Valuation of Ecological Benefits: Improving the Science Behind Policy Decisions

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Resources for the Future

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Abstract

For 20 years acid rain has been a central issue in the debate about clean air regulation, especially in New York State's Adirondack Park. Based on a contingent valuation survey of a random sample of New York residents, our study quantifies for the first time the total economic value of expected ecological improvements in the Park from likely policies. Our preferred estimates of the mean willingness to pay using the base case characterization of ecological improvements range from $48 to $107 per year per household in New York State. The alternative scope case yields mean WTP ranging from $54 to $159. Multiplying these population-weighted estimates by the approximate number of households in the state yields benefits ranging from about $336 million to $1.1 billion per year. The instrument passes an external scope test, a test of sensitivity to bid, and a test of sample selection.

Key words: Adirondacks Park, air pollution, contingent valuation, ecological values, New York, non-market valuation, scope test.

Valuation of Natural Resource Improvements in the Adirondacks

1. Introduction

For 20 years acid rain has been a central issue in the debate about clean air regulation and the controversy has centered on the Adirondack Park, which covers some six million acres in New York State. The park was prominent when Congress created the 1980 National Acid Precipitation Assessment Program (NAPAP), which coordinated the expenditure of roughly $500 million to study the effect of acid precipitation on the Adirondacks' ecosystem and other natural resources in the United States. The 1990 Clean Air Act amendments, an important legislative milestone in the protection of air quality, dedicated a separate title to the reduction of acid rain that initiated the well-known sulfur dioxide (SO_2) emission allowance-trading program. More recently, the Environmental Protection Agency (EPA) has cited the reduction in acid precipitation as a benefit of further reductions in SO_2 and nitrogen oxides (NO_X) in its support of the Bush administration's Clear Skies legislative initiative and its regulatory alternative, the Clean Air Interstate Rule. New York State justifies its own regulatory policies and lawsuits against utilities by emphasizing the benefits of reduced acid deposition in the Adirondacks.

Until now, all of these abatement initiatives have taken place in the absence of economic estimates of the total benefits that would result from improvements to the park's ecosystem.[1] In part, this mismatch is explained by the large health benefits that independently justify most policies that reduce acid rain precursors as in U.S. EPA 1999. But it has resulted primarily from an inadequate link between the ecological science and social science necessary to enable

[1] The NAPAP research effort did include a partial assessment of benefits, including an estimate of $4-15 million annual recreational fishing benefits in the Adirondacks, from a 50 percent reduction in acid deposition (NAPAP 1991). No study has ever attempted to estimate the *total* value of improvements in the Adirondacks.

economic valuation of the benefits of emission reductions. This mismatch has also resulted from a lack of information on the ecological effects of changes in emissions and deposition to support that linkage.

Accordingly, while analyzing the environmental pathways linking changes in emissions to economic benefits, Burtraw et al. (1998) identified the quantification of nonuse values as a key gap in the literature and thus a priority area for future research. Indeed, the need for improved estimates of nonuse benefits from ecosystem protection has arisen in many policy contexts. Consequently, the EPA and other agencies are placing increased emphasis on gathering this information, as seen for example in the recent formation of the EPA Science Advisory Board Committee on Valuing the Protection of Ecological Systems and Services.

This study seeks to fill this gap within the important context of air pollution policies by estimating the change in the total economic value (the sum of use and nonuse value) to New York State residents that would result from an improvement in the Adirondack Park ecosystem through further reductions in air pollution. Because stated preference is the only method capable of estimating nonuse values and because our research application focused on a total value rather than a value function of attributes, we employed a contingent valuation survey. The survey was administered both on the Internet and via mail, providing a comparison of mode of administration and an indirect test of convergent validity. While these different modes have their pros and cons, the key survey results are remarkably consistent across modes.

This survey was designed to meet or exceed the stringent protocols for stated preference surveys developed by the NOAA Panel on Contingent Valuation (1993) and the OMB (2003). One of these protocols stresses that the "commodity" being valued map closely to the underlying science. Following this guideline, we interviewed a number of top experts on ecological damages in the park and developed a summary of the science report (Cook et al, 2002).[2] The report serves as the foundation for the description of the park's condition as well as the commodity being valued, that is, the type and magnitude of improvements reasonably following further reductions of acid deposition precursors.

A major effort of our research was to accurately but meaningfully distill this information and convey it to a general audience. To this end, during development of the survey we convened 31 focus groups and conducted two major pretests to develop and extensively assess alternative text, debriefing questions, and graphics.

Our scientific review indicated that there remains much uncertainty about the future status of the park in the absence of intervention and about the benefits of intervention. Nonetheless, focus group results clearly indicated that credibility of the survey depended on respondents believing that scientists understand the problem and how to fix it. Consequently we developed two versions of the survey to span the range of opinion about the status of the park. We use the terms *base case* to refer to the survey that describes a constant baseline (in the absence of a policy intervention) paired with small ecosystem improvements (in the presence of an intervention) and *scope case* to refer to a gradually worsening baseline paired with larger ecosystem improvements. This design choice has the added advantage of permitting an external scope test of preferences, a key test of contingent valuation performance highlighted by the NOAA Panel. We find strong evidence that our instrument is in fact sensitive to scope.

A common criticism of contingent valuation is that the hypothetical nature of the exercise tends to yield overestimates of willingness to pay (WTP). In response, we typically followed a cautious or conservative approach when faced with questions of appropriate survey design by

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[2] A draft of this report was peer-reviewed by field scientists, advocates, and staff at the New York Department of Environmental Conservation (NYDEC).

characterizing the science, presenting information, and applying statistical methods in ways that are expected to yield estimates likely to understate rather than overstate the true WTP for the improvements described.

Our preferred estimates of the mean WTP using the base case characterization of ecological improvements range from $48 to $107 per year per household in New York State. The alternative scope case scenario yields mean WTP ranging from $54 to $159 per year per household. Multiplying these population-weighted estimates by the approximate number of households in New York State yields benefits ranging from about $336 million to $1.1 billion per year.

The results of this study help complete the two-decade-long project of integrated assessment across natural and social sciences, resulting in economic estimates that can be used to guide policymaking to address the ecological effects of acid rain in North America. The above values exceed cost estimates of reducing SO_2 and NO_x emissions from power plants subject to the Clear Skies initiative if the cost share is determined according to the share of these emissions actually being deposited in the park.

2. From Science to Survey

Comprising both public and private lands, the Adirondack Park covers 20 percent of New York State, encompassing nearly three times the area of Yellowstone National Park. One-sixth of the park is designated as wilderness—85 percent of all wilderness area in the northeastern United States. The park has 2,769 lakes larger than 0.25 hectares, six major river basins, and the largest assemblage of old growth forests east of the Mississippi River. Thirty tree species, along with numerous wildflowers and a multitude of shrubs, herbs, and grasses, are native to the park. These attributes draw nine million visitors each year.

The Adirondacks' watersheds are particularly sensitive to potential acidification from atmospheric deposition of sulfates and nitrates, in part because they tend to have shallow soils and bedrock with low acid-neutralizing capacity. However, as is said in the survey, "[m]ost of the lakes affected by past air pollution are small; they are typically much smaller than Central Park in New York City. The large lakes that you may have heard of (such as Saranac Lake or Lake George) are much bigger than Central Park and are not lakes of concern."

Table 1 shows some of the conclusions reached in our analysis of the scientific research and how they translated into descriptions in the survey. Currently, a small fraction of the lakes in the park are acidic due to natural causes (roughly 10%), but most degradation is a result of acidification linked to emissions from power plants and other sources. About half of the lakes are degraded in quality, some of these without fish populations. The actual cause of declining populations of fish is often increased aluminum concentrations, a by-product of the process of acidification.

The future baseline for the park's ecosystem depends largely on nitrogen saturation. If a watershed becomes nitrogen saturated, then increased nitrogen deposition will lead to greater chronic acidification of the receiving water body. Significant reductions in SO_2 and NO_X emissions resulting from the 1990 Clean Air Act Amendments (CAAA) have led to some recovery of acid-neutralizing capacity and surface water pH in the Adirondacks, but not in proportion to the drop in emissions (Driscoll et al., 2001a; 2001b; 2003; Stoddard et al., 1999). Estimates of the time scale for reaching saturation vary considerably from watershed to watershed. Some may never become saturated at current or forecasted deposition levels; others may and would thus require further reductions in deposition for recovery.

This variability and underlying uncertainty implies a range for the future baseline of chronically acidic lakes (assuming constant future deposition) from great degradation to a modest improvement. Assuming full implementation of the 1990 CAAA and no further emission reductions, the share of lakes that are chronically acidic could rise from 19 percent in 1984 to 43 percent or more by 2040 with saturation at 50 years or fall to 11 percent or less by 2040 if saturation is never reached (EPA, 1995). Our response to this information was to develop base case and scope case alternatives.

We found widespread scientific consensus that acidification also has harmed forests (Driscoll et al., 2001a; 2001b; Lawrence, 2001). In particular, because acid deposition has been implicated in declines of high-elevation spruce stands, in the base case scenario respondents are told that the improvement program would yield small benefits to these stands. Moreover, there is mounting but as of yet not definitive evidence that damage to sugar maple and white ash stands also can be caused or exacerbated by acidification.

In the scope case scenario the described damage to the spruce stands is greater, damage to sugar maple and white ash is described, and it is stated that the stands are expected to decline in the future. Improvements from the current and future state of the forests also are more significant in the scope version of the survey.

There is also mounting evidence that acidification is affecting some bird populations. In the base case scenario, acidification is implicated in reduced, but stable, populations of the common loon and hooded merganser. The improvements to these species as a result of the policy intervention are characterized as minor in the base case scenario. In the scope case ecosystem acidification also is implicated in loss of nesting places and changes to songbird populations of wood thrush and tree swallow in the park. In the scope case, all four species are expected to gradually worsen without the policy intervention.

3. Description of Survey Instrument

To develop an estimate of societal WTP to avoid the effects of acidification, we employed a contingent valuation (CV) survey, an approach that has been used since the early 1960s (Davis, 1963) to determine both use and nonuse values and has been extensively examined (Mitchell and Carson, 1989; Haab and McConnell, 2002) in a wide variety of applications. Of the thousands of CV instruments administered to date, there is generally a handful of studies that are considered models. One relatively famous example is the application of the CV technique to estimate damages from the Exxon *Valdez* oil spill in Prince William Sound in 1989 (Carson et al., 2003). A later, widely known, and thorough application by the same team of researchers estimated damages from the Montrose Corporation's release of DDT and PCBs off the coast of Los Angeles (Carson et al., 1994). These studies served as models for the organization and treatment of information in our study provided below.[3] This information is followed by treatment of several thematic issues, which arose from our objective of developing a cautious, valid WTP estimate grounded in science and useful for policy.

Context

The introductory section of the survey is designed to place the proposal into a broad context of household and public decisionmaking and address the embedding problem, which is a tendency of respondents to expand the commodity definition to include many other things than

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[3] A burgeoning literature on valuing ecosystems is increasingly able to inform policy but it is rarely capable of providing estimates of specific value that can be used in benefit–cost analysis (for example, Nunes et al., 2003; Simpson et al., 1996). In a limited application Morey and Rossman (2003) use stated preferenece methods to measure the value of delaying damage to cultural materials from acid deposition.

those intended to be valued (Kahneman and Knetsch, 1992). Respondents are helped to think about substitutes to the proposal without explicitly asking them to choose among different goods. The opening is austere, with the title "Policy Priorities Study: Adirondacks Version," giving respondents the impression that there are many different versions of the survey addressing different issues and public policy priorities. Respondents are asked if they felt their income taxes are too high or low.

To encourage consideration of public goods trade-offs, subjects are asked to specify whether more or less state spending in various areas (such as crime prevention or providing and maintaining natural areas) is called for. They are explicitly reminded that spending increases or decreases may result in higher or lower taxes. Respondents are then told that their version of the survey deals with a tax-and-spending program to improve the health of lakes in the Adirondack Park, while other versions focus on such diverse topics as infant health care and fire protection.

Baseline

Subjects are next introduced to the Adirondack Park and educated about damages to the ecosystems of the park's lakes with specific attention paid to their altered fish populations. We call the affected lakes the "lakes of concern," a sterile term intended to discourage overly dire interpretations of their status.[4] We state that about half (1,500 lakes of approximately 3,000 total) are lakes of concern. We emphasize that these lakes are generally smaller and less well known than the large lakes, such as Saranac Lake or Lake George, that attract most of the park's visitors. In the base case, the condition of forests and bird populations is also characterized. In

[4] Initially we defined lakes as "healthy," "sick," or "dead," and found in focus groups that many subjects had graphic images of "dead" lakes and "sick" lakes and thought that a "dead" lake could not be recovered. We found that using the term "lakes of concern" did not create such a vivid mental image and allowed a more dispassionate description of the commodity. Similarly, we used sterile black-and-white pictures to introduce the affected animals.

the scope case more forest and more bird species are characterized as damaged. Subjects learn that the cause of these problems is acid deposition, acting directly and through aluminum leaching from the soil.

Respondents learn that acid deposition has slowed dramatically thanks to programs to reduce air pollution and that, in the base case, acid deposition is not expected to harm any additional lakes in the future, but nor will the lakes improve on their own. As seen in many polls (Bowman, 2004), in general people believe the environment is worsening over time. That view applied to the Adirondack Park would be erroneous, based on our understanding of the science. We appealed to the authority of scientists studying the lakes and the Environmental Protection Agency (as our focus groups indicate great trust in these groups) to refute this preconception. In the scope case we say that the lakes, forests, and bird populations will worsen slowly without intervention.

A potentially troublesome concern in creating the survey was that the respondents would associate human health damages with damage to the lakes. There are no direct human health hazards from contact with the affected lakes. To address this issue respondents are told that the acidity of the lakes is no more than that of orange juice, that they are safe for swimming, and that there are no health effects from eating affected fish. They are also told that there is no commercial market for these fish.

Scenario

A scenario for the improvement must be plausible to respondents but, as seen in the Montrose and Exxon *Valdez* surveys and many others, need not be a real scenario currently acted upon or even under consideration. What is important is that the improvement approach is credible, is a public good requiring payment by individuals and not so expensive or cheap to make cost an issue. A perfect scenario is transparent and uses a payment vehicle that avoids any bias in WTP responses. Telling the truth—that imposing reductions on power plants and other sources of air pollution is the best way to fix the problem—could very well lead to biased responses, which is what we found in initial focus group settings.

Our solution was to develop a fictional program that "scientists determined to be the safest and most practical" for improving the Adirondacks ecosystem, involving the application of a Norwegian technology to lime lakes (each year for ten years) and, in the scope case, forests by airplane. In fact, liming of lakes to reduce acidity on an individualized basis does occur, but it remains controversial and, to our knowledge, an application of the scale described in the survey has never been recommended. However, liming constitutes an active, public program that would require the collection of additional taxes—and, hence, the opportunity to elicit WTP.

The ten-year improvement period is probably in reality too short a time for the ecological improvement from reducing acidification precursors to be fully realized. We choose a ten-year horizon for benefits for two reasons. Practically, focus group participants equated long time frames with uncertainty of outcome, which reduced the perceived effectiveness of the intervention and thus biased WTP downward. Furthermore, emission reductions under Title IV of the Clean Air Act Amendments have shown a change from trend in the Adirondacks lakes in less than ten years since the program took force in 1995, so that important improvements could in fact be expected in this time frame (Driscoll et al., 2003).

Focus group responses pointed to distrust of the ability of New York State government to implement the program as described, and there was concern that the government would use the taxes raised for the program for other purposes. Consequently, we invoked "an independent Adirondacks Management Board of scientists, a representative from the U.S. Environmental

Protection Agency, and other experts" that would oversee the program. In focus group testing, this board appeared to deflect many of the concerns about management credibility.

In response to concerns that anglers will reap benefits and should pay their share of the costs of improvements, we said that, where necessary, the fish will be restocked using revenue from fish license fees. To fill out the scope case, we said that a tree-planting program would supplement the liming of the forest.

Commodity

The effects of this program, and the commodity to be valued, vary for the base and scope cases. In the base case, the improvement[5] is to 600 lakes of concern (out of 1,500), which will take place over a ten-year period, after which the lakes will be stocked with fish. Small improvements in the populations of two bird species and one tree species will also occur, limited to areas surrounding the affected lakes. In the scope case, improvement is to 900 lakes, plus two additional bird species and two additional tree species. The status of the lakes with and without the intervention is summarized in a pie graph and recapped in a summary table along with the baseline and changes to tree and bird populations. For the scope version, improvements to the forests are displayed using a pictograph with each square on a grid representing some number of trees of various species, and their health, as a portion of total forests in the park.

Payment Vehicle

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[5] In early focus groups, we described the resource as being "restored," but found considerable evidence of loss aversion in voting decisions as many people felt that ethics demanded we "clean up our messes." We believed that, though such ethical perspectives are an important element of the policy debate, the issue is independent from a measure of the benefits from the particular resource. A cautious approach to valuing benefits required that we divorce stated WTP for the particular improvements from the general desire to rectify past harm. As a solution, we turned to "improvement" over "restored."

Respondents (speaking for their households) are then presented with an opportunity to pay increased taxes annually for ten years, if the majority of voters agree. To strengthen the certainty of the government's commitment, the funding instrument for the program is a revenue bond that must be paid off by the increased tax revenue. Prior to voting, respondents are presented a balanced list of three reasons they may want to vote for or against the program. They are also presented with "cheap talk" language that warns the respondent of a tendency by people to answer survey questions about WTP in a different way than they would behave in actual decisions and to try to consider their choice as though it was an actual decision.

