VALUATION OF NATURAL RESOURCE IMPROVEMENTS IN THE ADIRONDACKS

Spencer Banzhaf, Dallas Burtraw, David Evans, and Alan Krupnick

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Summary

For 20 years the debate about clean air regulation has centered on acid rain and the controversy about acid rain in the Adirondack Park, which covers some six million acres in New York State. But until now policymakers have never had an estimate of the economic value of improvements to the park to New York State residents. Our five-year study quantifies the change in total economic value (the sum of use and nonuse value) that would result from an improvement in the ecological attributes of the Adirondack Park that could be expected to follow from policies currently under consideration, such as Clear Skies. To obtain these estimates a contingent valuation survey was administered to a random sample of New York State residents through the Internet, Web TV, and mail.

Our preferred estimates of the mean willingness to pay (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 the state yields benefits ranging from about $336 million to $1.1 billion per year. The instrument passes an external scope test and a test of sensitivity to bid, both of which are important measures of validity for stated preference studies.

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 values above 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.

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1. Introduction

For 20 years the debate about clean air regulation has centered on acid rain and the controversy about acid rain 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.

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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 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

[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.

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 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

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

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 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

[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 preference methods to measure the value of delaying damage to cultural materials from acid deposition.

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 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

[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.

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 the 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 would 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

[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."

some number of trees of various species, and their health, as a portion of total forests in the park.

Payment Vehicle

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 were 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'

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

beliefs about the information 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 the 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 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

[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.

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 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

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

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 do not 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.

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

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 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 subjects' comprehension of and attention to the scenario and vote, as well as warm glow and embedding, or what Mitchell and Carson (1989) call

[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.

"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 the 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.

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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.

Willingness to Pay

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 provides gains in efficiency (Hanemann et al. 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

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

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 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 et al. 1991; Haab and McConnell 1997), and assumed 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

[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 value across votes (compared to the alternative hypothesis of falling values in the follow up). Admittedly, this is a weak test.

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 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

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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.

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 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:

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[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.

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

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 cost shares to each utility 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

[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.

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 provide long-sought and valuable information about the benefits of air pollution policy.

Tables and Figures

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 and two bird species. Scope case: Effect on three tree and 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 and 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 was 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 (Sample Size in Parentheses)

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	

*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. Lognormal Econometric Models (Base Instrument)

Variable	Model 1	Model 2	Model 3
Constant	4.6277***	4.0116***	4.4076***
	(5.53)	5.23	(20.08)
Sigma	1.5432	1.2737	1.3825
	–	–	–
Income < $20k	0.5221	0.3929	
	(1.41)	(1.53)	
Income $20-35k	0.2331	0.1210	
	(0.94)	(0.54)	
Income $35-50k	0.2464	0.2208	
	(1.09)	(1.10)	
Income $85-125k	0.2237	0.2991	
	(0.91)	(1.37)	
Income >$125k	0.5569**	0.6611***	
	(2.41)	(2.90)	
Future income higher	0.2191**	0.2267***	
	(2.32)	(2.81)	
Household size	-0.0849	-0.1036	
	-(0.87)	-(1.22)	
Presence of children (0/1)	-0.4767	-0.5286*	
	-(1.41)	-(1.90)	
Number of children	0.2717*	0.3491**	
	(1.73)	(2.39)	
Female	-0.0688	-0.1846	
	-(0.38)	-(1.30)	
Black (Not Hispanic)	-0.2058	-0.5227*	
	-(0.68)	-(1.93)	
Other (Not Hispanic)	0.0608	0.1080	
	(0.16)	(0.34)	
Hispanic	-0.3397	-0.4557	
	-(0.82)	-(1.50)	
Age	-0.0181	0.0200	
	-(0.61)	(0.75)	
Age^2	0.0002	-0.0002	
	(0.50)	-(0.58)	
Reduce spending on clean air & water	-0.7298	-0.4684	
	-(1.38)	-(1.08)	
Increase spending on clean air & water	0.9370***	0.3284	
	(3.89)	(1.53)	
Environmentalist	0.7453***	0.4484***	
	(3.83)	(2.57)	
Frequent visitor to park	0.4874**	0.2903*	
	(2.35)	(1.65)	
Live in park	-0.5603	0.0027	

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

Z-scores in parentheses.
*significance at 10% level
**significance at 5% level
***significance at 1% level

