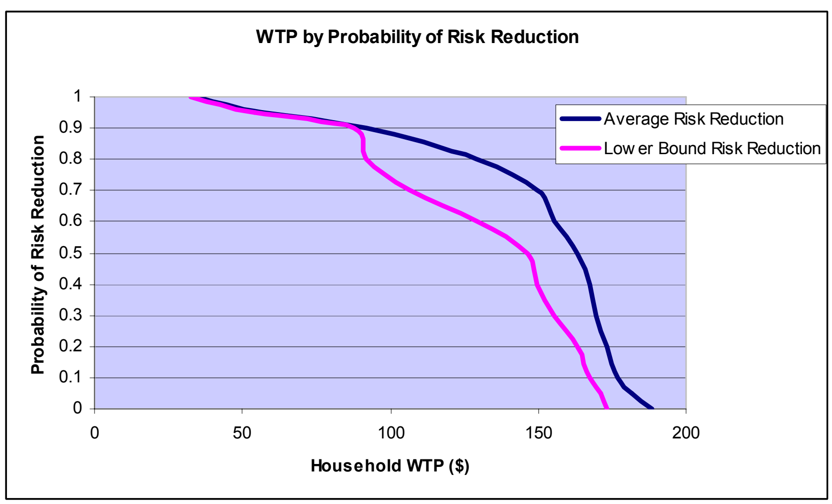
In addition to distrust in the government, approximately 70 of these open-ended responses suggested that the "companies responsible" should pay. A few individuals remarked that they would be willing to pay for humans but not for animals (this question, of course, having been asked prior to the questions related to WTP for developmental effects).

The number of risk reductions, endpoints, and randomization lead to small sample sizes for any given survey (approximately 200). These sample sizes are too small to have any power. However, they provide an initial evaluation into the question of benefits associated with potential risk reductions, and in particular, ecological benefits, which tend not to be quantified let alone monetized and yet which may represent a significant proportion of the overall benefit of management actions taken to mitigate or manage environmental contamination.

4.1 Example of an Application to a Risk Assessment

Using data from the Hudson River and a series of models designed to predict potential ecological risks as a result of exposure to PCBs in specific fish species, we use the results from the eagle model to demonstrate a potential application of WTP in terms of estimating the benefit of predicted risk reductions.

The ecological risk assessment for the Hudson River evaluated a series of management alternatives, including monitored natural attenuation and no action, and developed a series of models that predict the probability of reproductive effects in specific species. Taking the difference between the predicted risk curves under particular alternatives leads to a cumulative distribution function of risk reduction. Substituting the risk reduction function into the WTP function results in the plot shown in Figure 5. This plot shows the estimated household WTP according to the probability of risk reduction between two alternatives. Two results are shown: the average risk reduction, and the lower bound on the risk reduction.



Aggregating over the number of households potentially impacted by the particular management action provides a monetary estimate of the benefits associated with risk reductions. For example, in the case of the Hudson River in New York State, there are approximately 300,000 households in the Upper Hudson River in the counties adjacent to the river, the area most impacted by the PCB contamination (extending approximately 50 miles on either side of the river). For the "total" models (both human health and ecological endpoints combined), the median WTP values ranged from approximately $125 to $300. For 300,000 households, the aggregated WTP would range from $37,500,000 to $90,000,000. These numbers would more than double if more counties were included in the aggregation (not an unreasonable assumption, given that people living near the Lower Hudson River are likely just as interested in potential remedial activities as those individuals living in the Upper Hudson River area).

The risk assessment framework provides the quantitative risk estimates (and reductions) to be valued, and the specific endpoints that provide the basis for evaluating potential decisions (e.g., comparative risk across alternatives). The cost of such a survey, relative to the overall costs of analysis and potential remediation at large hazardous waste sites such as Superfund sites, is actually quite small.

5.0 Conclusions

To our knowledge, a survey that elicits WTP for risk reductions to ecological receptors has not been conducted. We chose this form of phrasing the question to allow a direct connection to the risk assessment framework. The entire set of surveys was designed to be exploratory in nature given the dearth of information on the expected benefits of risk reductions to ecological receptors and for morbidity in humans (particularly regarding low-level cognitive deficits in children as valued by their parents). As such, the sample sizes for our surveys are quite small and highlight directions for further research as well as providing initial information on predictors and relationships among predictors in terms of their influence on WTP.

Much more needs to be done in this area, but using CV methods represents a reasonable approach to developing monetary estimates of benefits associated with management actions, particularly regarding risk reductions. Risk assessment is a process that is used in many contexts to determine the potential human health and ecological impacts of contaminants in the environment, including permitting and development of remedial alternatives. Therefore, it is important to explore methods that link risk assessment and economics in ways that benefit both disciplines and continue to conduct studies that further our understanding and basis for decisionmaking.

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APPENDIX A: Survey 1

PCB Exposure Valuation Survey

November 2004

– Study Details –

SNO	**8551**
Survey Name	**Willingness to Pay for Noncancer Developmental and Ecological Effects Pretest**
Client Name	**Harvard University**
Great Plains Project Number	**K0499**
Project Director Name	**Stefan Subias**
Team/Area Name	**TM Dennis**

Sample Criteria	**General population adults**
Samvar	**Standard demos only.**
Specified Pre-coding Required	**No**
Timing Template Required	**Yes**
Multi-Media	**Images**
Incentive	**No**
Disposition Information (Provide exact descriptions with reference to question numbers and answer list responses for all groups that daily counts are desired)	

NOTES TO SCRIPTER:

FOR B1-B3, THE LOGIC SHOULD WORK LIKE THIS:

- **YES - YES: PICK A STARTING BID FROM ANY OF THE BIDS FROM THE NEXT HIGHEST ON UP (IF THEY AGREED TO $50 RANDOMLY PICK FROM $100, 200, 400)**
- **YES - NO: PICK THE NO BID AS THE STARTING BID FOR THE TOTAL**
- **NO - YES: PICK A STARTING BID FROM ANY OF THE BIDS FROM THE NEXT HIGHEST ON UP (IF THEY AGREED TO $50 RANDOMLY PICK FROM $100, 200, 400)**
- **NO - NO: TOTALLY RANDOMIZED FOR THE TOTAL**

[DISPLAY]
We are conducting this survey to get your opinion on issues such as education, crime, and the environment facing people in your state. The study will provide information so that State policy makers can understand how people like you feel about these issues.