Eliciting WTP

Finally, we elicit a vote in referendum format for or against the program, plus a single follow-up vote in referendum format, motivated by the idea that engineering costs are uncertain.

Based on the results of two pretests, we targeted initial annual payment (bid) levels at approximately the median and the 30th and 70th percentiles of the WTP distribution for the base case improvements. We also sought information in the right-hand tail given that estimates of mean WTP can be particularly sensitive to distributional assumptions in that region. Initial bids were set at $25, $90, $150, and $250. Follow-up bids, conditional on a "no" or "yes" response on the initial bid in the first vote were set at ($10, $50), ($50, $150), ($90, $250), and ($150, $350).[6] The first number in the follow-up bid is if they voted "no" initially and the second is if they voted "yes."

Debriefing

After they voted for the program, we asked participants several debriefing questions. The primary purposes of these questions were: (i) to solicit respondents' beliefs about the information

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[6] In addition, one of the pretests, used in the final data analysis, had initial bids set at $35, $85, $150, and $200.

and improvement scenario they were provided; (ii) to give them some limited opportunities to revote when their beliefs were at odds with the survey's intent (if they believed there were health effects,[7] if they voted "no" only because New York State was responsible for implementing the improvement plan or if they voted "no" because they believed upwind electric utilities should pay); and (iii) to examine their more general attitudes and beliefs that might lead them to provide "nay-saying," or "yea-saying" responses (see below). We also asked demographic questions in this section, including one rarely asked about respondent's future family income. This question was asked because the payment was to be over a ten-year period. This variable turned out to be more significant than current income in explaining WTP.

After the demographic questions, at the end of the survey we inform respondents that the liming program is not being considered by the New York State government and is not feasible. Respondents are also told that these improvements would actually occur through further reductions in pollution and who the sponsors of the survey were.

Expansive Priors

One may reasonably ask why we bother to introduce the effects of the intervention on forests and birds in the base case if these endpoints do not improve significantly as a result of the intervention. Initially our approach was to simply limit the description of the damage to the aquatic ecosystem in the base case. However, we discovered in focus groups that omitting mention of forests and birds in the base case was inconsistent with respondents' prior beliefs. Because it was judged so unlikely that forests and birds were neither being currently damaged nor would be helped by an improvement plan, respondents substituted their own expansive

[7] 52 percent accepted that there were no human health effects, 38 percent thought that there may be minor health effects, and 10 percent thought there were important health effects. Of those who had voted for the program and thought there were health effects, about 12 percent changed their vote to "no" when asked to suppose there were no health effects.

priors, ascribing much broader and larger effects to our improvement plan than we intended or that the science can substantiate. There is some evidence that this substitution had the effect of actually making their WTP higher for the base case than for the scope case. Accordingly, we validated respondent priors by both narrowly identifying effects on forests and birds and describing their improvements as minor. In focus groups we found this change made the information treatment more credible, so that respondents suspended their priors and accepted our characterization.[8] A similar challenge was to make credible and certain the characterization of a constant future baseline and limited health effects, as discussed above.

Yea-saying and Warm Glow

One potential concern with contingent valuation is a presumed tendency of respondents to vote “yes” for programs in a pro forma way, perhaps out of a sense of obligation or desire to please the survey administrator, but in any case without truly registering the economic trade-offs involved and hence without truly revealing preferences. A special case is “warm glow,” in which respondents value the giving per se as much as the commodity acquired (Andreoni, 1990). Including warm glow would overstate values for the actual commodity, in this case the Adirondacks.

As noted previously, the introductory pages of the survey are designed to make respondents immediately think about the opportunity cost of paying for the program, and before voting they were reminded of costs and other reasons to vote “no.” In addition, we took pains to use line drawings and other design features to minimize embedding and to avoid emotional triggers. Also, we asked a series of debriefing questions that could be used to identify this type of vote. In particular, we asked respondents if they agreed that “costs should be a factor when

[8] Moreover, this nuance in fact made the scenario more consistent with the science than the simplistic no-terrestrial-effects description.

protecting the environment." Fully 75 percent of the respondents agreed that costs should be a factor, suggesting they believe in the trade-offs inherent in a willingness-to-pay exercise. Moreover, of the others, one-fifth exhibited implicit acceptance of the maxim when they switched their vote to "no" in the follow-up valuation question when the bid was changed.

Nay-saying

In contrast to yea-saying, nay-saying is a tendency for respondents to vote against a program for reasons that are extraneous to its benefits and costs. This includes respondents who reject the scenario or choice construct as presented or who use their vote to register some other protest. For example, some people vote against the program on the principle of limiting taxes or because they do not trust the New York State government to implement the program or because they don't think the program will work. Although our cautious approach made us more tolerant of nay-saying than yea-saying, we nevertheless designed the survey to limit and identify this phenomenon. About 79 percent of the sample agreed in principle that there are programs that could justify new taxes. But as with our debrief targeting warm glow, actions speak louder than words here, with almost half of the remaining 21 percent voting for the program and its tax increases at some bid level. Moreover, as discussed below we asked several debriefing questions on beliefs about the baseline and the feasibility of our program, with most respondents accepting the scenario.

4. Survey Protocol

The survey was administered by Knowledge Networks (KN) from August 2003 through February 2004 to residents of New York State. We selected this population for several reasons. First, New Yorkers are most likely to hold nonzero values for improvements to the Adirondacks. Second, designing an acceptable method of payment was easier if the sample were limited to

New York. Third, by ignoring people out of state we were being cautious in our total benefit estimates.

Table 2 summarizes the total sample, useful completions, and response rates for the different modes of survey administration. Results from a second pretest were included in the data analysis.[9] Response rates to KN's preselected panel were, as expected, quite high, ranging from 84 percent for the pretest to 74 percent for the final implementation. The group comprises 53 percent of our total completed surveys.

To boost the sample size provided by Knowledge Networks and to examine the potential sample selection caused by attrition in the KN panel, the survey was given to a group that had withdrawn from the panel. This version was administered over the Internet and, with the exception of some demographic debriefing questions, was the same as the version given to the panel. The response rate for this group was 14 percent and totals 16.8 percent of our completed surveys. Although this response rate seems low, it is not surprising from a group of subjects who had already declined participation in one venue.

As a formal test of mode of administration, as an additional check on the KN panel, and to further boost sample size, a final wave was mailed using a random-digit selection of telephone

[9] An initial pretest was omitted from the final analysis, as it was too different from the final instrument.

numbers that were in turn matched to available addresses. The response rate for the mail survey was 24 percent, and the group constitutes 31.3 percent of our completed surveys.[10]

Table 3 presents descriptive statistics of the demographics of each sample. It illustrates the difference among the samples and, where possible, compares them to the general population of New York State. While there are some differences across the samples (for example, the mail sample had the oldest average age, while the withdrawn sample had the youngest), in general they display fairly consistent attributes. On each measure, the samples are proximate to the characteristics of the general adult population in New York State.

5. Results

With the NOAA Panel protocols and OMB guidelines putting the burden of proof squarely onto the researchers to show that their results are valid, we start with showing the validity of our results before actually summarizing what they are.

Measures of Validity

We present three basic measures of validity: the external scope test, sensitivity of vote to bid, and construct validity, that is, the extent to which patterns in the data reflect common sense and expectations based on economic theory.

The external scope test examines whether two separate samples have different average WTP for differing scales of environmental improvements (Boyle et al., 1994). It is a test both of the

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[10] Techniques used to induce response from respondents varied amongst the samples. Members of KN's panel received compensation equivalent to about $10 in Internet service in exchange for completing the survey while withdrawn and mail respondents received $10. In addition to these incentive payments, subjects received reminders to complete their surveys. Members of the panel received reminder e-mails encouraging completion of the survey. Members of the withdrawn and mail samples received follow-up phone calls and reminder letters. For the mail sample up to five attempts at person-to-person calls were made to contact the potential respondent to directly request that they take the survey.

subjects' comprehension of and attention to the scenario and vote, as well as warm glow and embedding, or what Mitchell and Carson (1989) call "part-whole bias." The scope test has been a major standard for contingent valuation since the NOAA Panel report.

A fundamental issue in designing a scope test is determining which dimensions of the resource or service to expand. For example, Boyle et al. (1994) failed to find sensitivity to the scope of a program to save migratory waterfowl from oiling themselves in dirty ponds. The scope was measured as a variation in the number of birds (in three different versions, 2,000, 20,000, or 200,000 birds would be saved respectively). Some have criticized this scope test on the grounds that the commodity is mistakenly defined: people might care more about the availability of the clean ponds themselves than the birds or perhaps measured birds in flocks rather than individuals or, again, in percentage terms rather than numbers. On the other hand, Carson et al. (1994) passed a test of scope when comparing a project that would improve the health of two fish species in Los Angeles Harbor to a project that would in addition improve the health of bald eagles and peregrine falcons. This approach to a scope test is in contrast open to the criticism that the scope of a commodity has not been measured at all, but rather an entirely new commodity that is more greatly valued than fish.

Our approach to the scope test attempted a compromise between the narrow more-individuals and the broad more-commodities approaches. We defined the resource to be scaled as the health of the Adirondack Park as a *system* of lakes, forests, and animals. Specifically, we varied the quantity of lakes improved (analogous to Boyle et al.) and also varied the number (and quantity, in percentage terms) of tree and bird species improved. Our results provide strong evidence of sensitivity to scope. Table 4 reports the share of "yes" votes at each bid level for the base and scope versions.

Several approaches can be used to test for scope sensitivity using these data. The most nonparametric and perhaps most persuasive is to test for differences in the mean share voting for the program at each bid level. P values for this chi-square test are provided in the final column of the table. As seen in the table, more respondents vote for the program under the scope scenario at each bid level, and the difference is statistically significant. Respondents are thus willing to pay more when they understand there will be greater improvements. In addition, estimates of mean WTP are higher for the scope version under a variety of model specifications (see the section on willingness to pay estimates below), and these differences are also statistically significant.

Finally, other results corroborate the interpretation that respondents were paying careful attention to the description of the resource. For example, when we asked whether respondents accepted our description of the baseline state of the Adirondack Park, in the base survey instrument 24 percent of the sample said that it was probably worse than we described it, compared to only 6 percent with the scope instrument, a statistically significant difference. Similarly, 15 percent of the sample thought that the survey was biased in favor of the program with the base instrument, but 27 percent thought so with the scope instrument. The relatively low numbers here overall are also evidence of content validity.

The second important statistical test is sensitivity to the level of the bid, that is, whether fewer respondents vote "yes" when the bid level is increased within each given scenario. In fact we find that responses are strongly statistically significant for both the base and scope versions (with the exception of those cells with few observations, accounted for by the pretest). Even including these cells, the difference is statistically significant according to a chi-squared test of the equality of means. Moreover, according to Kendall's tau test these differences are statistically ranked monotonically by bid, showing a consistent increase.

Figure 1 concisely illustrates the sensitivity to scope and bid, omitting the sparse cells from the pretest. Sensitivity to scope is indicated in each bid category by the higher percentage who voted “yes” in the scope scenario than the base scenario. Sensitivity to bid is indicated by the decline in the share of respondents willing to vote for the program as the initial bid level is increased, for both the base and scope scenarios.

The third set of construct validity tests verifies that the other patterns in the data conform to theory and common sense. We find that they generally do. Table 5 provides a representative regression output covering three types of variables: demographic, attitudinal, and the degree to which respondents accept the concepts in the survey and other information provided to them (protests or indications of yea- or nay-saying). Model 1 contains only demographical and attitudinal variables, model 3 contains only the protest variables, and model 2 contains both. Some of these variables may be considered endogenous, an issue we return to below in the discussion of willingness to pay.

Models 1 and 2 in the table show households with the highest incomes have the highest WTP, as expected. The poorest households are also more likely to vote for the proposal, presumably because they do not expect to have to pay for it, but the effect is not significant. Consistent with the permanent income hypothesis and with the fact that payment would occur over a ten-year period, those who expected their future income to be higher are willing to pay more than those who thought otherwise. Household size is also a consistently significant factor, with larger households less likely to vote for the program, although the effect is not significant. On the other hand, holding household size constant, households with more children are significantly more likely to vote for the program.[11] Other standard demographic variables (age, race, sex) are unsigned as hypotheses and were not considered in our analysis.

Measures of personal stake in the resource are also important. Households that frequently visit the park (more than ten times a year) are willing to pay more for the program than others who visit less frequently. In addition, those living farther from the park are willing to pay less, with WTP falling by about $0.08 per kilometer from the household's closest entrance (by road) to the park and with an elasticity of WTP to distance of about 0.4 when controlling for indicators of protests (model 2).[12] This information is important for this study because of the inferences one might make about WTP of households outside of New York. The finding is consistent with previous work (Johnson et al., 2001).

Regarding the effect of attitudes on voting, self-classified environmentalists are more likely to vote for the program, just as self-proclaimed conservatives and those who think taxes are too high are more likely to vote against. We also asked people in the beginning of the survey if they are interested in government spending more on nature and wildlife programs and on air and water pollution control programs, among other things. Those who favored more government spending on the environmental programs are more likely to vote for the program. In alternative models, we replaced these variables with indicators for those who describe themselves as "liberal" or "conservative," and find that the former are more likely to vote for the program while the latter are less likely to do so.

Willingness to Pay

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[11] The model includes an indicator variable for the presence of children, plus a linear term for the number of children. The former is negative, but the latter is positive and offsets the former at two children.

[12] After conditioning on distance, those living within the park's boundaries do not appear to pay more than other households.

We designed our strategy for estimating willingness to pay to limit three potential sources of bias: the representativeness of the sample, anchoring in the follow-up vote on the program, and yea-saying or nay-saying votes.

The first potential source of bias is the possibility of an unrepresentative sample, especially for the KN panel of regular survey takers. To address this potential problem, first we weighted all responses by all observable demographics, including location of residence, to reflect the New York State population. To address unobservable factors, we included a random mail-based sample of the entire New York population as a check on the KN panel. After weighting the data to account for the differing demographics of the sample (see Table 3), we could not reject the hypothesis of equal WTP from the differing survey modes.

Furthermore, one of the advantages of the KN panel is that Knowledge Networks elicited initial background demographic and attitudinal questions for all its panel members. Thus, we have individual-level details about the nonrespondents. This information provides a unique opportunity to estimate sample-selection models against both those currently on the panel, but not completing our survey, and those who have dropped out of the panel over time. We estimate a Heckman sample selection model with a joint normal distribution between the unobserved component of responding to our survey (among all those ever on the KN panel) and the unobserved component of voting for the program. With this model, we cannot reject the hypothesis that the correlation is zero, again implying no differences among the samples.[13]

The second potential source of bias is the use of the follow-up dichotomous choice question, giving double-bounded rather than single-bounded data. Using double-bounded data

[13] The test is in the context of a model implying that WTP is lognormally distributed, one of the econometric models presented below.

provides gains in efficiency (Hanemann, Loomis, and Kanninen, 1991), but may induce bias if the WTP distributions differ across the two equations, for example because the new price in the follow-up question sends a signal about the program quality or suggests that a strategic game may be being played (see Haab and McConnell, 2002, for discussion). Estimating willingness to pay with a lognormal distribution and restricting a completely general binary probit model to be consistent with a single distribution (Cameron and Quiggin, 1994), we reject the hypothesis of identical distributions at the one percent level using a log-ratio test.[14] Although we cannot reject the hypothesis of constant median WTP, estimated mean WTP is lower using the double-bounded data, a typical finding. Still, as with others using dichotomous choice data, we prefer to make use of the additional efficiency afforded by the follow-up question. Moreover, any potential bias introduced by this approach is downward, which is consistent with our cautious philosophy.

The third type of potential bias is yea-saying or nay-saying. If these problems came undetected, they would contaminate the estimates of WTP for the intended commodity with values for other commodities. As discussed above, we attempted to identify such problems by probing people's beliefs about the scenario and their willingness, in principle, to make trade-offs between taxes and public goods. Table 6 summarizes the key probes and divides them into those tending to bias WTP upward (yea-saying) and downward (nay-saying). It also shows the share of respondents whose answers raised flags and our response. In some cases, when we identified

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[14] However, employing a nonparametric test suggested by Haab and McConnell (2002), we find that, for those bid levels used both in initial votes and in follow-ups ($150 and $250), the percentage voting "yes" in the second vote, conditional on voting "yes" in the first vote, was higher than the unconditional percentage voting "yes" in the first vote. This finding is consistent with the existence of a single distribution, and so constitutes a failure to reject the hypothesis of a constant values across votes (compared to the alternative hypothesis of falling values in the follow up). Admittedly, this is a weak test.

problems (such as a belief that human health would be improved by the program), we asked respondents to hypothetically accept our premise and revote. If they did not change their vote, or in cases where we did not ask them to revote, we then have the opportunity to eliminate the respondents from the sample or to control for them econometrically. As discussed below, our results are robust to these differing treatments.

Using the full double-bounded data, we used standard methods for analyzing interval data (Hanemann, Loomis, and Kanninen, 1991; Haab and McConnell, 1997), and assume that the responses are distributed according to Weibull and lognormal distributions. These distributions imply that WTP is always positive. They generally provide similar estimates of the effect of covariates, but mean WTP is generally larger with the lognormal distribution because of a thicker right-hand tail.

We estimated population-weighted interval models of the WTP distribution, controlling for indicators of scenario or task rejection. In estimating WTP, we did not control for demographic and attitudinal variables, such as those in models 1 and 2 of Table 5, as these variables have no "right" answer and can simply be integrated over in computing mean WTP as long as they are properly weighted to reflect the New York population.