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

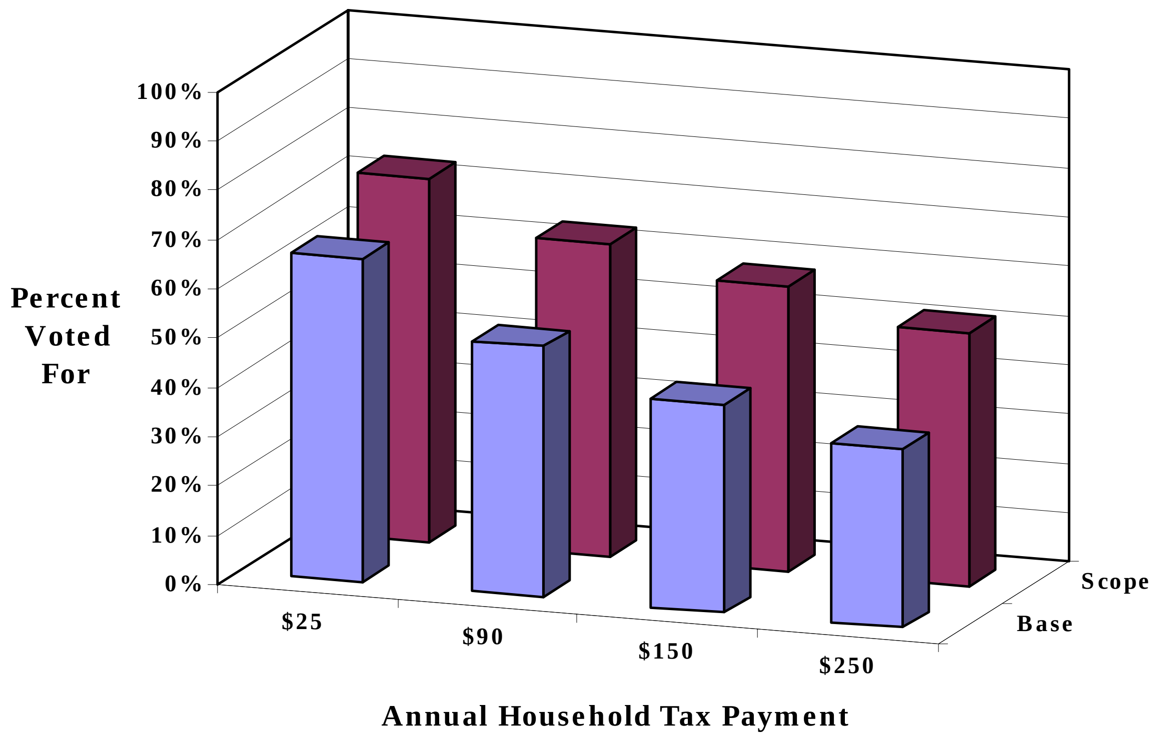