A. Introductory Questions

[Grid – SP by Row]

A1. There are many issues that require resources facing residents in your State. Some of them may be important for you personally and others may not. Please identify whether the listed issue is not important, somewhat important, or very important to you personally:

	Not Important		Somewhat Important		Very Important

Reducing crime
Cleaning up the environment
Improving education
Protecting State waterways
Reducing State taxes
Reducing air pollution
Improving library services
Providing more security at public events

[Grid – SP by Row]

A2. Your State government must allocate financial resources among many different programs. Below you will see a list of different programs. For each one, please indicate whether the amount of money being spent should be reduced, stay the same, or increased, keeping in mind that overall expenditures cannot be increased without an increase in revenue:

	Reduced A Lot	Reduced A Little	Stay the Same	Increased A Little	Increased A Lot

Public transportation in metropolitan areas
Providing homeless shelters
Protecting endangered wildlife
Increased funds for education
Building new prisons
Updating water treatment facilities
Maintaining the court system
Increasing security around public buildings

[Display]

Every year, the State must decide how to allocate money for the State budget. Sometimes new programs are proposed, and the State is interested in knowing how taxpayers feel about these programs in order to decide whether they should be funded or not. Surveys like this are used to explore how people like you feel about the various programs that the State can spend money on in the coming year. Everyone feels differently, and it's important to hear from as many people as possible in order to capture all the different points of view.

This survey is asking specifically about a program involving the potential effects of chemicals in the environment on animals. The next part of this survey will provide some background information on the situation and the potential effects of these chemicals. After that, the survey will ask you whether you think anything should be done about the situation. Finally, we are interested in knowing why you feel the way you do.

[Display]

[INSERT PICTURE OF EAGLE HERE.]

PCBs can have effects on the environment and the birds and mammals that use the environment. Many years ago, eagles were in danger of becoming extinct. Now, they are successfully hatching young and maintaining their populations in some places in the United States. But that is not the case along several waterways in this State. Studies have shown that eagles are sensitive to chemicals in the environment and will often show effects at lower concentrations than humans. As exposure to PCBs increases, there is an increase in the probability that all species will have trouble producing young. Scientists aren't sure what probability of a decline in reproductive capability leads to extinction, but any decline is likely to have a noticeable effect in the population of a species like an eagle, which only produce one or two young per year and which have small populations to begin with.

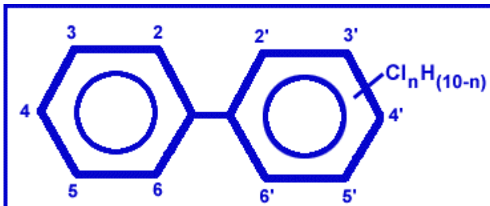
Scientists have studied the issue, and have determined that the trouble is a result of being exposed to a specific chemical that is found in the sediment (dirt) of several rivers, streams, and lakes in your State. Scientists representing the State, Federal government, and academic institutions have spent years studying this issue. They agree that the known deposits of a specific chemical in the riverbeds bears some responsibility in causing these reproductive effects. The chemical is called polychlorinated biphenyls, or PCBs.

[SP]

A3. PCBs are chemicals that were developed in the early 1940's for electrical transformers and for other industrial purposes. They were an ideal insulating fluid because they are not flammable. Have you ever heard of PCBs?

Yes	1
No	2
Not Sure	3

[DISPLAY]



Polychlorinated Biphenyl (PCB)

Up until the early 1970's, people didn't realize that PCBs could affect fish and wildlife. Several companies that manufactured electrical transformers, or provided other industrial services, were located on different rivers in the State. Some of these companies are out of business now, but in the 1940's, 50's and 60's, they were allowed to discharge PCBs with other wastes from their manufacturing processes. Even though there have been no new PCBs discharged into rivers in at least 20 years, the amounts that were historically released continue to affect wildlife in the State. PCBs are very oily and do not dissolve in water. Once they are in water, they fall to the bottom of the river and remain in the sediment. Sediment, which is just sand and dirt at the bottom of the river, is very stable, except when there is a big storm. As a result, there are layers and layers of sediment containing PCBs.

[DISPLAY]

INSERT FOODWEB GRAPHIC HERE

As this graphic shows, insects and shellfish living in the sediment absorb PCBs and transfer them to fish. Animals eat the fish and in this way PCBs accumulate through the food web.

The State is proposing to either clean up or remove the contaminated sediment from the river to make sure that wildlife are no longer exposed. If the sediments are not cleaned up, they will continue to be a source of PCBs to the system.

[DISPLAY]

Eventually, PCBs in the sediments will grow less and less due to natural causes. New, clean sediment will deposit over the dirty sediment over a period of many years. The insects, as they continue to work the sediment, will eventually release or use up much of what is there. Scientists using models developed just for this system have shown that PCBs in the sediment will decrease to levels that aren't expected to have effects on animals and humans in 50 to 75 years. A clean up remedy is expected to take one or two years and will decrease PCB levels immediately after the clean up is completed. It will still take a few years for the species to recover, but they will not be exposed to any new PCBs during that time.

In order to pay for this cleanup, the State is proposing a one-time additional amount on next year's state income tax. Only this one time payment is required and the money will go into a special cleanup fund. There are lots of reasons why you might vote for or against such a program.

D. QUESTIONS RELATED TO ECOLOGICAL RECEPTOR EXPOSURE TO POLYCHLORINATED BIPHENYLS

PROGRAMMING NOTES:

PLEASE SHOW D1 AND D2 RANDOMLY; 50% SEE ONE VERSION, 50% SEE THE OTHER. PLEASE CREATE A DATA-ONLY VARIABLE INDICATING WHICH SCREEN WAS SHOWN.

IN THE FIRST DISPLAY SCREEN, PLEASE SHOW "10%" AND "5%" RANDOMLY; 50% SEE ONE AND 50% SEE THE OTHER. PLEASE CREATE A DATA-ONLY VARIABLE INDICATING WHICH PERCENTAGE WAS SHOWN.

IN THE SECOND DISPLAY SCREEN, PLEASE SHOW "25%" AND "10%" RANDOMLY; 50% SEE ONE AND 50% SEE THE OTHER. PLEASE CREATE A DATA-ONLY VARIABLE INDICATING WHICH PERCENTAGE WAS SHOWN.

[DISPLAY]

D.1. Scientists predict that eagles will have a 20 in 100 (or 1 in 5) chance of failing to produce young if exposed to PCBs. Put another way, if there are 100 eagles, then 20 of them will be unable to produce young. Each dot below represents one eagle. The red dots represent the eagles that won't be able to reproduce.