In order to control for yea-saying and nay-saying, we either dropped respondents or controlled for them econometrically. Model 3 in Table 5 presents the regression results for the all-econometric-control case using the lognormal distribution. Table 7 presents the full array of mean WTP estimates arising from different combinations of these two approaches (drops and controls) for the base case survey. Table 8 does the same for the scope case. Each cell contains estimates of the mean WTP for the lognormal and Weibull models. The columns represent adjustments made for nay-saying controls, while the rows represent adjustments made for yea-saying controls.

To decide which variables to target for dropping (instead of adjusting econometrically), we ran a series of regressions to determine which variables had the most important affect on WTP. For yea-saying, the most significant variables are the attitude that costs should not be a factor when protecting the environment and the belief that health effects are important; for nay-saying, the most important variables are the belief that taxes should not be raised under any circumstances and the belief that the liming program was not practical.

In the various treatments indicated in Tables 7 and 8 these variables are either dropped or else controlled for econometrically by calculating WTP from the estimated regression coefficients after redefining the targeted variable's value appropriately (for example, setting the "thought there were health effects" variable to zero). All other variables of concern listed in Table 6 were similarly controlled for econometrically.

Looking down the first column of data on Table 7, note how close the estimates are to one another, ranging from $58 to $80. This implies that the results are remarkably robust to various attempts to correct for warm glow and other yea-saying effects. The results appear to be less robust when adjusting solely for the nay-sayers in the first row of the table, but still fairly robust overall. As expected, the lognormal model produces substantially larger estimates than that of the Weibull model, although results based on the latter model are fairly similar.

The other rows and columns of this table provide results for various combinations of controls on the different groups of people in the sample. The diagonal is particularly important, as it represents a symmetric treatment of yea- and nay-sayers. Across all the cells with some form of control (either econometric controls or dropping specific variables) the results are quite close to one another, ranging from $156 to $266. This suggests that our estimates are quite robust to the choice of dropping or controlling econometrically for these responses. However, comparing the middle of the table with various choices of dropping or controlling econometrically to the first row and column, it is clear that our results are sensitive to treating various yea-sayers and nay-sayers in some form versus not at all. We tend to favor models with more controls, but a case could be made for omitting some controls if it is believed responses to the debriefs are endogenous with responses to the vote. In other words, after the vote, people might look for additional reasons to justify their vote when they respond to the debriefing questions.[15]

We consider the symmetric, all-econometric-controls option as our preferred model in Table 7 since it maintains the largest sample size and symmetrically controls for both yea-sayers and nay-sayers. The Weibull model gives an estimate of $159, while the lognormal model gives an estimate of $213. Turning to Table 8 for the scope case, the corresponding best estimates are $179 and $308 per household per year.

The range of results across the cells of the table, and between the Weibull and lognormal models, represents model uncertainty in the WTP estimates. The range between the base and scope estimates represents the scientific uncertainty about the baseline state of the Adirondacks and the effects of policy interventions. Each of these estimates is further subject to statistical uncertainty, as indicated in Figure 2. The figure reflects uncertainties in WTP from the regressions with only econometric controls and shows that statistical uncertainties are quite small for the Weibull model and considerably larger for the lognormal model. Ninety-five percent

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[15] One might in particular accept respondents' statement that they would not have changed their vote if there were no health effects or even if New York State were not involved, obviating any need to control for those responses. Dropping those controls lowers estimates by about one-fourth and widens the differences between the base and scope cases.

confidence intervals for the latter are two to two-and-one-half times greater than the mean on the high side, compared to about a 25 percent confidence interval on the Weibull models.

An even more cautious approach, using the most conservative design, is to estimate the Turnbull lower bound (Carson et al. 1994, Haab and McConnell, 1998). This approach considers the WTP of each household to be the lower bound of each interval of data. For example, if a respondent answers "yes" to an initial bid of $25 and "no" to $50, this approach would interpret $25 to be the actual WTP. In fact it is the lower bound of the $25-to-$50 interval. Besides being unassailably cautious, this approach has the advantage of avoiding any distributional assumptions.[16]

Using the double-bounded referendum format, the Turnbull lower-bound estimates in the base case scenario yield an estimate of mean WTP of $53 per household using all the data and $46 per household dropping those who say costs should not be a factor, who believed there were significant health effects, or who thought taxes should not be raised for any reason. The Turnbull lower bound estimates of the mean WTP for the scope case are $155 and $111 per household respectively.

6. From Survey to Policy

The foregoing results, although they are weighted to represent the population of New York, lack three elements to make them policy relevant. The first is that they are developed from a particular temporal phasing of payments and benefits that is unique to the survey. Converting them to annualized benefits over an infinite time period would make them more generally useful. Second, they provide total values for improvements at the park. But in some applications it may

[16] Note that because it is a nonparametric estimator, the Turnbull lower bound cannot control for protest attitudes. Thus, respondents must be either maintained in the sample or dropped.

be important to have some idea of the use and nonuse value components. Third, as with any estimate of benefits, the question arises: are these big numbers or small numbers? That question is answered by comparing the estimates to a cost benchmark.

Discounting

The WTP estimates computed directly from responses as provided above are for payments over a ten-year period beginning immediately to obtain a stream of benefits that won't begin in full until the end of that ten years. For use in a benefit–cost analysis, we need to convert these estimates into an annualized infinite stream. Assuming benefits phase in linearly over ten years, the equation below provides this conversion:

$$\text{Annualization Factor} = \frac{\sum_{i=0}^{9} \delta^{i}}{\delta^{10} * \left(\frac{1}{1-\delta}\right) + \sum_{i=0}^{9} 0.1 i * \delta^{i}} = 10\text{r}$$

where $\delta = \frac{1}{1+r}$ and r is the discount rate.

Using the factor associated with a three percent discount rate, for instance, the \$159 best Weibull estimate with economic controls for all yea-saying and nay-saying variables provided above is multiplied by 0.3, reducing WTP to \$48 per year per household for a benefit phased in over ten years and continuing indefinitely. As an upper bracket on the range of values for the base case, we take the lognormal estimate of \$213 times 0.5 (the factor associated with the five percent discount rate), for a WTP of \$107. For the scope case we similarly take the estimates of \$179 and \$308 from the same cell, times the respective three and five percent adjustment factors, for a WTP range of \$54 to \$154.

Total Value versus Use and Nonuse Values

People who recreate in the Adirondacks hold use and nonuse values. People who do not recreate in the Adirondacks hold nonuse values. Thus, it is possible to get some insight into the subcategories of values by examining WTP for the two groups. To do this, we first regressed variables for frequency of use and the standard variable list against vote responses. We found that the only significant distinction was between those whose visit frequency is over ten times in the previous five years (23 percent of the sample) and those with less frequent visits (or no visits). Using this variable, we predicted WTP for the two groups and found that the frequent users had a WTP about 70 percent higher than that of the infrequent and nonusers, implying relatively large use values.

Are the Benefits Large?

Are our WTP estimates "big" numbers? First, note what is not included in these numbers that would be relevant to a formal benefit–cost analysis concerning reductions in acid deposition precursors. They omit benefits to residents of other states, be they users or nonusers of the Adirondack Park. Our results on the effect of location on WTP suggest that such benefits may be smaller per household than those enjoyed by New York State residents. They also exclude benefits to other ecological assets and those to other types of endpoints, most importantly the health effects related to fine particulate exposure.

Second, these numbers can be compared to a cost benchmark. EPA (2004) has estimated the costs of its Clear Skies proposal to utilities to be $4.3 billion in 2010, rising to $6.3 billion per year by 2020.[17] Clearly only a fraction of these costs should be attributable to improvements in the Adirondacks because only a fraction of utility emissions affects that region. Although there is no universally accepted way to make such allocations, a reasonable approach is to assign

[17] Clear Skies ultimately would lead to reductions of 75 percent in SO_2 and 65 percent in NO_x by sometime after 2020 when allowance banks are exhausted.

cost shares to each utility's in accordance with the fraction of their emissions falling in the Adirondacks. Using the TAF model (Bloyd et al., 1996) for the source-receptor relationships to do this and model runs that provide the costs by electricity-producing region, we find that on average, 2.3 percent of utility SO_2 emissions fall on the Adirondacks. Multiplying each region's share by their costs for implementing Clear Skies gives an estimate of $86 million in 2010 and $126 million in 2020 for costs attributable to Adirondack improvements. These cost estimates are significantly less than our estimates of the benefits.

7. Conclusions

This paper has presented the first-ever results for the total value of the ecological improvements to the Adirondack Park that might be expected from another round of reductions in air pollution emissions. These estimates matter because damage to the Adirondacks has been a focal point in the clean air debate for over 20 years. Further emissions reductions are being justified, in part, by how they will improve this unique resource. How much these improvements are worth to the public is important to understand.

Not surprisingly, there are a large number of results, reflecting uncertainties in the science, the underlying model of people's preferences for such improvements, normal statistical uncertainties, and a variety of assumptions. Because these results have policy significance, we work through these uncertainties and assumptions to provide a range of best estimates for use in the policy process. We adopt a cautious interpretation of the natural science and cautious design and analytical decisions to provide a value for an ecological outcome that scientists and economists can agree would be achieved at a *minimum* by policy proposals to reduce precursor emissions.

The resulting cautious, best defensible estimates of the mean WTP using the base case characterization of ecological improvements and adjusting for discount factors ranging from three to five percent range from $48 to $107 per year per household in New York State. The alternative scope case scenario yields mean WTP ranging from $54 to $159 per year per household. Multiplying these population-weighted estimates by the approximate number of households in New York State yields benefits ranging from about $336 million to $1.1 billion per year. Accounting for statistical uncertainties underlying these estimates could halve them or more than double them.

This study was designed to adhere closely to scientific information about the park and to build a bridge between the natural and social sciences that could allow people to meaningfully express a willingness to pay for ecological improvements in the Adirondacks. The methodology adheres to all the appropriate protocols suggested by the NOAA Panel and OMB and passes their suggested tests, most importantly the scope tests. As such our results are the culmination of over two decades of a major federal research effort and provides long-sought and valuable information about the benefits of air pollution policy.

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Table 1. Summary of the Science of Acid Precipitation at Adirondacks Park

Science	Instrument
Approximately 3,000 lakes, mostly small; half degraded or devoid of fish**.**	In description.
Fish decline attributable to acidification through aluminum mobilization; some from natural causes.	In description.
Effect on forests, but less well understood. Possible effect on birds.	Base case: Effect on one tree, two bird species. Scope case: Effect on three tree, four bird species.
1990 CAAA reductions leave stable ecological baseline or improving slightly; potential of nitrogen saturation.	Base case: Baseline not worsening, not improving. Scope case: Baseline worsening.
Uncertainty in time period for recovery; uncertain time period to nitrogen saturation.	Uncertainty excluded.
No health effects.	Explicitly addressed and excluded in instrument.
Expected changes from lower acidification include improvements in between 20% and 40% of lakes; small improvements in forests and bird populations.	Base case: 20% increase in lakes that support fish in ten years. Slight improvements to forests, birds. Scope case: 40% improvement in lakes that support fish in ten years; larger improvements in more types of forest and bird populations.

Table 2. Summary of Survey Administration

Administration	Mode	Versions	Surveyed	Useful Responses[†]	Response Rate	Share of Sample
Pretest KN Panel	Web TV/ Internet	Base	141[*]	118	84%	6.5%
Main KN Panel	Web TV/ Internet	Base and Scope	1,143[*]	841	74%	46.2%
KN Withdrawn	Internet	Base and Scope	2,120[*]	293	14%	16.8%
Mail	Paper	Base	2,372[††]	570	24%	31.3%
ALL		Total/Base/ Scope	5,776/4,150/1,626	1,822/1,254/568		

[*]To exhaust the New York residency on KN's panel certain households had multiple members surveyed. If a household had one or more surveys where there was a response to the first referenda question, the first member of the household that completed the survey was kept as part of the sample and the remaining members were not counted as surveyed. If there was no response from the household, only the member of the household first solicited to take the survey is retained in the calculation of response rates. Thus, the response rates should be viewed as a household response rate.

[†]Useful responses include those surveys where respondents answered at least the first referendum question and completed the survey in a reasonable amount of time. Respondents who indicated they had not realized that the payment was over a ten-year period were also excluded from being a useful response.

[††]3,905 mail surveys were distributed. The reported figure is adjusted for the number of addresses that were not English-speaking residences or were forwarded to addresses outside New York. The response rate for mail is calculated using "response rate one" (RR1) in American Association for Public Opinion Research (2004), defining cases with no answer during a fifth disposition reminder call as ineligible.

Table 3. Mean and Standard Deviation of Demographic and Attitudinal Questions, by Survey Wave and for New York Population

Variable Description	Panel (N=959)	Withdrawn (N=293)	Mail (N=570)	Total (N=1822)	New York State Adult Population†
Age in years	48.2 (14.3)	42.1 (13.1)	51.4 (15.1)	48.2 (14.7)	45.5
Female	58.2%	46.8%	41.4%	51.2%	52.7%
Nonwhite	22.8%	20.8%	12.4%	19.3%	32.1%
Household size	2.50 (1.43)	3.33 (1.35)	2.67 (1.72)	2.68 (1.54)	2.61
Number of children per HH	0.55 (0.99)	1.11 (1.10)	0.64 (1.13)	0.67 (1.07)	0.65
Annual household income*	$57,928 ($38,903)	$72,021 ($39,001)	$67,411 ($49,071)	$63,078 ($42,585)	$57,171
Expectation of income in five years					
Lower than current	55.0%	52.1%	57.1%	55.2%	N/A
Same as current	14.2%	10.2%	18.6%	15.0%	N/A
Higher than current	30.8%	37.7%	24.3%	29.9%	N/A
High school educated	96.4%	99.6%	96.3%	96.8%	79.1%
Heard of Adirondack Park	90.1%	91.1%	92.0%	90.8%	N/A
Distance (mi) to Park entrance	149.4 (63.3)	150.5 (61.0)	144.7 (64.0)	148.1 (63.2)	N/A
Reside in a metropolitan area	93.3%	94.5%	89.0%	92.2%	92.1%
NY resident 5+ years	96.2%	96.1%	97.0%	96.4%	91.8%
Paid NYS taxes last year	84.5%	91.5%	85.1%	87.0%	N/A
Environmentalist	12.3%	11.7%	22.0%	15.4%	N/A
Self-identified political persuasion					
Liberal	18.4%	17.6%	18.8%	18.5%	N/A
Moderate	67.0%	65.1%	61.5%	65.0%	N/A
Conservative	14.4%	17.3%	19.7%	16.5%	N/A

*Computed assuming each household is at the midpoint of its income range.

†Drawn from 2000 U.S. Census.

Table 4. Share Voting for Program by Bid and Scenario

First Vote Bid Level	Base Scenario	Scope Scenario	P-value
25	65.6% (291)	73.5% (147)	0.10
35*	44.8% (29)	-- (0)	--
85*	39.3% (11)	-- (0)	--
90	50.9% (275)	63.4% (142)	0.02
150	41.8% (316)	57.9% (140)	<0.01
200*	32.3% (10)	-- (0)	--
250	36.3% (289)	51.5% (134)	<0.01
P-value (chi-square)†	<0.01	<0.01	
P-value (Kendall's tau)†	0.03	0.04	

(Sample Size in Parentheses)

*Bid values were used in the second pretest only, so sample sizes are small.

†The chi-square test provides a test of simple joint inequality across bid levels; Kendall's tau is a stronger test of monotonic ordering.

Table 5. Log-Normal Econometric Models (Base Instrument)

Variable	Model 1	Model 2	Model 3
Constant	4.6277*** (5.53)	4.0116*** (5.23)	4.4076*** (20.08)
Sigma	1.5432 --	1.2737 --	1.3825 --
Income < $20k	0.5221 (1.41)	0.3929 (1.53)	
Income $20-35k	0.2331 (0.94)	0.1210 (0.54)	
Income $35-50k	0.2464 (1.09)	0.2208 (1.10)	
Income >$125k	0.5569** (2.41)	0.6611*** (2.90)	
Future income higher	0.2191** (2.32)	0.2267*** (2.81)	
Household size	-0.0849 -(0.87)	-0.1036 -(1.22)	
Presence of children (0/1)	-0.4767 -(1.41)	-0.5286* -(1.90)	
Number of children	0.2717* (1.73)	0.3491** (2.39)	
Female	-0.0688 -(0.38)	-0.1846 -(1.30)	
Black (Not Hispanic)	-0.2058 -(0.68)	-0.5227* -(1.93)	
Other (Not Hispanic)	0.0608 (0.16)	0.1080 (0.34)	
Hispanic	-0.3397 -(0.82)	-0.4557 -(1.50)	
Age	-0.0181 -(0.61)	0.0200 (0.75)	
Age^2	0.0002 (0.50)	-0.0002 -(0.58)	
Reduce spending on clean air & water	-0.7298 -(1.38)	-0.4684 -(1.08)	

Increase spending on clean air & water	0.9370*** (3.89)	0.3284 (1.53)	
Environmentalist	0.7453*** (3.83)	0.4484*** (2.57)	
Frequent visitor to park	0.4874** (2.35)	0.2903* (1.65)	
Live in park	-0.5603 -(1.21)	0.0027 (0.01)	
Distance to park (km)	-0.0019** -(2.01)	-0.0008 -(1.08)	
Protect environment at any cost (warm glow)		1.3655*** (7.34)	1.3915*** (7.22)
Health effects (minor)		0.5519*** (3.41)	0.7562*** (4.43)
Health effects (significant)		1.4671*** (4.87)	1.1737*** (3.12)
Future w/o liming is worse than survey depicts		0.2899 (1.63)	0.2939 (1.62)
Future w/o liming is better than survey depicts		-0.3603 -(1.18)	-0.1557 -(0.54)
Other animals effected		0.1029 (0.69)	0.0986 (0.63)
Didn't pay taxes		0.3207 (1.32)	0.3112 (1.45)
Liming not practical		-1.1779*** -(4.24)	-1.4697*** -(4.63)
Not confident in NY State to admin. program		-0.4930*** -(3.56)	-0.5117*** -(3.23)
Don't raise taxes for any reason		-0.2508 -(1.31)	-0.2225 -(1.18)
Vote doesn't matter		-0.1460 -(1.00)	-0.0138 -(0.09)
Upwind polluters are at fault		-1.1976** -(2.40)	-1.8245*** -(2.71)
N	938	872	1056
Log Likelihood	-925.75	-678.10	-921.22

(Z-scores in parentheses.)