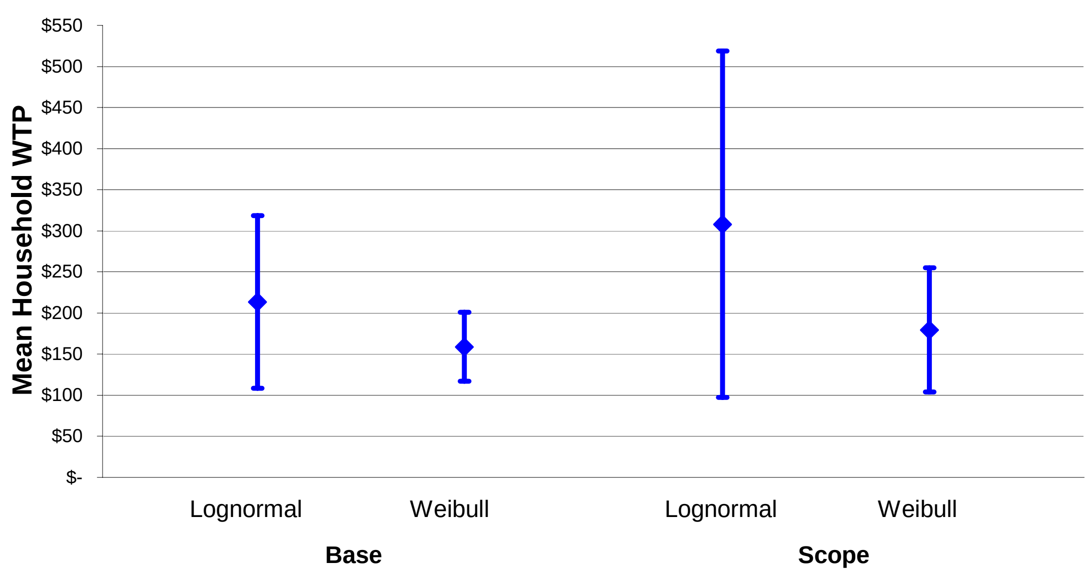
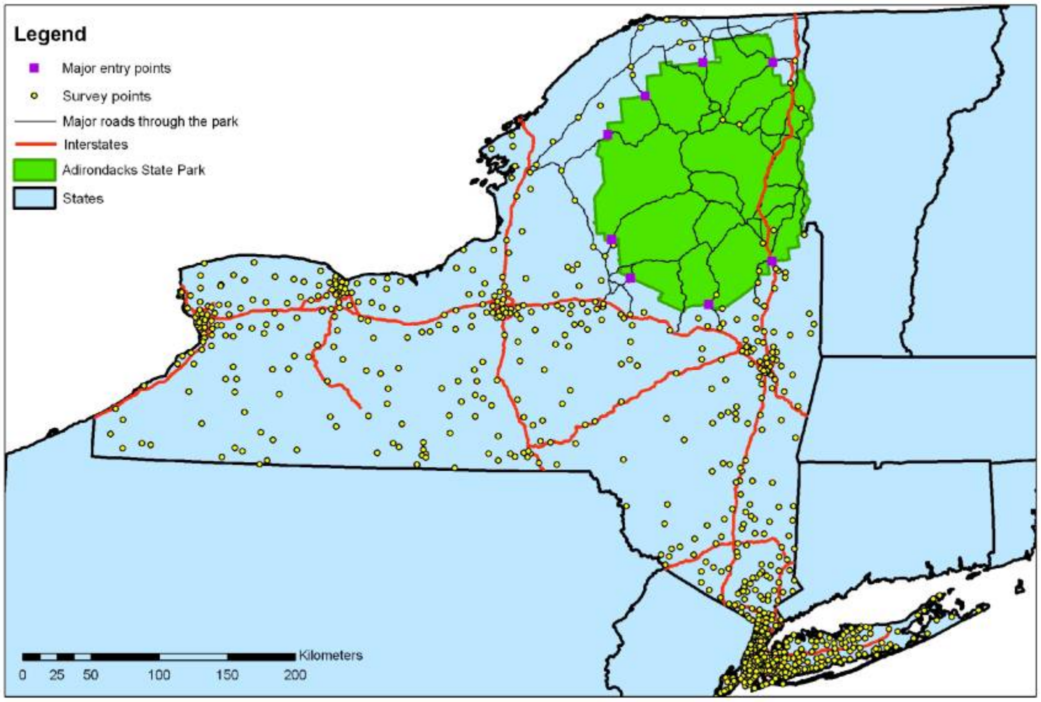