[SHOW IMAGE WITH 20 RED DOTS AND 80 BLACK ONES]

If the river is cleaned up, scientists predict that the risk will drop to **[**1 in 10 / 1 in 20**]**, or that **[**10 out of 100 / 5 out of 100**]** animals will be affected. There will always be some chance that eagles will have trouble reproducing because the sediments can't be totally cleaned up. Each dot below represents one eagle: the red dots represent the eagles that will still have trouble reproducing after the river is cleaned up.

[SHOW IMAGE WITH 10 RED / 90 BLACK DOTS<u>**[DISPLAY]**</u>

<u>D.1. Scientists predict that eagles will have a 20 in 100 (or 1 in 5) chance of failing to produce young if exposed to PCBs. Put another way, if there are 100 eagles, then 20 of them will be unable to produce</u>

young. Each dot below represents one eagle. The red dots represent the eagles that won't be able to reproduce.

[SHOW IMAGE WITH 20 RED DOTS AND 80 BLACK ONES]

If the river is cleaned up, scientists predict that the risk will drop to **[**1 in 10 / 1 in 20**]**, or that **[**10 out of 100 / 5 out of 100**]** animals will be affected. There will always be some chance that eagles will have trouble reproducing because the sediments can't be totally cleaned up. Each dot below represents one eagle: the red dots represent the eagles that will still have trouble reproducing after the river is cleaned up.

OR 5 RED / 95 BLACK DOTS DEPENDING ON CONDITION SELECTED.]

[DISPLAY]

D2 INSERT RISK GRAPHIC HERE. TEXT BELOW SHOULD BE SHOWN BASED ON WHICH RISK GRAPHIC IS SHOWN.

All species exposed to PCBs will have some risk of reproductive effects. Scientists can plot a graph, like this one, that shows the probability of the number of species that will be affected. From this graph, we can see there is a 50% (1 in 2) chance that **20% (1 in 5)** exposed species will have trouble producing young. This risk decreases to **[25% (1 in 4) / 10% (1 in 10)]** if there is a cleanup.

NOTE TO SCRIPTER: RANDOMLY SELECT THE VALUE FOR COST_E FROM THE FOLLOWING CHOICES: $25, $50, $100, $200, $400, $800; EACH VALUE SHOULD BE ASSIGNED FOR APPROXIMATELY 16.7% OF THE RESPONDENTS (I.E., 100/6). PLEASE CREATE A DATA-ONLY VARIABLE INDICATING WHICH VALUE WAS CHOSEN.

ALSO NOTE THAT FOLLOWUP ITEMS USE THE NEXT HIGHEST/LOWEST BID.

PLEASE MAKE THE HIGHEST BID FOR PEOPLE ASSIGNED TO THE $800 CATEGORY EQUAL TO $1000. PLEASE MAKE THE LOWEST BID FOR PEOPLE ASSIGNED TO THE $25 CATEGORY EQUAL TO $10.

[SP]

D1. The State estimates that this program will cost each household $**[COST_E]**. Your household would pay this one time tax on next year's income tax and the money would go into a special fund set up to clean up the river. There will be a referendum to decide whether the river will be cleaned up and how much the one-time tax should be. If the election were being held today and the total cost would be a one time tax of $**[COST_E]**, would you vote for or against it?

For 1
Against.. 2

PROMPT ONCE.
IF R SKIPS D1, SKIP TO NEXT SECTION.

SHOW D2 IF D1 = "FOR".

[SP]

D2. $**[COST_E]** represents the best estimate of the engineering costs. It could be that the cost to each household would be as high as $**[NEXT BID UP FROM COST_E]** instead of $**[COST_E]**. If this was the case, and the one time tax would be $**[NEXT BID UP FROM COST_E]**, would you vote for or against it?

For 1
Against.. 2

PROMPT ONCE.
SHOW D3 IF D1 = "AGAINST".

[SP]

D3. $**[COST_E]** represents the best estimate of the engineering costs. It could be that the cost to each household would be lower and would only be $**[NEXT BID DOWN FROM COST_E]** instead of $**[COST_E]**. If this was the case, and the one time tax would be $**[NEXT BID DOWN FROM COST_E]**, would you vote for or against it?

For 1
Against.. 2

PROMPT ONCE.

LOGIC FOR D4 AND D5:

D1-D2/3 SEQUENCE: WHICH ONE R SHOULD SEE
Y-Y: THE STATE IS INTERESTED IN KNOWING WHY YOU WOULD VOTE FOR (D5)
Y-N: THE STATE IS INTERESTED IN KNOWING WHY YOU WOULD VOTE FOR (D5)
N-N: THE STATE IS INTERESTED IN KNOWING WHY YOU WOULD VOTE AGAINST (D4)
N-Y: THE STATE IS INTERESTED IN KNOWING WHY YOU WOULD VOTE FOR (D5)

[MP]

D4. The State is interested in knowing why you would vote against the program. There are lots of different reasons why you might vote against the program, like it just isn't worth that much money, or it would be difficult for your household to pay that much even though you support the program, or you are opposed to dredging as an alternative. Or there might be some other reason.

Isn't worth the money 1
Difficult for my household to pay 2
Don't believe the cleanup would work 3
Some other reason, please specify: _______ 4

SHOW D5 IF D1, D2 OR D3 = "FOR".

[GRID – SP BY ROW]

D5. People have lots of different reasons for voting for the program. Please rate the importance of the following reasons why you might vote for the program:

	Not Important		Somewhat Important		Very Important

SHOW "EAGLES" IF D1A/B WAS SHOWN. SHOW "WILDLIFE" IF D2 WAS SHOWN.

I think it's important to preserve **[EAGLES / WILDLIFE]** not just for my enjoyment but for everyone

I would like my children to have the opportunity to have **[EAGLES / WILDLIFE]** in their environment

I think it's important to protect **[EAGLES / WILDLIFE]** – it's important to me know that they are ok even if I don't see them directly

I enjoy seeing **[EAGLES / WILDLIFE]**

It's not very important to me right now if see **[EAGLES / WILDLIFE]**, but I would like the option of doing so in the future

I support a cleanup no matter what the risk might be (I don't like the idea of chemicals in the environment generally)

B. QUESTIONS RELATED TO HUMAN RECEPTOR EXPOSURE TO POLYCHLORINATED BIPHENYLS

[DISPLAY]
PCBs can also have effects on people, especially if they eat a lot of fish. Studies have shown that babies developing in the womb (fetuses) are affected later in life by some chemicals found in fish and other foods that are eaten by their mothers. Developing fetuses are exposed to the same things as their mothers – but because they are so small, and their organs are still developing, even very small amounts of substances that have little or no effect on the mother can have a big impact on a developing fetus. The effects, typically different kinds of developmental delays, can be observed even in small infants and they persist throughout childhood.