Table 6. Identification of Possible Yea-saying and Nay-saying Votes

Indicator	Share of Final Sample	Treatment
Yea-saying		
Costs should not be a factor	24.9%	Dropped or controlled.
Some health effects	38.1%	Given chance to revote. Others controlled.
Significant health effects	10.3%	Given chance to revote. Others dropped or controlled.
The future status of Adirondacks is worse than described	18.4%	Controlled.
Other animals are affected beyond those mentioned	58.5%	Controlled.
Does not pay taxes	13.0%	Dropped or controlled.
Nay-saying		
Taxes should not be raised for any reason	21.1%	Controlled.
The future status of Adirondacks is better than described	8.3%	Controlled.
Not confident in New York State government to run the liming program	37.1%	Given chance to revote. Others controlled.
Liming program not practical	15.0%	Dropped or controlled.
Voted against program solely because upwind polluters should reduce instead	19.1%	Controlled.

Table 7. Base Improvement: Mean WTP, By Yea-saying Controls, Nay-saying Controls, and Distributional Assumption (L=Lognormal, W=Weibull)*

		Nay-saying Controls									
		None		All econometric controls		Econometric controls, drop tax haters		Econometric controls, drop if tax hater AND lime rejector		Econometric controls, drop if tax hater OR lime rejector	
Distribution		L	W	L	W	L	W	L	W	L	W
Yea-saying Controls	None	324	180 N=1175	986	565 N=1099	817	505 N=884	1037	609 N=1024	721	441 N=795
	All econometric controls	66	58 N=1102	213	159 N=1056	203	159 N=848	223	173 N=983	201	156 N=763
	Econometric controls, drop warm glower	77	63 N=841	223	156 N=800	194	156 N=638				
	Econometric controls, drop if warm glower AND health embedder	67	58 N=1050	231	166 N=1004			238	180 N=932		
	Econometric controls, drop if warm glower OR health embedder	80	63 N=810	266	179 N=770					233	180 N=544

*N applies to both lognormal and Weibull distributions.

Table 8. Scope Improvement: Mean WTP, By Yea-saying Controls, Nay-saying Controls, and Distributional Assumption (L=Lognormal, W=Weibull)*

		Nay-saying Controls									
		None		All econometric controls		Econometric controls, drop tax haters		Econometric controls, drop if tax hater AND lime rejector		Econometric controls, drop if tax hater OR lime rejector	
Distribution		L	W	L	W	L	W	L	W	L	W
Yea-saying Controls	None	730	316 N=532	1791	841 N=515	2597	1962 N=424	1962	782 N=497	2921	866 N=388
	All econometric controls	135	98 N=523	308	179 N=506	316	135 N=417	336	179 N=488	346	144 N=384
	Econometric controls, drop warm glower	122	98 N=394	331	192 N=380	341	142 N=307				
	Econometric controls, drop if warm glower AND health embedder	134	98 N=487	308	180 N=470			337	180 N=452		
	Econometric controls, drop if warm glower OR health embedder	123	99 N=359	332	188 N=346					384	155 N=252

*N applies to both lognormal and Weibull distributions.

Figure 1. Share Voting for Program by Bid and Scenario

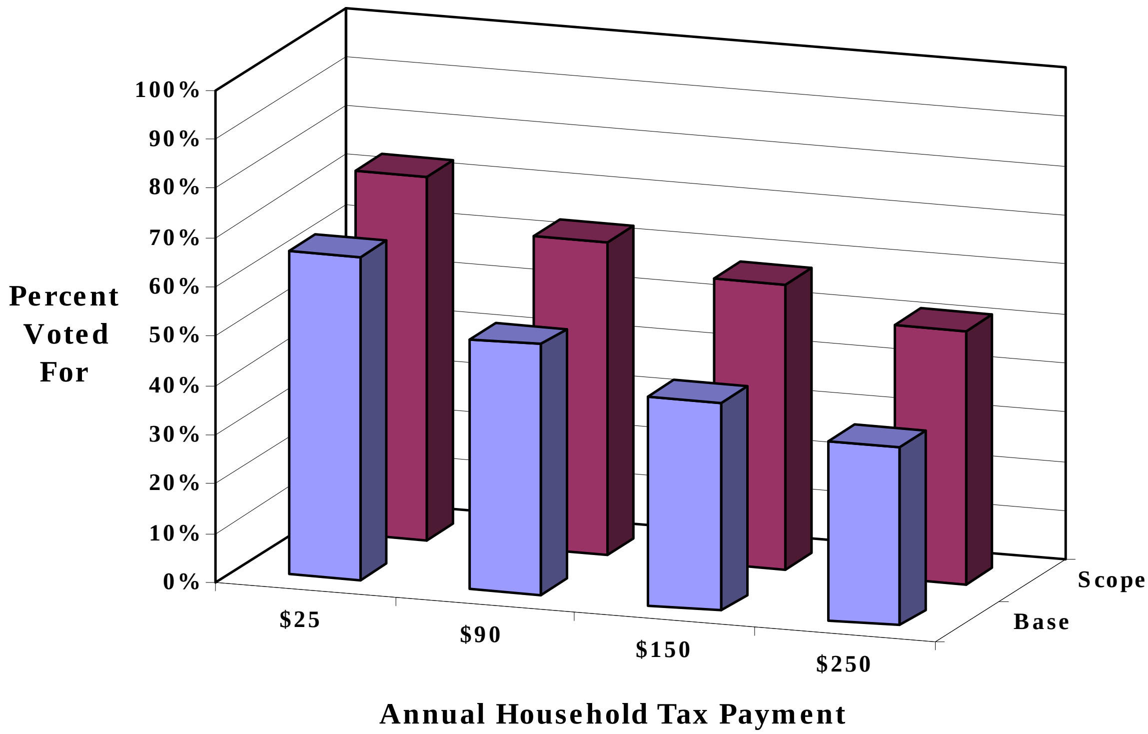
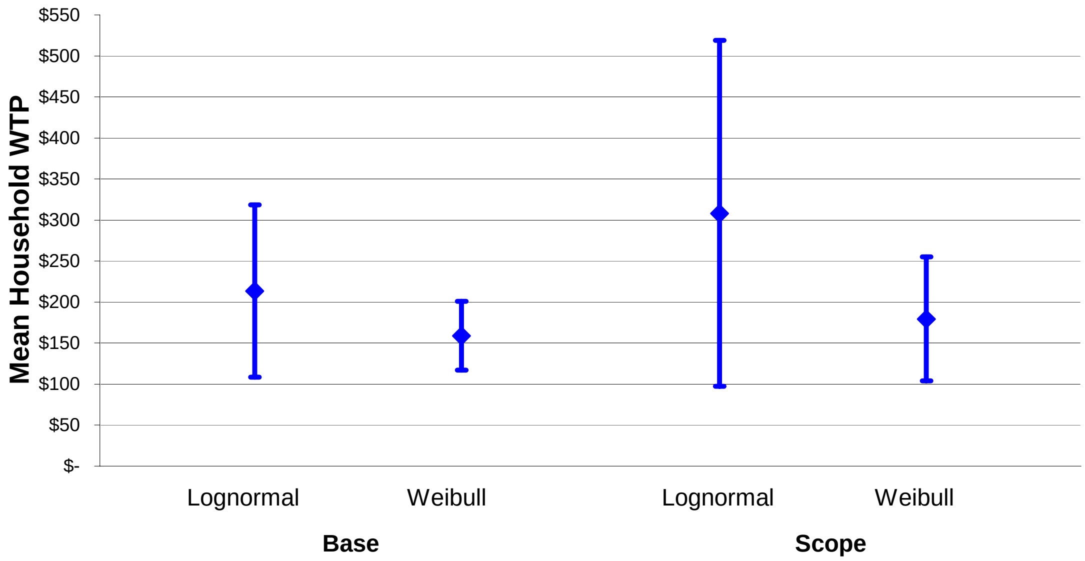
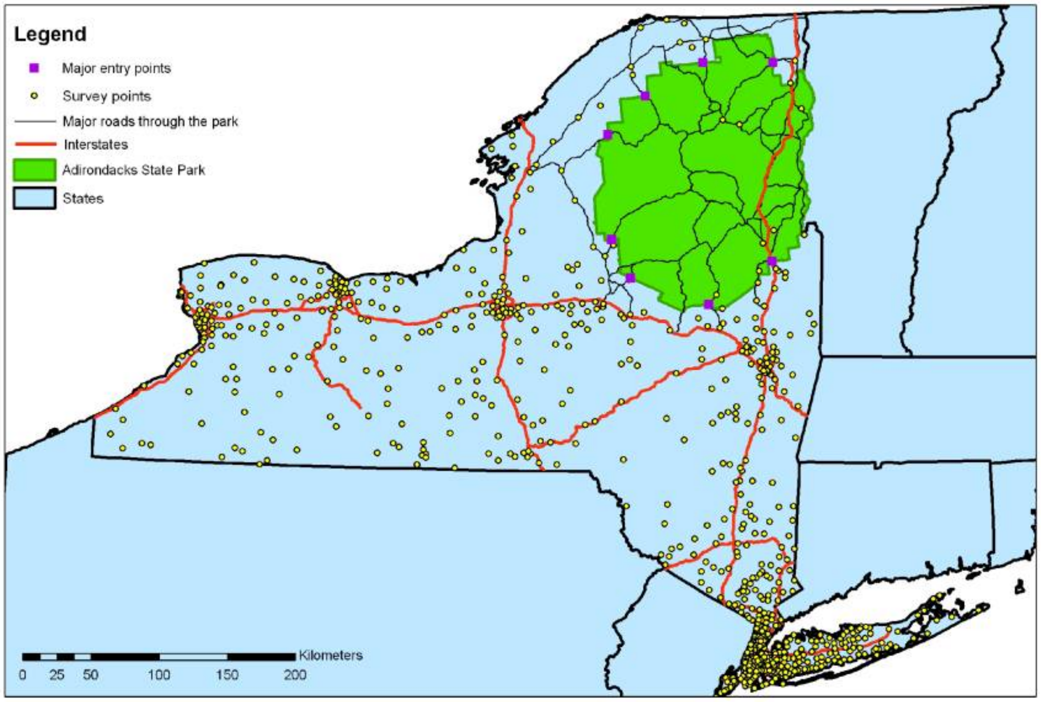


Figure 2. Model and Statistical Uncertainty of Mean WTP for All Econometric Models

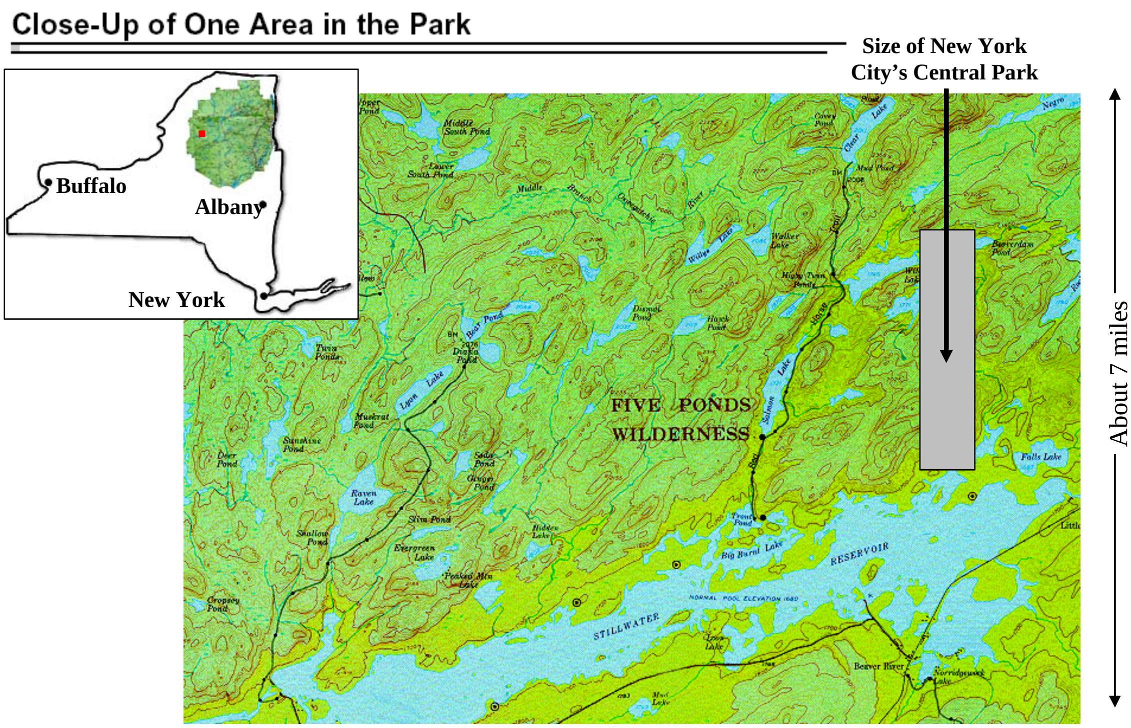


Appendix A: Geographic distribution of respondents within New York State.



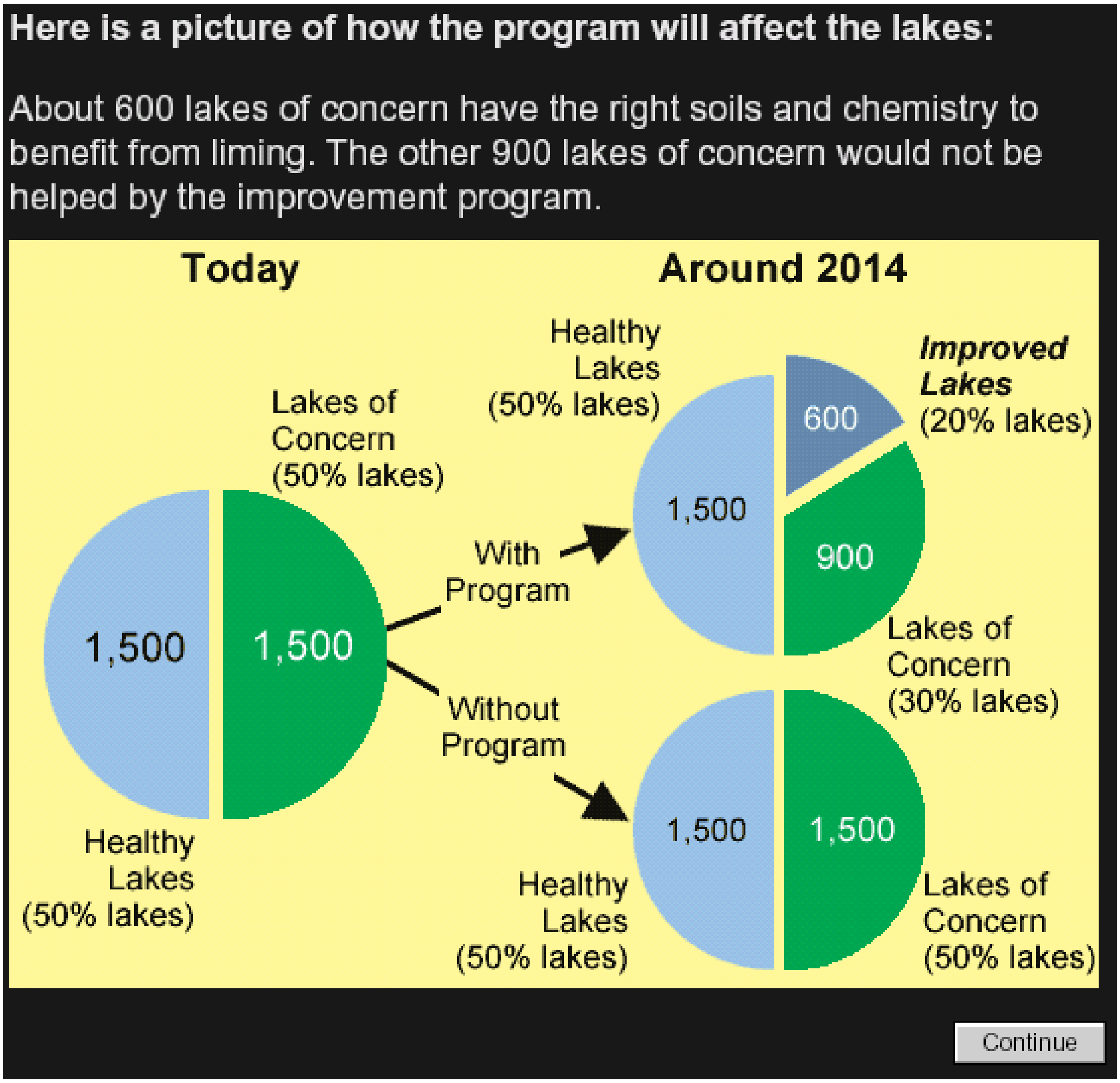
Appendix B: Screen and page captures from survey

Map illustration of size of affected lakes.

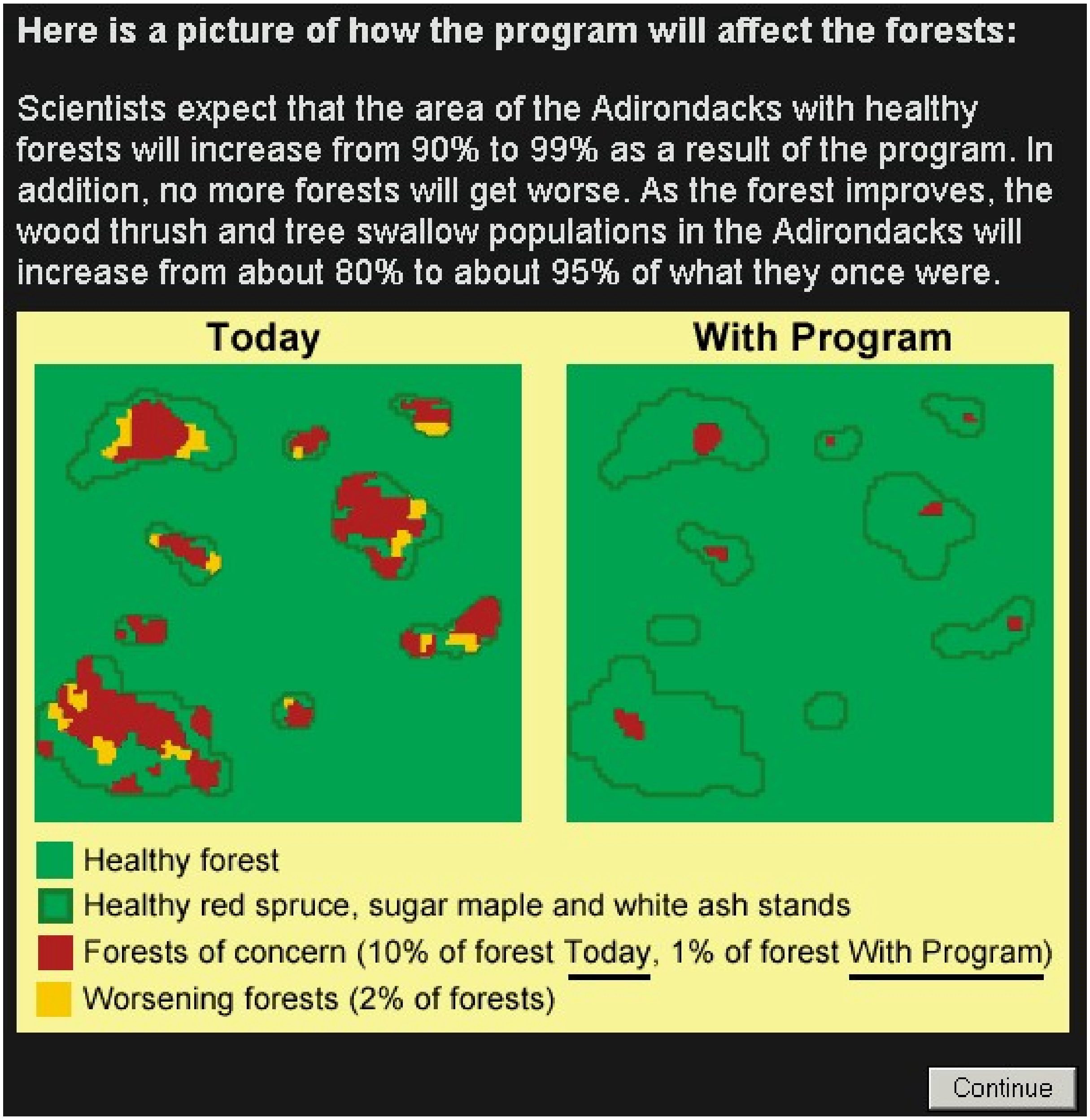


This map illustrates one small part of the Adirondack State Park. This part is located where the red dot is on the inset map. Most of the lakes affected by past air pollution are small; they are typically much smaller than Central Park in New York City. The large lakes that you may have heard of (such as Saranac Lake or Lake George) are much bigger than Central Park and <u>are not</u> lakes of concern.

Chart representing how the program will affect the lakes.



Representation of forest improvement



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THE VALUE OF REGIONAL WATER QUALITY IMPROVEMENTS

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The Value of Regional Water Quality Improvements

W. Kip Viscusi,* Joel Huber, and Jason Bell

Abstract

Four years ago, Magat, Huber, Viscusi, and Bell (2000) reported pretest results that introduced an iterative choice approach to valuing water quality improvements. This paper applies this approach to a nationally representative sample of over 1,000 respondents. We find that the method provides stable, policy relevant estimates of the amount people are willing to pay for improvements. Willingness to pay for a one percentage point improvement in water quality has a mean value of $23.17 with a median of $15, and appropriately increases with family income, age, education, and the likelihood of using lakes or rivers. In addition, the method passes an external scope test demonstrating that greater gains in the percent of water rated "good" increase the likelihood that the respondent will choose the alternative with better water quality. We tested the appropriateness of a national web-based panel of respondents and find that the Knowledge Networks sample does not fall prey to difficulties that could plague such panels. First, the sampled web-based panel matches United States demographics very well, and predictors of sample responsiveness, such as the likelihood to take a long time to respond to the survey, have minimal impact on the critical estimates of the value of good water. Second, the results are quite insensitive to doubly censored regression that accounts for the portion of respondents who indicated an unboundedly high or low estimate for the value of cleaner lakes and rivers. Finally, the stability of the benefit values is further demonstrated by the selection-corrected estimates that adjust for people invited to participate but who did not successfully complete the survey.

Keywords: water quality, environmental benefits, survey, contingent valuation

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The Value of Regional Water Quality Improvements

W. Kip Viscusi, Joel Huber, and Jason Bell

1. Introduction

The economic benefit of water quality improvements is society's willingness to pay for increases in water quality. Early measures of water quality were derived from travel cost values of recreational benefits[1]. Subsequent benefit assessments, which remain in use in some policy applications, consist of analyzing the value of improvements in the water's ranking on a water quality ladder.[2] This unidimensional water quality index assumes that there is a hierarchy of quality levels in terms of whether the water is drinkable, swimmable, fishable, or boatable. Thus, water that is drinkable also meets acceptability criteria for all lower ranked uses. Unfortunately, this hierarchical characterization is problematic, as these categories of uses do not reflect our current scientific understanding of the empirical ordering of water quality. That is, if one examines the pattern of quality levels across states, there is almost no evidence of such a hierarchy.[3] The focus of the survey results reported here is on people's willingness to pay for water that is rated "good" based on an overall index, developed by the U.S. Environmental Protection Agency (EPA), that initially merges benefits with respect to fishing, swimming, and the quality of the aquatic environment. An additional survey component makes it possible to

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[1] See Berkman and Viscusi (1973).
[2] Mitchell and Carson (1989) and Carson and Mitchell (1993) provide benefit assessments using this approach, which was consistent with the previous scientific literature at that time. A different perspective is provided by Smith and Desvousges (1986).
[3] Examples of these differences using data from EPA's National Water Quality Inventory appear in Magat, Huber, Viscusi, and Bell (2000), pp. 10-11.

separate the component values.[4] The survey results reported here will focus on the overall water quality valuation component.[5]

This paper expands and tests the methodology developed by Magat, Huber, Viscusi, and Bell (2000), where water quality values are derived from hypothetical market choices. These values are based on simple choices between regions that differ on water quality and cost of living. A series of such choices yield bounds on the value of water quality improvements for each individual. The method has the advantage of generating estimates of the private value of improvements in water quality from a simple understandable task.

This paper discusses econometric stability of these estimates as well as some reliability and sampling questions that arise in this use of iterative choice to assess private values. The study is based on over 1,000 new surveys implemented through web-based interviewing. Generally, we find that water quality valuations follow expected economic patterns: factors such as income, education, and visits to lakes or rivers are appropriately related to the value of water quality. Further, a scope test indicates greater valuations for larger changes in water quality gains, increasing confidence in the metric quality of the results. We assess the reliability of this approach by testing for the stability of the results given different econometric assumptions, with particular focus on those responses for which the dollar value of water quality could only be bounded on one side.

A second important improvement in this study is the use of a national web-based panel rather than the recruitment to regional central sites or mall intercepts used in the Magat *et al.* (2000) study. The use of respondent panels for policy has emerged as a response to increasing difficulty and expense attached to recruiting probability-based random samples. It is

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[4] See Magat, Huber, Viscusi, and Bell (2000).
[5] The attributes of good water quality will be addressed in a separate survey to be administered by the authors in 2004.

fundamentally an empirical question whether a panel-based sampling approach will produce acceptable results. We find that the demographic characteristics of the final sample closely correspond to that of the target universe of U.S. adults. Additionally, we show that that the results are not affected by factors that might distinguish between those who take the survey against those who do not. Finally, a sample selection procedure adjusts the water quality valuations for the probability that a panel member will not take or successfully complete the survey. These estimates differed little from the unadjusted means, providing assurance that they are relatively independent of possible panel selection biases.

Section 2 describes the overall study design, the survey methodology and the iterative choice method for generating values for improvements in water quality. Section 3 explores the logical adequacy of the results, including an exploration of consistency tests for the responses as well as the variation of the valuation responses conditioned on demographics. Section 4 provides tests of survey and sample validity. The survey was internet-based, using the Knowledge Networks panel. We examine the extent to which attrition bias from the panel and other aspects of this survey mode influence the water quality values. As indicated in the concluding Section 5, the results are quite robust and meet a wide variety of tests for rationality and consistency.

2. Study Design

The survey used a computer-based methodology and was administered to a representative national sample.[6] The average respondent completed the survey in 25 minutes. The instrument initially acquainted the respondent with the meaning of regional differences in lake and river water rated of good quality and differences in annual cost of living. This introductory section

[6] While our survey uses an iterative choice format, it is related to contingent valuation surveys, though it uses a different survey approach. For discussions of contingent valuation, see among others Bishop and Heberlein (1990), Fischhoff and Furby (1998), and Mitchell and Carson (1989), and Schkade and Payne (1986).

establishes the cognitive groundwork for the respondents so that a choice between regions differing in these aspects can be reliably answered.

Introductory section in the survey

The key valuation task involves choices between regions differing in their levels of water quality and the annual cost of living. A critical part of the method involves introductory sections that encourage the respondent to think about these tradeoffs. This process begins with some very general questions to encourage the respondent to think about the value of freshwater bodies. It also elicits information on the frequency of visits to lakes and rivers as well as related activities, such as boating, fishing, or swimming. The primary reason for asking about usage is to encourage respondents to think about why they might value differences in water quality. However, it may also be the case that respondents reporting greater usage of lakes and rivers have higher valuations of improvements in the quality of those water bodies.

Immediately following the introduction to water usage, the survey explains the meaning of cost of living and elicits the respondent's level of concern with an annual increase in cost of living of $200. Respondents then respond to a question that tests comprehension involving a simple choice between two regions, identical except that one is more expensive. The few respondents who chose the more expensive location are provided a brief educational module before being asked to proceed.

Next, respondents are introduced to the criteria that define what it means for water quality to be "good." Consistent with definitions used by EPA's National Water Quality Inventory, the survey provides the following definition:

> The government rates water quality as either
> * Good, or
> * Not Good.

Water quality is Good if the water in a lake or river is safe for all uses. Water quality is Not Good if a lake or river is polluted or unsafe to use.

More specifically, water quality is Good if the lake or river
* Is a safe place to swim,
* Fish in it are safe to eat, and
* Supports many plants, fish, and other aquatic life.

Water quality is Not Good if the lake or river
* Is an unsafe place to swim due to pollution,
* Has fish that are unsafe to eat, or
* Supports only a small number of plants, fish, and other aquatic life.

The survey then explicitly excludes drinking water from the valuation task.

Once familiar with the concepts of water quality and cost of living, these contexts are framed within context of a region, defined as "within a 2-hour drive or so of your home, in other words, within 100 miles." A 100 mile radius is appropriate because it reflects a reasonable 2-hour drive for the recreational use of bodies of water, and about 80 percent of all recreational visits for lakes, rivers, and streams are within such a radius.[7] This text explanation of region contrasts with the method reported in Magat et al. (2000) where respondents viewed pictorial representations of the region size. However, our pretest interviews indicated that the 100-mile region radius could be well understood when described through the text used.

After they learned about water quality and the region, respondents received a warm-up choice. In this case they were asked to choose between two regions that differed in the percentage of water bodies with quality rated good. Respondents who preferred the region with a lower percent of lakes and rivers rated good received a brief interactive tutorial on the meaning of the benefit measure and the error in their response.

Key Valuation Choice Task

[7] Data generated by the EPA NCEE Office for this study indicate that 77.9% of boating visits, 78.1% of fishing visits, and 76.9% of swimming recreational visits are within a 100 mile radius. Calculations were made by Jared Creason of NCEE using the 1996 National Survey on Recreation and Environment.

Once respondents learn about water quality, cost of living and their application to a region, they are ready for the iterative choice questions. This key valuation task is designed to elicit the respondent's tradeoff between water quality and cost of living in choices between different regions. These regions are "the same in all other ways, including the number of lakes and rivers near your home." As a final warm-up question respondents are asked to make a choice where one alternative dominated another on both cost of living and water quality. That is, they choose between two regions, where one region had more quality lakes and rivers and lower cost of living. Respondents who erred received a remedial tutorial that reviewed the nature of the choice being made.

The critical choice questions take the form shown in Figure 1. It is noteworthy that the task itself is not complex, which past evidence suggests should enhance the validity of the survey approach.[8] We will also present a series of rationality tests of the survey responses as validity checks of the methodology.

If a respondent was indifferent in the initial choice presented in Figure 1, then the iterative choice process is complete, yielding a cost of living willingness to pay value for the illustrated choice of (\$300-\$100) / (60%-40%) = \$10 per 1 percent improvement in water quality. A choice of either alternative led to successive choices that terminated either at indifference or a narrowly bounded value estimate. Specifically, if we let C_i be the cost of living in region i, i=1,2; and let G_i be the percent of water in region i rated good, then the value V of water quality benefits is given by

$$V = (C_2 - C_1) / (G_2 - G_1).$$

[8] DeShazo and Fermo (2002) show that complex choice sets can pose difficulties with respect to respondents' ability to process the choices and give consistent responses.

Figure 2 displays the logic of the iterative choice questions. The program iterates choices, each time degrading the desirable aspect of the last alternative chosen until the selection reverses. For example, a respondent preferring the lower cost region on the initial question in Figure 1 then considers the same pairwise choice, except the cost of living in that region is raised. Continued preference for the lower cost region leads to continued increases in the cost of living in the chosen region until the respondent faces a dominated choice in which the regions have the same cost of living but differ only in terms of water quality. Similarly, continued preference for the higher quality region leads to continued reductions in the water quality of the chosen region until the regions have the same water quality but differ only in cost of living. This series of questions permits a bounded estimate value of water quality improvements for all respondents except for those at the corners of the decision tree. For these corner respondents, we analyze their results in two ways. First, for those respondents who choose the non-dominated region, we estimate the value as twice the maximum observed dollar value for water improvements for those with very high and halved it for those with very low values of water quality. Second, we used more appropriate econometric treatment for those respondents based on censored regression methods, as described in Section 3.

As another check of rationality, for respondents who reach a corner boundary of the tree indicating zero value for money or good water, the survey brings this decision to the respondent's attention, offers a chance to reconsider, and then inquires regarding the reason for their choice. The analysis deals with the 6% who indicated that they would still choose the dominated alternative or had no preference by dropping them from the initial analysis and by treating as non-respondents in the Heckman adjustment for selection bias.

The survey also ends with a number of additional sections, such as a brief series of demographic questions and whether the respondent had difficulty understanding any part of the survey.

This process of elaborate training before the choice questions is one we have used a similar formulation in a wide variety of other environmental risk contexts. We have found that with sufficient grounding, the tradeoff against cost of living can be well understood.[9] We deliberately framed the choice as one between regions similar to but abstracted from the region where the person now lives. This abstraction is one that we believe contributes to the stability, validity and actionability of the results. In terms of stability, not having to focus on a particular body of water conditioned on the location of one's home discourages inferences about one's particular circumstance that may or may not apply to a particular change in the percent of good water quality in a region. In terms of validity, the survey focuses on a free market choice that has minimal social consequences—whether one buys in region A or B primarily influences one's own utility. These market choices contrast with referenda where one's vote can affect the welfare of others, confounding the results with an array of conflicting forces including altruism, confidence in the efficacy government action, willingness to impose costs on others, and attitudes about taxation to fund such referenda. Finally, the results are actionable in helping to establish a general social metric for policy decisions across regions. The projected dollar value for changes in water quality can be related to general citizen characteristics such as age, income and education. These values can be applied using census data to evaluate a broad range of options that affect the quality of water.

<u>Experimental conditions</u>

[9] The first of these many studies is Magat, Viscusi, and Huber (1988).

In order to test the robustness of the results to different versions of the questionnaire, randomly identified groups received alternative versions. These tests permit an assessment of the effects of anchoring and the initial range of the alternatives in the initial trade off.