Studies involving children exposed while in the womb to PCBs have shown that these children perform less well on a variety of developmental tests. Government officials are interested in knowing whether you would be willing to pay an additional tax for the additional benefit of protecting children exposed in the womb. PCBs are known to cause different kinds of developmental effects, such as small decreases in IQ, and having trouble reading and doing simple math problems. The chemical doesn't cause the exact same effects in every child, but it does cause some effect in every child. **[**One specific effect that government officials are worried about is the evidence that exposure to PCBs causes decreases in reading comprehension below levels considered normal in school-age children. 1 in 5 children exposed to PCBs in this area will read at 7 months below grade level. Put another way, if 100 children represented by the dots below are exposed, scientists expect 20 of them to read at 7 months below grade level. / One specific effect that government officials are worried about is the evidence that exposure to PCBs causes a small but measurable decline in IQ. 1 in 5 children exposed to PCBs in this area will have a 6 point decline in IQ. Put another way, if 100 children represented by the dots below are exposed, scientists expect 20 of them to have IQs 6 points lower than they would have if they hadn't been exposed to PCBs.]

[SHOW IMAGE WITH 20 RED DOTS AND 80 BLACK ONES]

If the river is cleaned up, scientists estimate that the risk will decrease to **[1 in 10 / 1 in 20]**, or that **[10 out of 100 / 5 out of 100]** children will be affected. There will always be some small chance of effects because the sediments can't be totally cleaned up.

[SHOW IMAGE WITH 10 RED / 90 BLACK DOTS OR 5 RED / 95 BLACK DOTS DEPENDING ON CONDITION SELECTED.]

SELECT THE VALUE OF COST_H BASED ON SELECTIONS IN SECTION D. IF THE ENDING BID IN SECTION D WAS $1000 (IN D2), START AT $1000 AS THE VALUE FOR COST_H AND GO UP TO $1500 IF NECESSARY IN B2.

COST_H IS TIED TO THE FIRST BID THEY DID OR DIDN'T AGREE TO:
Y-Y FOR COST_E: SHOW THEM THE NEXT VALUE UP FOR THE TOTAL
Y-N FOR COST_E: SHOW THEM THE "NO" VALUE THEY DIDN'T AGREE TO FOR THE TOTAL
N-Y FOR COST_E: SHOW THEM THE NEXT VALUE UP FOR THE TOTAL
N-N FOR COST_E: RANDOMIZE THE BID VECTOR FOR THE TOTAL

PLEASE MAKE THE HIGHEST BID FOR PEOPLE ASSIGNED TO THE $800 CATEGORY EQUAL TO $1000.
PLEASE MAKE THE LOWEST BID FOR PEOPLE ASSIGNED TO THE $25 CATEGORY EQUAL TO $10.

[SP]

B1. Considering both the human health and ecological effects, the State estimates that the cost for this program will be $**[COST_H]**. Your household would pay this one time tax on next year's income tax and the money would go into a special fund set up to clean up the river. There will be a referendum to decide whether the river will be cleaned up and how much the one-time tax should be. If the election were being held today and the total cost would be a one time additional tax of $**[COST_H]**, would you vote for or against it?

For 1
Against.. 2

PROMPT ONCE.
SHOW B2 IF B1 = "FOR".
FOR B2, CREATE A DATA-ONLY VARIABLE INDICATING WHAT BID HIGHER THAN COST_H WAS SELECTED.
IF COST_H = $1000 AND B1 = "FOR" THEN NEXT BID UP FROM COST_H = $1500.

[SP]

B2. $**[COST_H]** represents the best estimate of the engineering costs. It could be that the cost to each household would be as high as $**[NEXT BID UP FROM COST_H]** instead of $**[COST_H]**. If this was the case, and the one time tax would be $**[NEXT BID UP FROM FROM COST_H]**, would you vote for or against it?

For 1
Against.. 2

PROMPT ONCE.
SHOW B3 IF B1 = "AGAINST" OR SKIPPED.
FOR B3, CREATE A DATA-ONLY VARIABLE INDICATING WHAT BID LOWER THAN COST_H WAS SELECTED.

[SP]

B3. $**[COST_H]** represents the best estimate of the engineering costs. It could be that the cost to each household would be lower and would only be $**[NEXT BID LOWER THAN COST_H]** instead of $**[COST_H]**. If this was the case, and the one time tax would be $**[NEXT BID LOWER THAN COST_H]**, would you vote for or against it?

For 1
Against.. 2

PROMPT ONCE.

LOGIC FOR B4 AND B5:

B1-B2/3 SEQUENCE: WHICH ONE R SHOULD SEE
Y-Y: THE STATE IS INTERESTED IN KNOWING WHY YOU WOULD VOTE FOR (B5)
Y-N: THE STATE IS INTERESTED IN KNOWING WHY YOU WOULD VOTE FOR (B5)
N-N: THE STATE IS INTERESTED IN KNOWING WHY YOU WOULD VOTE AGAINST (B4)
N-Y: THE STATE IS INTERESTED IN KNOWING WHY YOU WOULD VOTE FOR (B5)

[MP]
B4. The State is interested in knowing why you would vote against the program. There are lots of different reasons why you might vote against the program, like it just isn't worth that much money, or it would be difficult for your household to pay that much even though you support the program. Or there might be some other reason.

Isn't worth the money 1
Difficult for my household to pay 2
Don't believe the cleanup would work 3
Some other reason, please specify: ______ 4

[GRID – SP BY ROW]
B5. People have lots of different reasons for voting for the program. Please rate the importance of the following reasons why you might vote for the program:

	Not Important		Somewhat Important		Very Important

I'm worried about the potential risk to my own unborn children

I'm worried about the potential risk to unborn babies generally

I support a cleanup no matter what the risk might be (I don't like the idea of chemicals in the environment generally)

Some other reason: please specify

RANDOMIZE CA OR CB (QALY OR TIME TRADEOFF)

RANDOMLY SELECT A VALUE FOR CA1—EITHER "5 in 10,000" "10 in 10,000" "20 in 10,000". . PLEASE CREATE A DATA-ONLY VARIABLE INDICATING WHICH ONE WAS SHOWN.

USE THE 1/10,000 GRAPHIC WITH THE FOLLOWING "RED AREAS"
LOGIC FOR CA1 AND CA2
STARTING RISK YES GO TO CA2 NO GO TO CA3

5 in 10,000	**10 in 10,000**	**2.5 in 10,000**
10 in 10,000	**20 in 10,000**	**5 in 10,000**
20 in 10,000	**40 in 10,000**	**10 in 10,000**

C. QUESTIONS RELATED TO QALYS

[SP]

CA1. Now we're going to ask a slightly different question. Assume for a moment that you have a 10-year old child that was exposed to PCBs and had a **[SLIGHT READING COMPREHENSION DEFICIT / SLIGHT REDUCTION IN IQ]**. Further assume there is a treatment available to remedy the impairment, but that it comes with a small chance of dying as a result of the treatment. Would you accept a risk of death of **[SEE CHART ABOVE]** for your child to cure the deficit for the rest of the child's life (assuming all other risks remain the same)?

The graphic below provides a picture of what this risk looks like:

Yes 1
No 2

PROMPT ONCE.
SHOW CA2 IF "YES" IN CA1. SHOW VALUE TEXT IN CA2 BASED ON VALUE SHOWN IN CA1—IT SHOULD BE HIGHER RISK (DOUBLE – SEE CHART ABOVE) THAN SHOWN IN CA1.

[SP]

CA2. If the risk of death was as high as **[SHOW RISK VALUE HIGHER THAN THAT SELECTED IN C1: SEE CHART ABOVE]**, would you take the treatment?

The graphic below provides a picture of what this risk looks like:

Yes 1
No 2

SHOW CA3 IF "NO" IN CA1. SHOW VALUE TEXT IN CA3 BASED ON VALUE SHOWN IN CA1—IT SHOULD BE LOWER RISK (HALF – SEE CHART ABOVE) THAN SHOWN IN CA1.

[SP]

CA3. If the risk of death was only **[SEE CHART ABOVE]**, would you take the treatment?

The graphic below provides a picture of what this risk looks like:

Yes 1
No 2

TIMETRADEOFF DAYS OF LIFE LOST

STARTINGVALUE	**YES DOUBLE IT**	**NO HALF**
11 DAYS (WEEK AND A HALF)	**22 DAYS (3 WEEKS)**	**5 DAYS (LESS THAN A WEEK)**
22 DAYS (3 WEEKS)	**44 DAYS (6 WEEKS)**	**11 DAYS (WEEK AND A HALF)**
44 DAYS (6 WEEKS)	**88 DAYS (12 WEEKS)**	**22 DAYS (3 WEEKS)**

CB1 Now we're going to ask a slightly different question. Assume for a moment that you have a 10-year old child that was exposed to PCBs and had a slight reading comprehension deficit [slight reduction in IQ]. Further assume there is a treatment available to remedy the impairment, but that it comes with a small chance of dying as a result of the treatment. Would you accept a reduction in life expectancy of **[SEE CHART ABOVE]** for your child to cure the deficit for the rest of the child's life (assuming all other risks remain the same)?

Yes 1
No 2

PROMPT ONCE.
SHOW CB2 IF "YES" IN CB1. SHOW VALUE TEXT IN CB2 BASED ON VALUE SHOWN IN CB1—IT SHOULD BE HIGHER RISK (DOUBLE – SEE CHART ABOVE) THAN SHOWN IN CB1.

[SP]
CB2. If the reduction in life expectancy was as high as **[SHOW RISK VALUE HIGHER THAN THAT SELECTED IN CB1:SEE CHART ABOVE]**, would you take the treatment?

Yes 1
No 2

SHOW CB3 IF "NO" IN CB1. SHOW VALUE TEXT IN CB3 BASED ON VALUE SHOWN IN CB1—IT SHOULD BE LOWER (HALF – SEE CHART ABOVE) RISK THAN SHOWN IN CB1.

[SP]
CB3. If the reduction in life expectancy was only **[SEE CHART ABOVE]**, would you take the treatment?

Yes 1
No 2

[SP]
C4. Thinking back on your responses for the tax you'd be willing to pay when thinking about the potential effects of PCBs on wildlife, how confident would you say you were about whether you would be for or against this referendum on a scale of 1 to 5 where 1 is "Not confident at all" and 5 is "Very confident"?

Not confident at all				Very confident
1	2	3	4	5

[SP]
C5. Thinking back on your responses for the total tax you'd be willing to pay when thinking about the potential effects of PCBs on both humans and wildlife, how confident would you say you were about whether you would be for or against this referendum on a scale of 1 to 5 where 1 is "Not confident at all" and 5 is "Very confident"?

Not confident at all				Very confident
1	2	3	4	5

[SP]
C6. Were you able to think about how much the ecological outcomes are worth to you separately from the human health outcomes?

Yes
No

[SP]
C7. Do you feel it is possible to think about ecological benefits separately from human health benefits?

Yes
No

E. QUESTIONS RELATED TO MOTIVATION

[DISPLAY]
It is important for government officials to know how you came to your decision.

[SP]
E1. How concerned are you about chemicals in the environment?

Not at all concerned.. 1
Somewhat concerned....................................... 2
Quite concerned 3
Very concerned 4

[SP]
E2. How concerned are you about PCBs in the environment?

Not at all concerned.. 1
Somewhat concerned....................................... 2
Quite concerned 3
Very concerned 4

[SP]
E3. Do you believe that PCBs can cause reproductive effects in wildlife?

Yes 1
No... 2
Not Sure 3

[SP]

E4. Do you believe that PCBs could cause developmental delays in young children exposed in the womb?

Yes 1
No 2
Not Sure 3

[SP]

E5. Did you feel like the survey pushed you to vote a particular way or did you feel like you really made up your own mind based on the best available information?

Pushed to vote for it............ 1
Pushed to vote against it 2
Made up my own mind 3
Not Sure 4

[LARGE TEXT BOX]

E6. What is it about the survey that made you feel that way?

[SP]

E7. Thinking back on all the information, would you say the reproduction problems facing wildlife in this state are…

Not serious at all............ 1
Somewhat serious 2
Very serious............ 3
Extremely serious 4
Not sure 5

[SP]

E8. Thinking back on all the information, would you say the risks facing unborn babies due to exposure to PCBs in this state are…

Not serious at all............ 1
Somewhat serious 2
Very serious............ 3
Extremely serious 4
Not sure 5

F. QUESTIONS RELATED TO RECREATIONAL ACTIVITIES

[SP]

F1. How often do you personally watch television programs about wildlife?