Our study tests for anchoring influence by manipulating the presence of an external norm for water quality. Approximately half the respondents received information that the national average of water quality was rated 65% Good, whereas the other respondents received no national information. Being told the US 65% value may increase the sensitivity to water quality, since there is now an anchor that helps respondents value of the water percent amounts provided.

Second, the value of a given change in percent good may itself be affected by the range of percent good and dollars in the initial choice. For example, if the first choice is between a gain of 20% good in return for $400 in cost of living (e.g., $20 for one percentage point), then respondents may reasonably use that information to assume that, say, $15 is a good price to pay for one percentage point gain. By contrast, if the initial choice pits a 20% gain against $200, ($10 per one percentage point), then the $15 seems relatively high. This inference is understandable if one takes the Gricean (1975) assumption that the initial choices provided in such questionnaires are reasonable. To test the impact of the initial range we altered the initial range in cost of living to be either $200, $300 or $500, and the range of the gain in percent good to be either 20, 30 or 40 percentage points. This test is whether the initial choice is appropriately sensitive to ranges, as required for appropriate sensitivity to scope.

3. Valuation of Water Quality Improvements

In reporting our results we first give the mean and distribution of our unit water quality benefit measure, the dollar value of a one percentage point change in water quality. Then, to validate the results, we regress these valuation measures against respondent characteristics to demonstrate that the kinds of respondents expected to have higher or lower valuations indeed have them. To show that these results are meaningful for policy, we demonstrate that the initial choice is appropriately sensitive to scope. That is, the choice of the region with better water quality increases with its advantage in percent good, and goes down with its disadvantage in cost of living.

Overall Benefit Values

The benefit value measures how much of an increase in the annual cost of living respondents are willing to incur for each percentage point improvement of water rated good. For each respondent, this value V is calculated at the point of indifference between two regions or the average V where a finite bound can be estimated. The mean value of V for a 1 percent improvement in water quality is $23.17 per year, with a standard error of the mean of 0.79, based on 1,103 respondents.[10] The median water quality benefit value V is $15, which indicates that the benefit distribution is skewed with a large upper right tail. It is reassuring to note that these summary statistics correspond well to a mean of $22.40 and median of $12 reported by Magat et al. (2000).

There was a substantial variability in water quality values across people. Respondents at the 25th percentile registered a value of $6.25 per unit improvement in water quality, as compared to $15 at the median and $30 at the 75th percentile. The disparity between the valuation at the 10th percentile value of $1.92 and the 90th percentile value of $75 indicates substantial heterogeneity in the value respondents place on clean lakes, rivers, and streams.

Validity Tests

[10] Carson and Mitchell (1993) examined willingness to pay for national water quality and estimated that people would pay $242 in 1990 dollars (or $315 in 2003 dollars) annually to improve from a baseline of non-boatable to nationally swimmable.

Two validity tests provide evidence of the meaningfulness of the estimated water quality values. The first test requires that the individual estimates of water quality value differ across respondents in ways predicted by economic theory. The second validity assessment is an across person test requiring respondents to be sensitive to the scope of differences in cost of living and water quality provided.

Consider first the relationship between generated values and respondent characteristics. The Magat *et al.* (2000) survey found very weak relationships between valuations and demographic characteristics. The current results are far more substantial, perhaps due to a sample almost three times as large and because of better survey implementation. The dependent variable for analysis is the log of respondent's unit water quality benefit value, V. The log transformation is used because it has the effect of making the right-skewed distribution of V approximately normal.

Table 1 presents two sets of regression results for the log value of V, the unit value of water quality. The first column presents the OLS estimates, while the second column of results presents the censored Tobit regressions. Survey respondents consistently choose the low priced or high quality option eventually reach or the corner maxima or minima in the iterative choices shown in Figure 2. The censored regression in effect combines the information from the respondents who hit the upper or lower limits with conventional regression results for the bounded respondents. Thus, the censored regression coefficients makes the best prediction taking into account the fact that the survey truncates the distribution of possible responses at both the high and low end of the distribution of water quality values. The Tobit estimates in Table 1 are remarkably similar to the OLS estimates.

The statistically significant explanatory variables all have coefficients that one would expect. The coefficient of .17 for log income indicates that water quality is a normal good, with valuations increasing by 17% for a doubling in income. Individual education is likely to be a proxy for lifetime wealth. Better educated respondents exhibit a higher value for good water quality, controlling for current income levels and personal characteristics. Older respondents likewise indicate a higher valuation of water quality that is consistent with life cycle changes in wealth.

Two variables that should reflect whether a respondent is likely to have particularly strong preferences for good water quality are whether the respondent is a member of an environmental organization or has visited a lake or river in the last 12 months.[11] The coefficients of the environmental group membership and environmental activities variables were almost identical in magnitude, with each increasing the value of water quality by around 28%. The significant positive influence on benefit values of visits to lakes and rivers accords with previous research by Cameron and Englin (1997) showing that respondent experience with the good being valued raises the valuation amounts. After accounting for the influence of the environmental variables and demographic effect such as income and education, variables pertaining to region, race, and gender were not significant on an individual basis.

Whether the respondent was told the percentage of water in the country rated good did not have a statistically significant effect on valuations. The sub-sample that was given information pertaining to this possible anchor exhibited no difference in their valuation amounts. This result indicates that the respondents focused on the difference between the alternatives in the choice set, rather than on the presence of an external reference point.

[11] The particular environmental organizations listed in the survey for possible membership were the following: Environmental Defense Fund, Greenpeace, National Audabon Society, National Wildlife Federation, Nature Conservancy, Natural Resources Defense Council, and Sierra Club.

External Scope Tests

The second validity assessment is an external scope test. The scope test is important in establishing context that the estimates of V were a meaningful quantitative, valuation metric.[12] If respondents are willing to incur the same cost of living increase for a 20 percentage point change in water quality as a 40 percentage point change, then all one is measuring is a general attitude towards water quality over cost of living, such as "warm glow" effects. The test we report is across respondents, a stronger test than a within subject test.

This test is possible because we altered the initial range of water quality ranges and the cost of living across respondents. In particular, one of the alternatives in the initial choice was either 20, 30, or 40 percentage points in good water quality higher than the other, and the difference in cost of living was either $200, $300 or $400 per year.[13] To demonstrate appropriate sensitivity to the scope of the choice, respondents' initial choices should favor the region with higher water quality when its gain in water quality is greater. Similarly, respondents should favor the region with lower cost of living when its gain in living expense is greater. Table 2 displays a logistic regression predicting initial choice as a function of initial ranges and the demographic variables used to predict the final valuation amounts for the regressions in Table 1. The variables pertaining to each of the scope tests are significant and in the expected direction. Increasing the water quality difference or decreasing the cost of living difference makes one more likely to choose the alternative with higher water quality. Further, the characteristics that predict the initial choice for the regressions in Table 2 parallel those predicting the final tradeoff reflected in the regressions in Table 1, with choice of the high water quality option increasing

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[12] For a detailed review of scope tests and the ability of contingent valuation studies to pass scope tests, see Smith and Osborne (1996).

[13] We also altered the average levels of water quality to see if response depended on these. Those analyses are available on a working paper: "Coping with the Contingency of Valuation: Range and Anchoring Effects in Choice Valuation Experiments," Huber, Viscusi and Bell (2004).

with age, income, education and the environmental preference variables such as visits to lakes and rivers or membership in environmental organizations.

4. Evaluation of the Panel Sample

Sample Characteristics

The sample used for the study came from the Knowledge Networks (Menlo Park, CA, www.knowledgenetworks.com) panel. Researchers on environmental benefits valuations have increased their use of internet panels, so that the performance of this survey approach has broad implications beyond our particular study.[14] The Knowledge Networks sample consists of a national sample of households recruited by random-digit dialing, who either have been provided internet access through their own computer or are given a WebTV console. The underlying Knowledge Networks sample has been selected to be broadly representative of the U.S. population.[15]

Table 3 compares the sample characteristics of those who completed the survey and with the 2001 U.S. adult population. The survey population closely mirrors the U.S. Census distribution. One might have hypothesized that people willing to be surveyed would be better educated, underrepresented at the extremes of income, and younger than the general population. However, there are no major discrepancies between the sample mix for our study and the population. While some differences are statistically significant, including the percentage of respondents age 64 and over and the representation of some income groups, these differences are not consequential. For example, 11 percent of the sample is age 64-74 compared to a national average 9 percent, and 21.1 percent of the sample have household income in the $50,000-

[14] Other researchers using the Knowledge Networks sample have included Krupnick et al. (2002), Berrens et al. (2004), and DeShazo and Cameron (2004).
[15] Ongoing research by Trudy Cameron and J.R. De Shazo has examined the representativeness of this sample and has developed a selection correction to account for differences from U.S. Census averages.

$74,999 range, as compared to the national average of 18.9 percent. Differences such as these are to be expected, both because of the stochastic nature of the sampling process as well as the fact that there is not an exact match up for the 2001 Census time period and the more recent sampling period. Overall, the sample tracks the U.S. population remarkably well.

Sample Validity Tests

Because the survey was administered via the internet using an existing panel of respondents, we undertook a series of validity tests specifically determining whether their panel membership influenced the valuation results. To the best of our knowledge, these are the first such tests to have been undertaken for this sampling methodology. We tested the panel influences of four variables on the regression analysis of the determinants of the value of water quality benefits. Table 4 reports these regression results in which these panel variables first are added to our earlier analysis shown in Table 1 and then are included without these variables.

The first variable is whether the respondent stopped the survey and then continued the survey at a later time. Conceivably, such respondents might be less engaged in the survey task. However, there was no significant effect of this variable on benefit values.

The second variable of interest is the time the respondent has been a member of the Knowledge Network panel. Length of time in the panel may affect attentiveness to surveys and potentially could be correlated with other personal characteristics that influence water quality valuations. The estimates in Table 4 fail to indicate any significant influence of this variable either.

Third, the number of days the respondent took to complete the survey after being offered the opportunity to participate could reflect a lack of interest in the survey topic or in taking surveys generally. Nevertheless, there is no significant effect of this variable on benefit valuations in either of the equations estimated in Table 4

The final survey methodology variable tested is whether the respondent subsequently quit the panel either immediately after the invitation for this survey or at any later time until May 2004, when data for this variable were collected. Such respondents could be less interested in taking surveys and might have different valuations. However, this variable was also not statistically significant in the water quality valuation equations.

Overall, there is no indication that any of these key aspects of the panel methodology bias the survey responses. In addition to the general match of our respondents to the U.S. population, we also examined whether these four variables reflecting the methodology had any influence on the probability that the respondent failed to pass the consistency test with respect to the benefit valuations. There were no significant effects of any of the Knowledge Networks panel variables so that there is no evidence that national performance of the survey task is importantly influenced by any of these variables.

Selection Effects

Although the sample is nationally representative and had a high overall response rate, it is useful to test for possible selection biases arising from panel members who were invited to participate but did not successfully complete the survey. Of 1,587 panel members invited to take the survey, 74% of respondents chose to participate. Of the 1,174 participants, three respondents did not complete the portion of the survey that elicits water quality value. Finally, 6% of participants completed the survey but were dropped because they chose the dominated alternative and continued with that choice even after being so informed. Therefore, 1,103 of 1,587 invitees consistently completed the water quality valuation portion of the survey. For the selection correction for bias, we used variables for which we had the values for non-respondents as well as survey respondents. This data is routinely collected by Knowledge Networks on its panel members. Thus, an additional advantage of such panels is that there is information available to analyze who chose not to take the survey after being offered the chance to do so.

To predict participation, we identified a number of variables that significantly affected survey completion. In particular, we found that being African American or Hispanic was negatively associated with completing the survey, as was household size. We also constructed two health-related stress dummy variables. The first stress variable was for individuals who reported that they had a high stress level. The high stress variable indicated respondents who reported more “stress, strain, or pressure” than usual “during the past few months.” The second stress variable was for people who failed to respond to the stress information question. Each of these variables was negatively related to the probability of taking the survey but not significantly related to the water quality valuation amount V, thus achieving the appropriate identification.

Table 5 reports the selection equation and the selection-corrected regression of the log value of water quality. The threshold empirical issue is whether there are any statistically significant selection effects. As the chi-squared statistic reported at the bottom of Table 5 indicates, one cannot reject the hypothesis that there is no significant effect of sample selection on our empirical estimates. Thus, the empirical estimates are not biased in any statistically significant way by the self-selection of respondents in the Knowledge Networks sample who chose to complete the survey and did so successfully.

Given this absence of statistically significant selection effects, it is not surprising that the selection-corrected estimates closely parallel our earlier estimates. Water quality values increase with income levels, age, and education, as before. The race variable has become significant, but this effect may have been due in part to the omission of the environmental group membership and water recreation use variables from the equation, since they were not available for non-respondents.

Similar stability in the results is implied by an examination of the extent to which the estimates of the dollar value of water quality changes with the selection adjustment. Using the parameter estimates of the selection-corrected regression, we estimated the log value of a one percent improvement in water quality. The average log value then decreased by 4.5% and the antilog by 11.1% compared to corresponding estimates using parameters from the ordinary least squares regression. These differences are well within sample variability and thus are not statistically significant. More important, these results indicate that the estimates are not substantively different even after careful adjustment for sample selection.

5. Conclusions

The survey results presented here passed a variety of consistency tests and rationality checks. These tests included dominance tests as part of the iterative choice process and external scope tests across respondents. In addition, the internet-based methodology itself was tested with respect to a variety of potential sources of bias, such as sample attrition, and these panel characteristics had no significant effect on the results.

It is appropriate to speculate on why these results are much stronger than those reported in Magat et al. (1988). The earlier study produced similar aggregate values, but the covariates with water quality value were largely insignificant, and a scope test was not even attempted. The Magat et al (1988) study had less than half the number of respondents, but the main differences are methodological. In the current study, greater effort was placed on preparing the respondent to make the trade-off between water quality and cost of living. Three warm up questions involving dominated choices provided easy ways to understand the choice task, and for the relatively low percent of respondents who 'failed' those questions, provided a way to communicate the importance of their answers.

Working with a panel had several advantages. First, since our survey design involved the use of a computer-based sample, the Knowledge Networks panel yielded a more representative sample of survey participants than other survey methods such as those used by Magat et al. (2000) in which a group of subjects contacted by phone came to a central location to take the survey. Second, respondents in the panel are accustomed to taking surveys, so they are not confused by the process. Third, and most important, because there are data on those who declined to take the survey, it is possible to estimate the impact of that self-selection on our results. In this case, that self-selection had minimal effect on our estimates. However, that result strictly applies only to our focal question about the value of water quality. The real value of panels is that they contain the information that permits an assessment of the impact of respondent selection mechanism that will certainly be an even greater problem in the future.

The practical benefit of these results is that they provide unit water quality benefit values that can be matched to existing EPA measures of water quality to provide an assessment of benefits of water quality programs. Good water quality has a unit value of $23 per percentage point increase in water quality. This value is dependent on variables such as income, education, and personal use of lakes and rivers in the expected fashion. To value water quality improvements, one can use these values in conjunction with results that break down the benefits in terms of benefits for the components of water quality—fishing, swimming, and health of the aquatic environment— to gauge the economic benefit of an improvement project to the affected local population.

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Figure 1
Sample Private Water Quality Benefit Question

We would like to ask you some more questions like these. However, in these questions, one region will have a lower annual cost of living and the other will have higher water quality. **Remember that the national average for water quality is 65% Good.**			
	Region 1	Region 2	
Increase in Annual Cost Of Living	**$100** More Expensive	**$300** More Expensive	
Percent of Lake Acres and River Miles With Good Water Quality	**40%** Good Water Quality	**60%** Good Water Quality	
Which Region Would you Prefer?	Region 1 *	Region 2 *	No Preference *

Figure 2
Survey Decision Tree

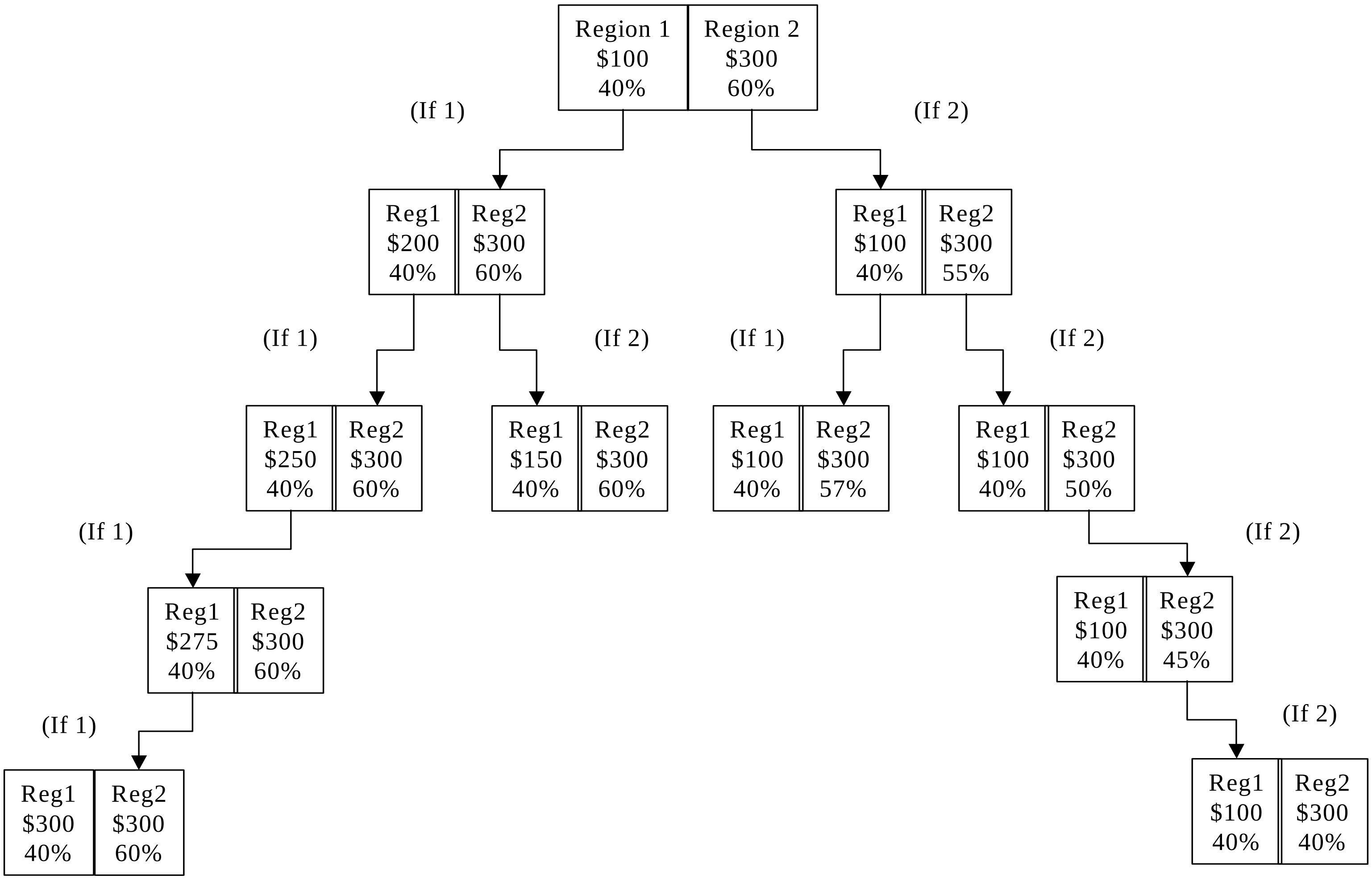

Table 1
Regression Estimates for Log of Unit Water Quality Benefit Value

	Log (Unit Value for Good Water Quality)			
	OLS		Censored	
Variable	Coefficient	Standard Error	Coefficient	Standard Error
Log (Income)	0.1668***	0.0480	0.1687***	0.0484
Years of education	0.0409***	0.0151	0.0423***	0.0153
Age	0.0115***	0.0023	0.0119***	0.0023
Environmental organization membership	0.2843	0.1734	0.3140*	0.1773
Visited a lake or river, last 12 months	0.2822***	0.0778	0.2839***	0.0784
Told national water quality	0.0966	0.0728	0.0955	0.0734
Race: Black	-0.1403	0.1109	-0.1404	0.1117
Race: Non-black, Non-white	-0.0661	0.1637	-0.0844	0.1642
Hispanic	0.1415	0.1223	0.1325	0.1232
Gender: Female	0.0166	0.0727	0.0169	0.0733
Household size	-0.0093	0.0291	-0.0099	0.0293
Region: Northeast	-0.0271	0.1126	-0.0333	0.1134
Region: South	-0.0765	0.0955	-0.0814	0.0962
Region: West	-0.0997	0.1096	-0.0980	0.1107
Intercept	-0.4646	0.5243	-0.5031	0.5282
Adjusted R^2	0.0614		0.0251	

Notes: * significant at the .10 level, ** significant at the .05 level, *** significant at the .01 level, all two-tailed tests.

Table 2
Scope Test: Demonstrating the Impact of
Water Quality and Cost of Living Range on Initial Choice

	Respondent Chose the Higher Water Quality Region in First Choice	
Variable	Coefficient	Standard Error
Logistic Regression		
Initial Cost of Living Range	-0.00161**	0.00072
Initial Water Quality Range	0.0180**	0.00751
Log (Income)	0.2904***	0.0847
Years of education	0.0620**	0.0269
Age	0.0196***	0.00404
Environmental organization membership	0.6427**	0.3420
Visited a lake or river, last 12 months	0.4445***	0.1357
Told national water quality	0.0642	0.1338
Race: Black	-0.0249	0.1933
Race: Non-black, Non-white	-0.1145	0.2846
Hispanic	0.2827	0.2154
Gender: Female	0.0574	0.1277
Household size	-0.0543	0.0508
Region: Northeast	0.0322	0.1999
Region: South	-0.1125	0.1679
Region: West	-0.1526	0.1927
Intercept	-4.6635***	0.9745
	c = 0.654	

Notes: * significant at the .10 level, ** significant at the .05 level, *** significant at the .01 level, all two-tailed tests.

Table 3
Comparison of Knowledge Networks Sample to the National Adult Population[1]

Demographic Variable	Survey Participants Percent	US Adult Population Percent
Employment Status (16 years or older)		
Employed	65.1	66.9
Age		
18-24	13.1	13.0
25-34	19.1	18.8
35-44	20.2	21.2
45-54	19.1	18.5
55-64	12.2	11.9
64-74	11.0*	8.6
75+	5.4*	7.9
Educational Attainment		
Less than HS	17.0	15.9
HS Diploma or higher	60.0	58.5
Bachelor or higher	23.0*	25.6
Race / Ethnicity		
White	81.5	82.3
Black/African-American	13.1	11.8
American Indian or Alaska Native	1.0	0.9
Asian/Pacific Islander	3.1*	4.1
Other	1.3	1.0
Race / Ethnicity of Household		
Hispanic	11.1	11.4
Gender		
Male	51.0	48.3
Female	49.0	51.7
Marital Status (2000)		
Married	61.4	59.5
Single (never married)	23.5	23.9
Divorced	9.0	9.8
Widowed	4.1*	6.8
Household Income (2000)		
Less than $15,000	13.2*	16.0
$15,000 to $24,999	11.3	13.4

$25,000 to $34,999	13.4	12.5
$35,000 to $49,999	18.9*	15.5
$50,000 to $74,999	21.1*	18.9
$75,000 or more	22.2	23.8

Statistical Abstract of the United States, 2002. 2001 adult population (18 years+), unless otherwise noted.
* The 95% Confidence Interval for survey participants does not include mean adult US population for this demographic variable.

Table 4
Validity Tests Based on Censored Regression of Log of Unit Water Quality Benefit Values

	Log (Unit Value for Good Water Quality)			
Variable	Coefficient	Standard Error	Coefficient	Standard Error
Log (Income)	0.1710***	0.0487	--	--
Years of education	0.0421***	0.0153	--	--
Age	0.0119***	0.0024	--	--
Environmental organization membership	0.3165*	0.1776	--	--
Visited a lake or river, last 12 months	0.2787***	0.0787	--	--
Told national water quality	0.0966	0.0736	--	--
Race: Black	-0.1362	0.1129	--	--
Race: Non-black, Non-white	-0.0876	0.1643	--	--
Hispanic	0.1326	0.1237	--	--
Gender: Female	0.0150	0.0734	--	--
Household size	-0.0086	0.0295	--	--
Region: Northeast	-0.0381	0.11406	--	--
Region: South	-0.0873	0.0971	--	--
Region: West	-0.1024	0.1119	--	--
Respondent stopped and continued survey later	-0.006	0.1467	0.0233	0.1517
Time as panel member, in months	-0.0021	0.0032	0.0023	0.0032
Days from invitation to completion	-0.0013	0.0023	-0.0039	0.0024
Has panel member quit panel	-0.0131	0.0789	-0.1006	0.0803
Intercept	-0.4561	0.5326	2.5538***	0.0950
Adjusted R^2	0.0254		0.0017	

Notes: * significant at the .10 level, ** significant at the .05 level, *** significant at the .01 level, all two-tailed tests.

Table 5
Log Unit Water Quality Value Regression Results Controlling for Selection Effects

Variable	Coefficient	Standard Error
Regression Model for Log of Value		
Log (Income)	0.1701***	0.0480
Years of education	0.0447***	0.0150
Age	0.0122***	0.0023
Race: Black	-0.2391**	0.1119
Race: Non-black, Non-white	-0.0919	0.1637
Hispanic	0.0446	0.1241
Gender: Female	0.0106	0.0727
Household size	-0.0195	0.0303
Region: Northeast	-0.0561	0.1124
Region: South	-0.1059	0.0951
Region: West	-0.1297	0.1094
Intercept	-0.3666	0.5243
Participation Equation		
High Stress level	-0.1929***	0.0749
Stress Data Unavailable	-1.4668***	0.1133
Race: Black	-0.2364**	0.0968
Hispanic	-0.3511***	0.1013
Household size	-0.1178***	0.0246
Intercept	1.2453***	0.0930

LR test of indep. eqns. (rho = 0): chi2(1) = 2.46 Prob > chi2 = 0.1164

Notes: * significant at the .10 level, ** significant at the .05 level, *** significant at the .01 level, all two-tailed tests.

A Consistent Framework for Valuation of Wetland Ecosystem Services Using Discrete Choice Methods

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Goal and Approach

- The overall goal is to develop and test a consistent framework to estimate wetland services values.
- Our approach uses a joint modeling strategy to integrate revealed preferences (RP) from a discrete choice model of the housing market and stated preferences (SP) from a choice model for wetland ecosystem services.
- The analysis will be based on a comprehensive database from a stratified sample of residential property owners in three Metropolitan Statistical Areas (MSAs) in Central Florida.

Objectives

- 1) To estimate the demand for proximity to wetlands and other water resources using discrete choice and hedonic pricing models of residential property values.
- 2) To estimate the demand for ecosystem services from different types of wetlands that are not in proximity to residential property using a stated choice survey.
- 3) To develop and test a combined discrete choice model from the RP and SP data to produce a general valuation function for wetland ecosystem services.
- 4) To estimate the implicit prices of wetland services in mitigation banking markets.

Conceptual Framework

- Assume that housing and environmental protection are separable so an individual *n* maximizes the utility function:

$$U_n(X,Z;S)$$

subject to $M = P_X X + P_Z Z$

where U is utility, X is a vector of housing attributes, Z is a vector of environmental services associated with wetland resources, S is a vector of observed individual characteristics, M is income, P_X is a vector of prices for housing attributes and P_Z is a vector of prices for environmental services.

- Wetland services are public goods so P_Z must be revealed through direct elicitation but some services may be packaged with housing units.

Conceptual Framework: Housing

- Discrete housing choice model:

$$U_n = V_n (X_{A1}, X_{A2}, \ldots, X_{Al}, P_A) + \varepsilon_n$$

where A_l represents attributes of the A^{th} alternative housing bundle from the choice set K.

- The probability that individual *n* chooses housing unit *A* is given by:

$$\pi_{An} = \exp(\lambda^1 V_{An}) / \sum_{B \in K} \exp(\lambda^1 V_{Bn})$$

where λ^1 is a scale parameter.

Conceptual Framework: Ecosystem

- Discrete stated choice model:

$$U_n = V_n(Z_{C1}, Z_{C2}, \ldots, Z_{Cl}, P_C)$$

where the C_l attributes represent specific wetland services such as size, type, habitat quality, and groundwater recharge and P_C is a cost associated with the C^{th} wetland alternative from choice set *E*.

- The probability that individual *n* chooses wetland services package *C* is given by:

$$\pi_{Cn} = \exp(\lambda^2 V_{Cn}) / \sum_{D \in E} \exp(\lambda^2 V_{Dn})$$

where λ^2 is a scale parameter.

Consistency Tests

- To empirically investigate the consistency of the housing and wetland services choices, we employ the likelihood ratio test:

  $$-2[(L^A + L^C) - L^{Joint}].$$

- Other tests will be used to evaluate the effects of treatments used in the stated choice experiments.

Treatment Effects

- Evaluate the effects of information on preferences and task complexity using a 3 x 2 block design. We contrast choice task complexity, choices involving partial sets of wetland attributes *vs* choices involving a full set of attributes, with the format for the provision of information, text description *vs* spatial description. Motivation for full/partial attribute design is the legal context for determining mitigation.

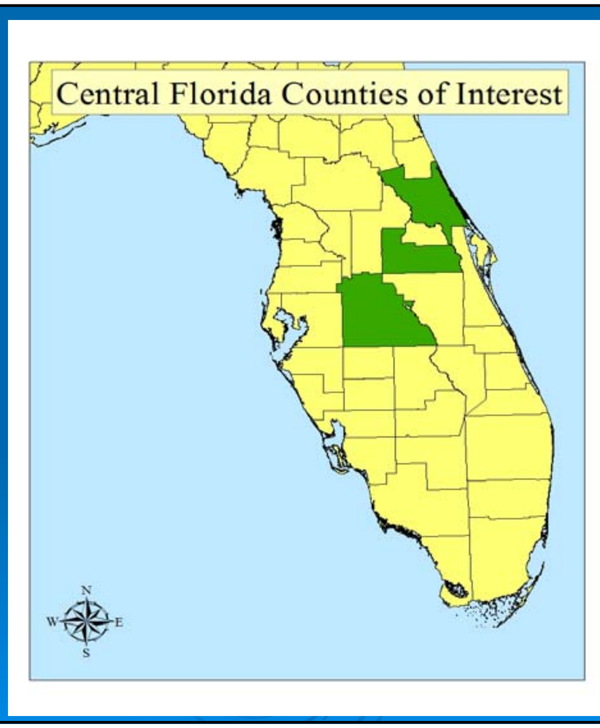
	Spatial Description	Text Description
Full Attributes		
Partial Attributes A		
Partial Attributes B		

Application

- Single family residential housing data will be collected from county tax appraisers in three Metropolitan Statistical Areas (MSAs) in Central Florida: Daytona Beach, Lakeland-Winter Haven and Orlando representing over 2.6 million people.
- From housing sales during the 2002 – 2004 period, develop a proportionally weighted sample of 1200 purchasers across the three MSAs.
- The sample of 1200 housing buyers will be contacted to participate in the stated choice wetlands survey. We anticipate a 50 percent response rate (600 property owners) to participate in interview surveys that will be conducted at a central location within each MSA.

Application

- GIS analysis will be used to identify the neighborhood and ecosystem attributes associated with each housing parcel.
- For the stated choice analysis, select a stratified random sample of wetland sites based on three stratification criteria: type of freshwater wetland, site acreage, and whether the wetland is connected to or isolated from surface waters. Sites will be from the land area containing the 3 MSAs.
- Each site selected will be profiled using GIS analysis to identify attributes of the site; these profiles will be ‘ground-truthed’ with site visits and additional information from wetland specialists in regional and state environmental agencies.