Never 1
Rarely 2

Sometimes..3
Often..4
All the time..5

[SP]
F2. Do you live near a river, lake or stream?

Yes..1
No..2

[SP]
F3. How often does your family spend time near a river, lake or stream?

Never..1
Rarely..2
Sometimes..3
Often..4
All the time..5

[SP]
F4. How often do people in your household eat fish?

Never..1
A few times a year..2
A few times a month..3
Every week..4

[GRID – SP BY ROW]
G2. You receive a lot of information from a lot of different sources. In general, how much confidence do you have in information you obtain from:

	No Confidence	Some Confidence	A Lot of Confidence

Federal government
Scientists who work for industry
Scientists who work for universities
Television media
Internet sources **[NO SELECTION FOR THIS HEADER ITEM]**
- Government web sites
- Commercial web sites
- Non profit web sites
- Academic web sites

Print media (newspapers, magazines)

APPENDIX B: FULL MODELS USED TO ESTIMATE MEDIAN WTP

Model 1: Full Human Health Model from Survey 2 (Developmental Effects to Children Asked First)

```
HMNFULL1 Human only
Distribution:  Lognormal

Standardized Residuals:
              Min    Max
Uncensored     NA     NA
  Censored  0.101 16.221

Coefficients:
                 Est. Std.Err. 95% LCL 95% UCL z-value   p-value
  (Intercept)  0.0447    2.027 -3.9284   4.018  0.0221 9.82e-001
           IQ -0.1484    0.212 -0.5637   0.267 -0.7005 4.84e-001
       LNHHRR  0.0793    0.518 -0.9362   1.095  0.1530 8.78e-001
      married -0.1061    0.225 -0.5472   0.335 -0.4715 6.37e-001
         Male -0.0221    0.218 -0.4491   0.405 -0.1016 9.19e-001
        White -0.6907    0.599 -1.8652   0.484 -1.1527 2.49e-001
     Hispanic -0.4687    0.649 -1.7405   0.803 -0.7224 4.70e-001
        Black -0.5264    0.640 -1.7805   0.728 -0.8228 4.11e-001
        LNInc -0.0480    0.135 -0.3133   0.217 -0.3546 7.23e-001
        Metro  0.6734    0.297  0.0905   1.256  2.2644 2.36e-002
         PCBs -0.4546    0.247 -0.9382   0.029 -1.8424 6.54e-002
  ChemConcern  0.6298    0.142  0.3509   0.909  4.4268 9.57e-006
       Educat  0.3844    0.236 -0.0788   0.847  1.6266 1.04e-001
      live.fw  0.0299    0.236 -0.4336   0.493  0.1264 8.99e-001
      time.fw  0.0319    0.121 -0.2048   0.269  0.2643 7.92e-001
      confgov -0.0601    0.284 -0.6170   0.497 -0.2114 8.33e-001
 conf.gov.web  0.4057    0.285 -0.1520   0.963  1.4258 1.54e-001
     PCBChild  0.2991    0.265 -0.2204   0.819  1.1285 2.59e-001
    risk.baby  0.1681    0.101 -0.0298   0.366  1.6645 9.60e-002
     eat.fish  0.2030    0.137 -0.0647   0.471  1.4863 1.37e-001
   conf.print  0.1521    0.230 -0.2992   0.603  0.6606 5.09e-001
 conf.sci.ind  0.1189    0.194 -0.2621   0.500  0.6117 5.41e-001
conf.sci.univ  0.6935    0.223  0.2566   1.130  3.1109 1.87e-003

Gaussian distribution: Dispersion (scale) = 1.689043
Observations: 403 Total; 403 Censored
-2*Log-Likelihood: 932
```

Model 2: Reduced Human Health Model from Survey 2

```
HMNFULL2 --human valuation not total
Distribution:  Lognormal

Standardized Residuals:
              Min    Max
Uncensored     NA     NA
  Censored  0.121 12.074

Coefficients:
                Est. Std.Err. 95% LCL 95% UCL z-value   p-value
  (Intercept) -0.628   1.3030 -3.1822   1.925  -0.482 6.30e-001
        Metro  0.760   0.2835  0.2044   1.316   2.681 7.34e-003
  ChemConcern  0.704   0.1367  0.4363   0.972   5.151 2.60e-007
 conf.gov.web  0.533   0.2095  0.1220   0.943   2.542 1.10e-002
           IQ -0.158   0.2096 -0.5688   0.253  -0.754 4.51e-001
       LNHHRR  0.109   0.5157 -0.9021   1.119   0.211 8.33e-001
    risk.baby  0.199   0.0902  0.0218   0.375   2.201 2.77e-002
conf.sci.univ  0.764   0.2065  0.3594   1.169   3.700 2.16e-004

Gaussian distribution: Dispersion (scale) = 1.717615
Observations: 403 Total; 403 Censored
-2*Log-Likelihood: 944
```

Model 3: Total Full Model from Survey 2 – Human Health and Ecological Endpoints Combined

```
HMNFULL3 TOTALS from HUMAN FIRST
Distribution:  Lognormal

Standardized Residuals:
              Min    Max
Uncensored     NA     NA
  Censored  0.147 18.628

Coefficients:
                   Est. Std.Err. 95% LCL 95% UCL  z-value   p-value
  (Intercept) -1.863181    1.752 -5.2976   1.571 -1.06329 0.2876484
      married -0.203873    0.195 -0.5870   0.179 -1.04305 0.2969244
         Male -0.084387    0.192 -0.4606   0.292 -0.43962 0.6602105
        White  0.347053    0.482 -0.5980   1.292  0.71974 0.4716880
     Hispanic  0.311541    0.525 -0.7168   1.340  0.59378 0.5526571
        Black  0.494291    0.519 -0.5223   1.511  0.95299 0.3405952
      LNEcoRR -0.226831    0.426 -1.0610   0.607 -0.53297 0.5940565
        LNInc  0.133044    0.118 -0.0981   0.364  1.12804 0.2593029
        Metro  0.143331    0.266 -0.3772   0.664  0.53972 0.5893888
  PCBWildlife  0.263551    0.275 -0.2755   0.803  0.95820 0.3379603
         PCBs -0.308300    0.215 -0.7302   0.114 -1.43222 0.1520796
  ChemConcern  0.555899    0.131  0.2996   0.812  4.25109 0.0000213
       Educat  0.011172    0.207 -0.3951   0.417  0.05389 0.9570196
   risk.wldlf  0.098744    0.116 -0.1292   0.327  0.84899 0.3958891
     tv.wldlf  0.026109    0.116 -0.2007   0.253  0.22557 0.8215324
      live.fw -0.140334    0.205 -0.5429   0.262 -0.68329 0.4944215
      time.fw  0.000398    0.107 -0.2101   0.211  0.00371 0.9970421
      confgov  0.092355    0.246 -0.3902   0.575  0.37515 0.7075519
 conf.gov.web  0.105447    0.246 -0.3766   0.588  0.42871 0.6681329
        Eagle -0.225660    0.430 -1.0679   0.617 -0.52512 0.5994976
           IQ -0.046935    0.186 -0.4124   0.319 -0.25169 0.8012780
       LNHHRR -0.199078    0.455 -1.0911   0.693 -0.43742 0.6618081
     PCBChild  0.170654    0.278 -0.3752   0.716  0.61281 0.5400038
    risk.baby  0.073802    0.110 -0.1411   0.289  0.67317 0.5008407
     eat.fish  0.050486    0.124 -0.1920   0.293  0.40811 0.6831947
   conf.print  0.272215    0.200 -0.1203   0.665  1.35935 0.1740349
 conf.sci.ind  0.224637    0.178 -0.1250   0.574  1.25923 0.2079462
conf.sci.univ  0.408504    0.192  0.0330   0.784  2.13219 0.0329910

Gaussian distribution: Dispersion (scale) = 1.594324
Observations: 402 Total; 402 Censored
-2*Log-Likelihood: 1234
```

Model 4: Total Reduced Model from Survey 2 – Human Health and Ecological Endpoints Combined

```
HMNFULL4 --TOTAL VALUATION
Distribution:  Lognormal

Standardized Residuals:
              Min    Max
Uncensored     NA     NA
  Censored  0.132 14.121

Coefficients:
                 Est. Std.Err. 95% LCL 95% UCL z-value   p-value
  (Intercept) -0.0354   1.1870 -2.3620   2.291 -0.0298 9.76e-001
      LNEcoRR -0.2196   0.4205 -1.0438   0.605 -0.5223 6.01e-001
        Eagle -0.1776   0.4247 -1.0099   0.655 -0.4181 6.76e-001
           IQ -0.0471   0.1822 -0.4042   0.310 -0.2584 7.96e-001
       LNHHRR -0.2382   0.4507 -1.1216   0.645 -0.5286 5.97e-001
        Metro  0.1717   0.2522 -0.3227   0.666  0.6806 4.96e-001
  ChemConcern  0.6040   0.1174  0.3739   0.834  5.1453 2.67e-007
 conf.gov.web  0.3294   0.1780 -0.0195   0.678  1.8507 6.42e-002
   risk.baby  0.1805   0.0814  0.0210   0.340  2.2180 2.66e-002
conf.sci.univ  0.5859   0.1758  0.2413   0.931  3.3325 8.61e-004

        Gaussian distribution: Dispersion (scale) = 1.620886
        Observations: 402 Total; 402 Censored
        -2*Log-Likelihood: 1249
```

Procedure to estimate median WTP: Estimate median WTP at covariate of means for Models 2 and 4. Subtract the results of Model 2 to from the results of Model 4 obtain the difference between the combined endpoint valuation and human health alone. Note that if a predictor was significant in the human health alone model (e.g., Metro), it was retained in the final model for the total as well.

Model 5: Full Model from Survey 1 – Ecological Endpoints First

```
ECOFULL3 USING JUST ECO
Distribution:  Lognormal

Standardized Residuals:
            Min   Max
Uncensored    NA    NA
  Censored  0.08 11.74

Coefficients:
                Est. Std.Err. 95% LCL 95% UCL z-value   p-value
 (Intercept)  1.5732   1.6448 -1.6505  4.7968   0.956 0.3388317
     married  0.1583   0.2096 -0.2525  0.5690   0.755 0.4500837
        Male -0.0271   0.2056 -0.4300  0.3757  -0.132 0.8949894
       White -0.2132   0.4414 -1.0783  0.6519  -0.483 0.6290817
    Hispanic  0.3274   0.5024 -0.6573  1.3121   0.652 0.5145744
       Black -0.3680   0.5164 -1.3801  0.6440  -0.713 0.4759846
     EcoLNRR -0.1558   0.4532 -1.0441  0.7324  -0.344 0.7309472
       LNInc -0.1110   0.1336 -0.3730  0.1509  -0.831 0.4061342
       Metro -0.0855   0.2694 -0.6136  0.4426  -0.317 0.7510953
 PCBWildlife  0.7200   0.2324  0.2645  1.1755   3.098 0.0019482
        PCBs  0.0846   0.2170 -0.3408  0.5100   0.390 0.6965905
 ChemConcern  0.5938   0.1352  0.3288  0.8588   4.391 0.0000113
      Educat  0.0927   0.2126 -0.3240  0.5094   0.436 0.6628326
  risk.wldlf  0.1189   0.0995 -0.0761  0.3139   1.195 0.2322397
    tv.wldlf  0.2859   0.1159  0.0588  0.5130   2.468 0.0136040
     live.fw -0.3494   0.2287 -0.7977  0.0989  -1.528 0.1265856
     time.fw -0.0299   0.1072 -0.2400  0.1803  -0.279 0.7805020
     confgov  0.6448   0.2620  0.1312  1.1584   2.461 0.0138654
conf.gov.web -0.6064   0.2527 -1.1017 -0.1112  -2.400 0.0163992
       Eagle -0.1328   0.4574 -1.0293  0.7637  -0.290 0.7716036
  conf.print  0.2575   0.2115 -0.1570  0.6721   1.217 0.2234150
conf.sci.ind  0.0603   0.1951 -0.3220  0.4426   0.309 0.7572219
conf.sci.uni  0.3229   0.1954 -0.0600  0.7059   1.653 0.0983981

Gaussian distribution: Dispersion (scale) = 1.607052
Observations: 402 Total; 402 Censored
-2*Log-Likelihood: 958
```