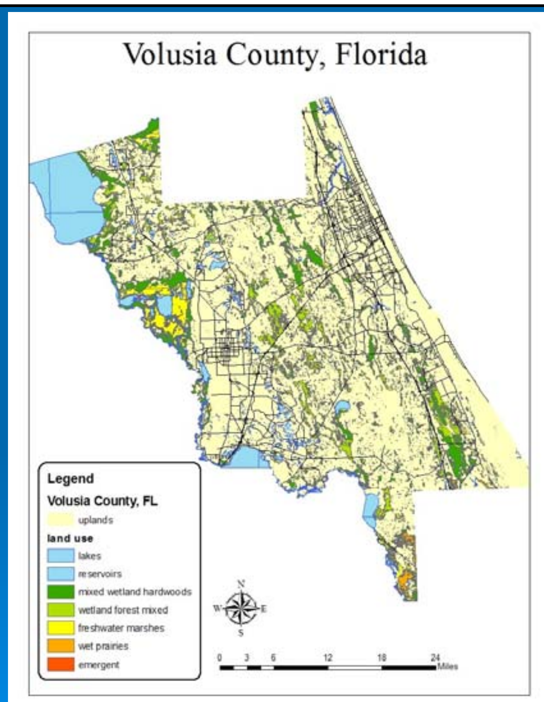


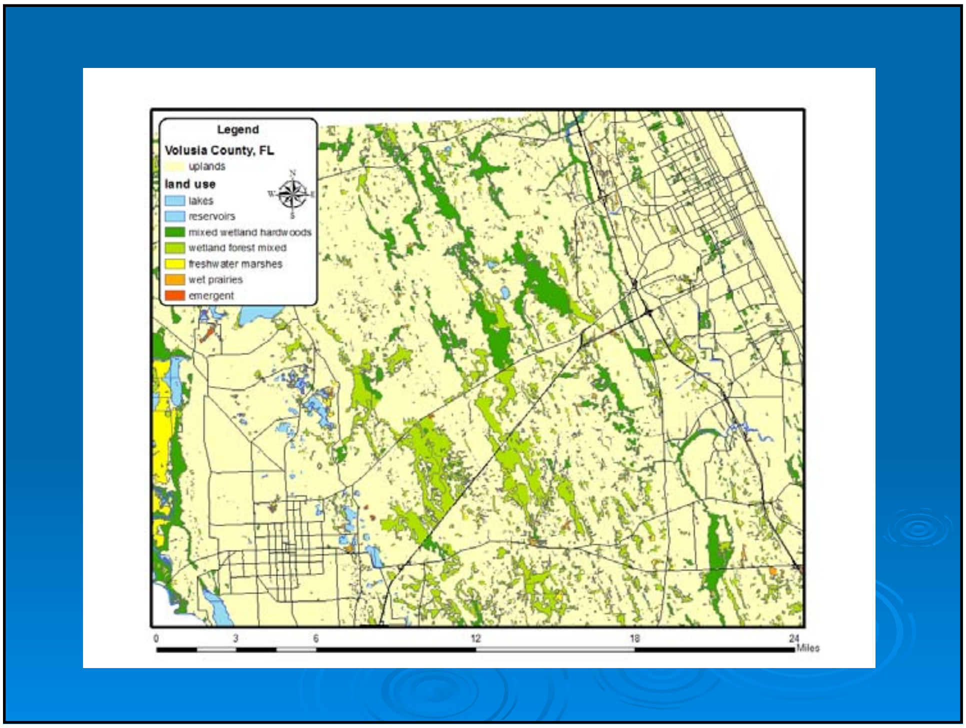
Land Use Coverage

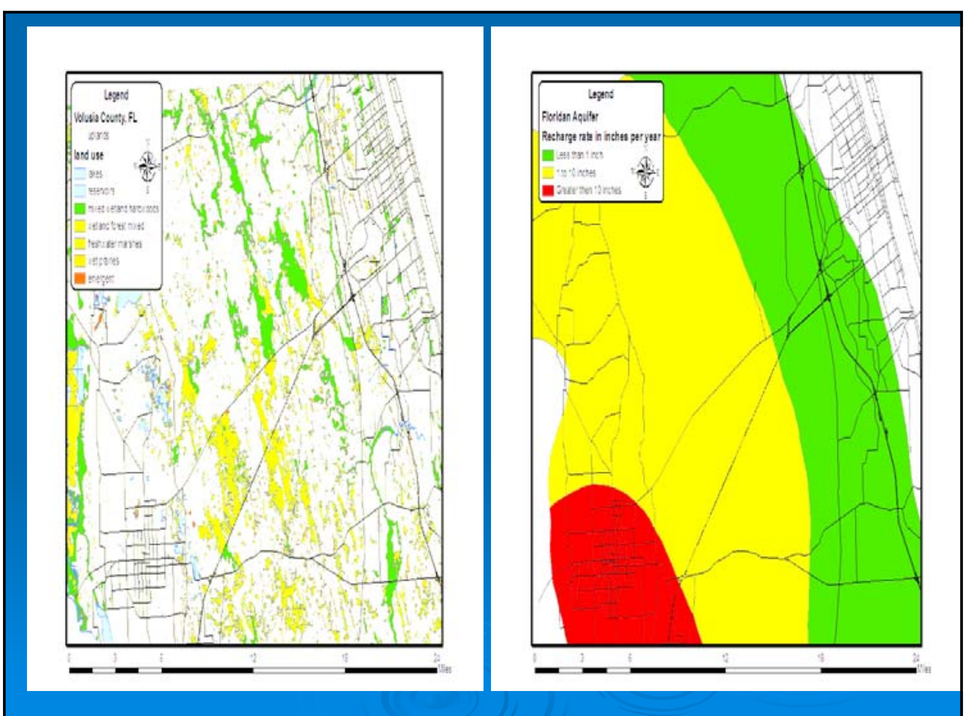
LAND USE	Percent Cover		
	Orange	Polk	Volusia
URBAN & BUILT-UP	17.3%	33.2%	12.3%
AGRICULTURE	9.1%	31.8%	6.0%
RANGELAND	5.7%	5.7%	4.1%
UPLAND FOREST	6.2%	5.8%	23.3%
WATER	21.1%	4.6%	19.4%
WETLANDS	36.8%	17.9%	33.3%
BARREN LAND	1.6%	0.1%	0.3%
TRANS & UTIL	2.2%	0.8%	1.2%

Wetland Coverage

WETLAND TYPES	Percent Cover		
	Orange	Polk	Volusia
Mixed Hardwoods	17.2%	43.5%	37.2%
Mixed Cypress/Forest	14.8%	35.2%	39.0%
Freshwater Marshes	62.5%	16.2%	9.8%
Wet Prairies	1.2%	3.9%	3.1%
Emergent Vegetation	4.2%	1.1%	10.8%




Legend
Volusia County, FL
uplands
land use
lakes
reservoirs
mixed wetland hardwoods
wetland forest mixed
freshwater marshes
wet prairies
emergent
0
3
6
12
18
24
Miles


Legend
Volusia County, FL
land use
Legend
Floridan Aquifer
Recharge rate in inches per year

Comments on:

Valuation of Natural Resource Improvements in the Adirondacks
Spencer Banzhaf, Dallas Burtraw, David Evans and Alan Krupnick

and

The Value of regional Water Quality Improvements
Kip Viscusi, Jason Bell and Joel Huber

By:

Kevin J. Boyle
Distinguished Maine professor
University of Maine

October 26, 2004

Introduction

These two papers make a nice comparison of applied studies on the benefits of improved surface water quality. My comments will address several key features in the design and implementation of stated-preference studies. I will discuss how each study addressed these specific design issues. The studies hereafter will be referred to as the Banzhaf and Viscusi studies, respectively.

Geographic Scope of Application

The Banzhaf study focuses on a specific region, the Adirondacks in New York, while the Viscusi study is designed to develop a national water quality value. These applications represent the two extremes of the spectrum in applied valuation studies. Regional studies for a specific application allow the design of precise and specific valuation scenarios, which most practitioners, I believe, would agree lead to better estimates of value in terms of validity and reliability. National value estimates are needed by U.S. EPA for RIAs of national policies. The question in my mind is whether the Viscusi study in the quest for a national value for policy results in value estimates that have very little empirical credibility. On the other hand, the Banzhaf value estimate has little relevance for national policy.

In other words, the Banzhaf says something very specific about benefits of a particular policy in a specific area, but has little to offer for national policy. The Viscusi study purports to comment on a general policy, but has little to say about any specific policy or regional application. Both types of value are needed. EPA does need estimates of value to address national policy initiatives. In application of policy EPA leaves states and/or regions with considerable latitude regarding how policies will be implemented. A national policy may overestimate or underestimate regional benefits, and more refined value estimates are needed to consider how and to what extent a policy should be implemented in a specific region.

The revealed-preference studies presented earlier in this session, Egan et al. and Smith et al., present a promising approach to addressing this dichotomy of policy needs that improves on the approaches in the Banzhaf and Viscusi studies. The Egan and Smith studies use aquatic ecosystem attributes that define the quality of anthropocentric uses. This type of attribute design provides flexibility in the computation of value estimates for national policy and for regional variations in the implementation of a national policy. Moreover, the results from these types of revealed preference studies could be used to design choice studies similar to the Viscusi study that would provide more credible estimates of value for both national and regional benefit calculations.

What is Being Valued?

This issue is related to my discussion above. The Banzhaf study substantially attempted to link the valuation scenario to bio-physical information on the quality change that would arise from a policy to improve surface water. However, the actual link is not as clear as it could be. Two suggestions arise here. First, a clearer link could be developed by a more formal presentation of an economic model that links the policy change to the design of the valuation scenario, to data analyses, and to interpretation of the statistical estimates. Second, as noted above, an attribute-based design of the scenario would have made the bio-physical link clear in the valuation questions and would have made it explicit in the econometric model used to analyze the valuation responses. This would not only have improved the value estimates for application sin the Adirondacks, but would have improved the transferability of the values estimates to other regions or for use in national p[policy.

The Viscusi study valued "good" water quality. Admittedly these investigators were constrained by EPA's decision to defined water quality categories. However, given the experience of this research team one might expect a more creative design that might allow for the estimation of more credible estimates of value while developing a mapping that would allow the value estimates to be applied to EPA's categories for policy analyses.

If I take the title of this workshop literally, "*Improving the Valuation of Ecological Benefits,*" then it seems imperative that EPA consider the support of developing more complex valuation approaches and empirical applications the link policy effects on ecosystem services to changes in economic value. As stated, in the preceding section, the Egan and Smith studies are a substantial step in this direction for revealed-preference applications, which have important implications for the design of stated-preference studies.

Framing of the Valuation Question

I think it is appropriate that both studies used a total economic value approach to estimate values. I think the value estimated in the Banzhaf study is clear and could be improve with a more explicit model that is carried though the empirical analysis.

The Viscusi study used a unique in interesting experimental choice to elicit values; the choice of a move to a new area. I have two concerns. First, respondents were not given a chance to say that they would not move, i.e., they are not in the market. Second, I do not know what economic concept of value they estimated. Some of the use value captured in a hedonic model would be included, and perhaps some recreation value of being closer to higher quality water bodies. I think that some nonuse value might be captured through the use of a higher cost of living as the payment vehicle. It does not appear that this framing of the valuation question captured all of respondents' recreation and nonuse values. This leaves the question of how much of national benefits are captured in the Viscusi study and how can other values estimated be included in the calculation of aggregate benefits without encountering substantial double-counting problems.

Internet Surveys

Both studies used an internet survey mode and investigated aspects of the validity of this mode, which is appropriate given the convenience and expanding use of internet surveys. The finding by Banzhaf that there is no difference between the value estimate between an internet survey and a mail survey is an important contribution to the literature.

The Viscusi study considered other the effects on aspects of respondents' actual participation in the internet survey on value estimates. No statistically-significant effects were identified, but the internet response features considered appear to be exogenous to valuation responses and it is not surprising that not significant effects were identified. I think it would be more interesting to consider data on time spent reading the valuation scenario and answering the choice questions, which may be more likely to be indicative of the difficulty of the exercise and effort that respondents invested in answering the valuation questions. Having said this, it is still good that the Viscusi study took these other internet survey response features off the list of concerns for future studies.

Educating Respondents

Both studies indicated that time was taken in the administration of the survey to educate respondents who had difficulty with the valuation tasks. Neither study fully documented what was done to educate respondents and how this influenced value estimates. This leaves a number of questions in my mind. Did these efforts keep people in the sample that might otherwise not have completed the survey? Did these efforts make these people statistically similar to other respondents in terms of their valuation responses? If valuation responses do differ, how so?

Econometric Analysis

Both studies are disappointing in their econometric analysis. Neither study has an empirical specification that is linked to a theoretical model, nor both studies have specifications that are not consistent with utility, e.g., including both bid amounts and income as separate linear arguments.

Tests of scope in both studies focused on valuation responses that include both use and nonuse values. I think the literature is clear that stated preference studies demonstrate scope for use values, while the real issue is in the estimation of nonuse values. The question is whether the use value component of the value estimate is driving the confirmation of scope in both studies. The Banzhaf study has the potential to address this issue by segmenting the sample to those who are not users and testing this group of responses for sensitivity to scope.

Usefulness of Value Estimates for Policy

The effects of public policy on aquatic ecosystems are highly uncertain. Both studies assumed this uncertainty away in the design of their studies. The Banzhaf study claimed to address uncertainty by using two scenarios. This split design does not address uncertainty as it simply give values for to different policy outcomes. Valuation studies that effectively value aquatic ecosystems need to include stronger links to ecosystem attributes in the design of valuation scenarios, and explicitly include physical and biological uncertainties into the scenario designs.

Summary of the Q&A Discussion Following Session III (Part 2)

Bill Mates (New Jersey Department of Environmental Protection)
Saying that he was not an economist or statistician but "might be in the position of *hiring* an economist or statistician," Mr. Mates addressed the three presenters: "*All* of your approaches are very well done and very persuasive, but the question I would like to ask each of you is "Where do you think your *own* approach is the best, and where might you be willing to admit that one of the other two approaches was superior?" In other words, what circumstances would lead to one approach versus another?"

Walter Milon (University of Central Florida)
Dr. Milon responded, "Well, if I'm in EPA's Office of Water, I would probably love Joel's [Huber] work, and I suspect that's, hopefully, what the fundamental orientation is. If I'm at the state level and I'm worried about wetland conversion decisions and policy choices about how we set up conversion ratios, public buyout programs, the set of ecosystem services that we would want to protect for the public, then I think we need the more detailed information. As laborious as it may be, I think you have to go that route. I personally think, as was said here earlier, you need to tailor the methods to the specific policy question."

Spencer Banzhaf (Resources for the Future)
Dr. Banzhaf said, "I would say something similar, or at least something that" gets back to the point made at "the beginning of these comments, which is the tradeoff between saying a lot about nothing versus saying a little bit about everything. That's really the tradeoff, so if it's a very specific policy question that one has *or* if shedding light on one specific region is enough to address the question, then that would be the way to go, but if you went . . . big . . . you could answer a host of questions."

Joel Huber (Duke University)
Dr. Huber added, "Basically, many of these signals are political ones, and for that we need the details. As an analogy, some of us *do* vote for President on the basis of what our party is, but most of us think about the individuals, and to assume that people do otherwise would be wrong. So, at best, the approach that we have is a good first pass, but it abstracts from *everything* that most of us hold *dear*, so in *no* sense am I saying this is true. The utilities are a fiction anyway, but ours are *true* fictions---theirs are *partial* fictions." (laughter)

Nancy Bockstael (University of Maryland)
Addressing her comment to Joel Huber, Dr. Bockstael asked, "Did you at any point try to get at, through focus groups or anything else, what people are thinking when they're answering these questions? I ask that because I can imagine that people—well, neither cost of living nor environmental quality drops from the sky. Presumably, people (some people, at least) think about a process by which some areas become higher in

environmental quality, some areas become higher in cost of living or whatever. Are they reading more into these questions and voting for more than they might get?

Joel Huber
Dr. Huber replied, "Right—there's the tendency to try to sort of make sense of it. The reason I actually asked you all to make the choice was it's about as deep as that—and you found you *could* make the choice, and if it were a real choice, could you make it?—yes, you probably could. Would you make the same choice every time?—no, probably not. Are you affected by anything around you?—yes. And then the question *we* asked: Is there any stability to what comes out?—and the answer is yes. *That* was the hard part, and it took a number of years to get it right. So, there's not *much* there—but it's enough.

Nancy Bockstael
Dr. Bockstael countered, "I have to ask: Is stability a good thing here? I don't know."

Joel Huber
Dr. Huber expounded, "Well, let me go back to the political issue. Part of the reason we have this is because we *need* to value things, and the solution I give is not a great solution, which is start with 50/50, but it does solve the problem of stopping anyone from entering bias into the mix. I'm a researcher—I can make the thing *very* biased—and this stops that, eliminates that."

Kerry Smith (North Carolina State University)
Dr. Smith said, "One of the issues that separates, invariably, economists and ecologists when they try to look at problems is that ecologists typically apply the risk at a spatial dimension. They're always *grounded* in a location and the characteristics of that location and a configuration, as Geof (Heal) said, of services that come as a consequence of those characteristics and resources and so forth. One of the advantages of your approach, Joel (Huber), from the perspective of the EPA's Office of Water, is that it *isn't* that way—it's much more compatible with the way in which economists like to think of things—away from space, away from locations, and you can *abstract* from all of that and get to a market, even though you don't define where it is. Do you see in the experience that you've had any *hope* that we could get to the point where we could do that with ecological services? I'm not sure, so I'm wondering—based on your experience not only in *this* study but in other studies, is that something we should aspire to" or not?

Joel Huber
Dr. Huber responded, ". . . the value for life, which we use. It's a number, and there's been some agreement on it, and it's very useful. Is it *the* value for life?—absolutely not. Does it apply to each person?—absolutely not. Is it useful for policy?—yes. Policy is way worse off if they don't have *some* number. What bothers me, and the reason I'm willing to put in as much as we put into this is: You've *got* to have a consistent number out there if you want to do consistent policy. And the number is pretty good. It's not

truth, but it's pretty good, and it's stable, and it will resist other people trying to say: Let's try a different way of getting at it. So, in that sense, it's a reasonable way to deal with this. But, for *most* cases, it would be a first pass, or if you have to do it quickly, you could use it."

Spencer Banzhaf
Dr. Banzhaf stated, "One of the other tradeoffs between the specific versus the generic approaches is what people are bringing to the task if it's a stated preference model. Things really are embedded in nature in various places. . . . In our case, it really is true in the Adirondacks that if you change water quality, you're going to change some other parts of the ecosystem, so these things really *are* embedded. We found that if we left that *out* and people were educated too well in high school, they embedded it themselves. We could, in some ways, make a concession to that, since it was really true, and it's actually easier to value a multiple than to try to divide things up and separate them piece by piece. What you lose when you go to the *generic* approach is the ability to control for that . . ."

Stephen Swallow (University of Rhode Island)
Responding first to Dr. Bockstael's statement about "whether environmental quality drops out of the sky," Dr. Swallow asserted, "In the Adirondacks, it does." (laughter) He continued, "Actually, I like the validity of the checks you did on the plausibility of that, but it still disturbs me that you're saying it's an unrealistic policy . . . On one hand I'm willing to go for that as a practical matter of the dirty work of policy analysis. On the other hand, I wonder if we could explore it even further, although you explored it pretty well."

Addressing a different issue, Dr. Swallow said, "This morning Nancy (Bockstael) said a whole lot of things that were absolutely right about the income point and evaluating . . .being careful about . . . welfare analysis." He said he was "encouraged with the sessions today to see that we're *not* getting caught entirely in what could become intellectual paralysis. We *need* to get some answers, and maybe *some* number is better than *no* number, and sometimes you need to check and be careful about what that number is. I like what Joel's doing because it *is* a step forward on what's really a dirty problem—when you get into policy" on an international scale or on a small, local scale, "you find out that when they get some information from several of these approaches, there's a lot of value to that information . . . "

"My final comment is that we've talked a bunch today about production functions and linking production functions, and I think that we've forgotten one type of production function . . . household production. Looking back at Joe Herriges' presentation on the Iowa lake water quality, I think that the trip behavior that people were exhibiting would have accounted for how the lakes interact with their household production. But, I wonder whether in some of the stated preference studies we focus a little too heavily on the production from the ecology side of "How do we get from water quality to recreation days?" Yet, there's still the respondent who has his or her own production function that we haven't necessarily tried to start to quantify."

END OF SESSION III (Part 2) Q&A