Model 6: Reduced Model from Survey 1 – Ecological Endpoints First

```
ECOFULL4 ECO ONLY
Distribution:  Lognormal

Standardized Residuals:
             Min   Max
Uncensored    NA    NA
  Censored 0.109 9.877

Coefficients:
                Est. Std.Err. 95% LCL 95% UCL z-value   p-value
 (Intercept)  0.3457    0.859 -1.3385  2.0299   0.402 6.87e-001
     EcoLNRR -0.0936    0.455 -0.9853  0.7981  -0.206 8.37e-001
 PCBWildlife  0.7847    0.221  0.3521  1.2173   3.555 3.78e-004
 ChemConcern  0.6529    0.126  0.4068  0.8989   5.200 1.99e-007
    tv.wldlf  0.2980    0.109  0.0842  0.5117   2.732 6.30e-003
     confgov  0.6511    0.257  0.1474  1.1547   2.534 1.13e-002
conf.gov.web -0.5246    0.249 -1.0134 -0.0357  -2.103 3.55e-002
       Eagle -0.1225    0.461 -1.0257  0.7808  -0.266 7.90e-001
conf.sci.uni  0.4220    0.188  0.0529  0.7911   2.241 2.50e-002

Gaussian distribution: Dispersion (scale) = 1.642964
Observations: 402 Total; 402 Censored
-2*Log-Likelihood: 969
```

Model 7: Full Model from Second Half of Survey 1 – Ecological and Human Health Endpoints Combined

```
ECOFULL1 USING TOTALS
Distribution:  Lognormal

Standardized Residuals:
            Min   Max
Uncensored    NA    NA
  Censored 0.064 7.829

Coefficients:
                Est. Std.Err. 95% LCL 95% UCL z-value   p-value
 (Intercept)  2.0409   1.7169 -1.3242  5.4059  1.1887 2.35e-001
     married  0.1922   0.1832 -0.1668  0.5513  1.0493 2.94e-001
        Male  0.3139   0.1799 -0.0386  0.6664  1.7453 8.09e-002
       White  0.0908   0.3867 -0.6672  0.8488  0.2349 8.14e-001
    Hispanic  0.5012   0.4431 -0.3672  1.3696  1.1311 2.58e-001
       Black  0.4600   0.4573 -0.4363  1.3563  1.0059 3.14e-001
     EcoLNRR -0.4325   0.3958 -1.2084  0.3433 -1.0926 2.75e-001
       LNInc -0.1430   0.1195 -0.3771  0.0912 -1.1967 2.31e-001
       Metro -0.0716   0.2382 -0.5386  0.3953 -0.3006 7.64e-001
 PCBWildlife  0.0965   0.2510 -0.3954  0.5883  0.3844 7.01e-001
        PCBs -0.0805   0.1924 -0.4576  0.2967 -0.4182 6.76e-001
 ChemConcern  0.5409   0.1189  0.3077  0.7740  4.5471 5.44e-006
      Educat -0.0250   0.1884 -0.3943  0.3443 -0.1327 8.94e-001
  risk.wldlf  0.0379   0.1165 -0.1905  0.2663  0.3252 7.45e-001
    tv.wldlf  0.1679   0.1034 -0.0347  0.3705  1.6240 1.04e-001
     live.fw -0.1596   0.1997 -0.5511  0.2318 -0.7991 4.24e-001
     time.fw -0.0179   0.0964 -0.2068  0.1711 -0.1852 8.53e-001
     confgov  0.5626   0.2324  0.1071  1.0181  2.4209 1.55e-002
conf.gov.web -0.3941   0.2289 -0.8427  0.0544 -1.7221 8.50e-002
       Eagle -0.4804   0.4043 -1.2727  0.3120 -1.1881 2.35e-001
          IQ -0.2919   0.1773 -0.6394  0.0556 -1.6464 9.97e-002
      HHLNRR -0.0395   0.4260 -0.8743  0.7954 -0.0927 9.26e-001
    PCBChild  0.4938   0.2432  0.0172  0.9705  2.0307 4.23e-002
  risk.baby  0.1089   0.1054 -0.0976  0.3155  1.0339 3.01e-001
    eat.fish  0.0141   0.1128 -0.2071  0.2352  0.1249 9.01e-001
  conf.print  0.3218   0.1842 -0.0393  0.6828  1.7468 8.07e-002
conf.sci.ind -0.2032   0.1719 -0.5401  0.1337 -1.1820 2.37e-001
conf.sci.uni  0.4015   0.1721  0.0641  0.7388  2.3326 1.97e-002

Gaussian distribution: Dispersion (scale) = 1.518524
Observations: 402 Total; 402 Censored
-2*Log-Likelihood: 1255
```

Model 8: Reduced Model from Second Half of Survey 1 – Ecological and Human Health Endpoints Combined

```
ECFULL2 TOTALS
Distribution:  Lognormal

Standardized Residuals:
             Min   Max
Uncensored    NA    NA
  Censored 0.059 7.383

Coefficients:
                Est. Std.Err.  95% LCL 95% UCL z-value   p-value
 (Intercept)  0.4750   1.1796 -1.83703  2.7870  0.4027 6.87e-001
     EcoLNRR -0.3987   0.3984 -1.17958  0.3821 -1.0009 3.17e-001
 PCBWildlife  0.0701   0.2426 -0.40542  0.5456  0.2888 7.73e-001
 ChemConcern  0.6348   0.1117  0.41601  0.8537  5.6860 1.30e-008
    tv.wldlf  0.1884   0.0979 -0.00349  0.3803  1.9243 5.43e-002
     confgov  0.5128   0.2271  0.06757  0.9580  2.2574 2.40e-002
conf.gov.web -0.4056   0.2288 -0.85396  0.0428 -1.7729 7.62e-002
       Eagle -0.4596   0.4065 -1.25632  0.3371 -1.1306 2.58e-001
conf.sci.uni  0.3407   0.1664  0.01460  0.6669  2.0477 4.06e-002
          IQ -0.3337   0.1755 -0.67768  0.0103 -1.9013 5.73e-002
      HHLNRR -0.0115   0.4305 -0.85529  0.8323 -0.0267 9.79e-001
        Male  0.3113   0.1742 -0.03012  0.6526  1.7871 7.39e-002
    PCBChild  0.5484   0.2368  0.08435  1.0125  2.3162 2.05e-002
  conf.print  0.3551   0.1823 -0.00223  0.7125  1.9478 5.14e-002

Gaussian distribution: Dispersion (scale) = 1.549919
Observations: 402 Total; 402 Censored
-2*Log-Likelihood: 1266
```

Procedure to estimate median WTP: Estimate median WTP at covariate of means for Models 6 and 8. Subtract the results of Model 6 from the results of Model 8 to obtain the difference between the combined endpoint valuation and ecological effects alone. Note that if a predictor was significant in the ecological endpoints alone model, it was retained in the final model for the total as well.