Figure 2. Model and Statistical Uncertainty of Mean WTP for All Econometric Models

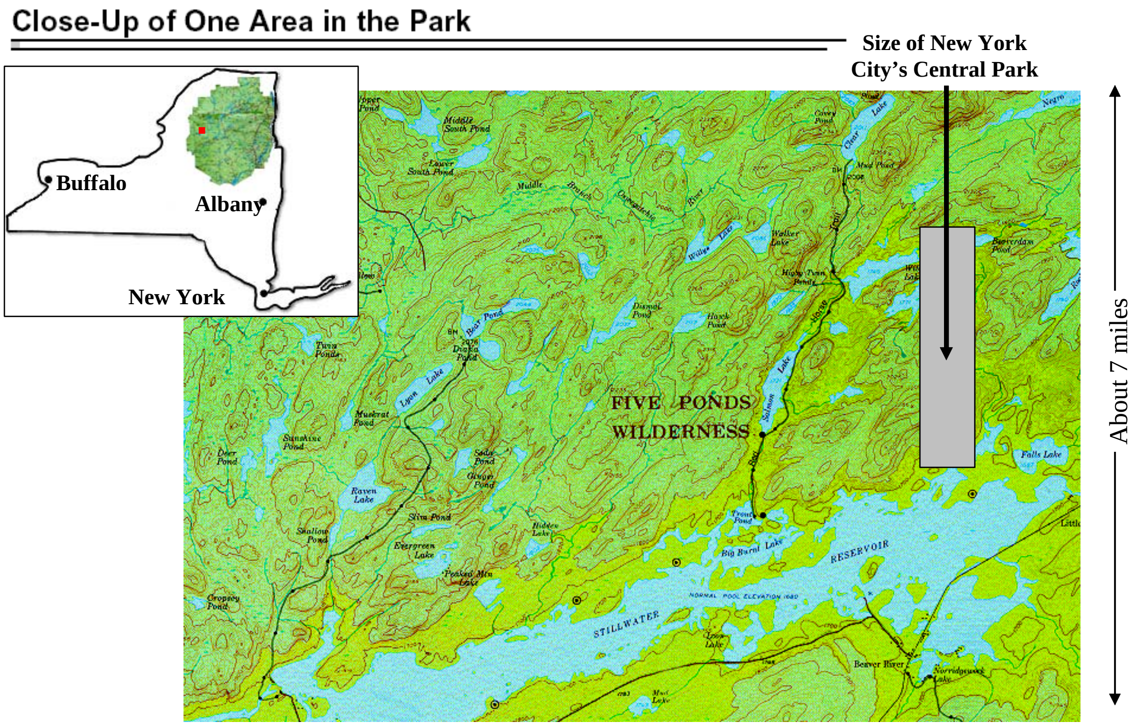


Appendix A: Geographic distribution of respondents within New York State



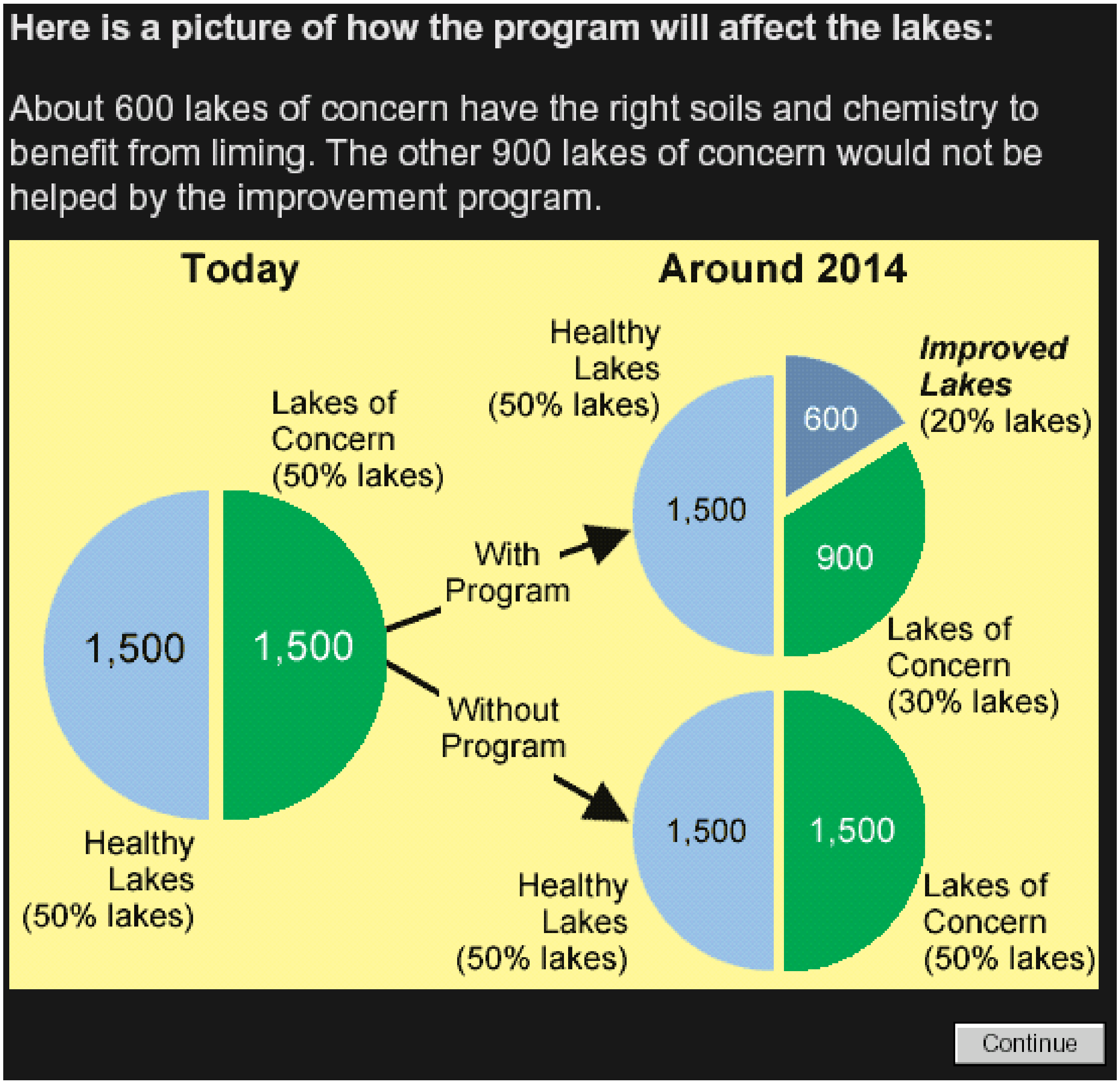
Appendix B: Screen and page captures from survey

a. Map illustration of size of affected lakes.

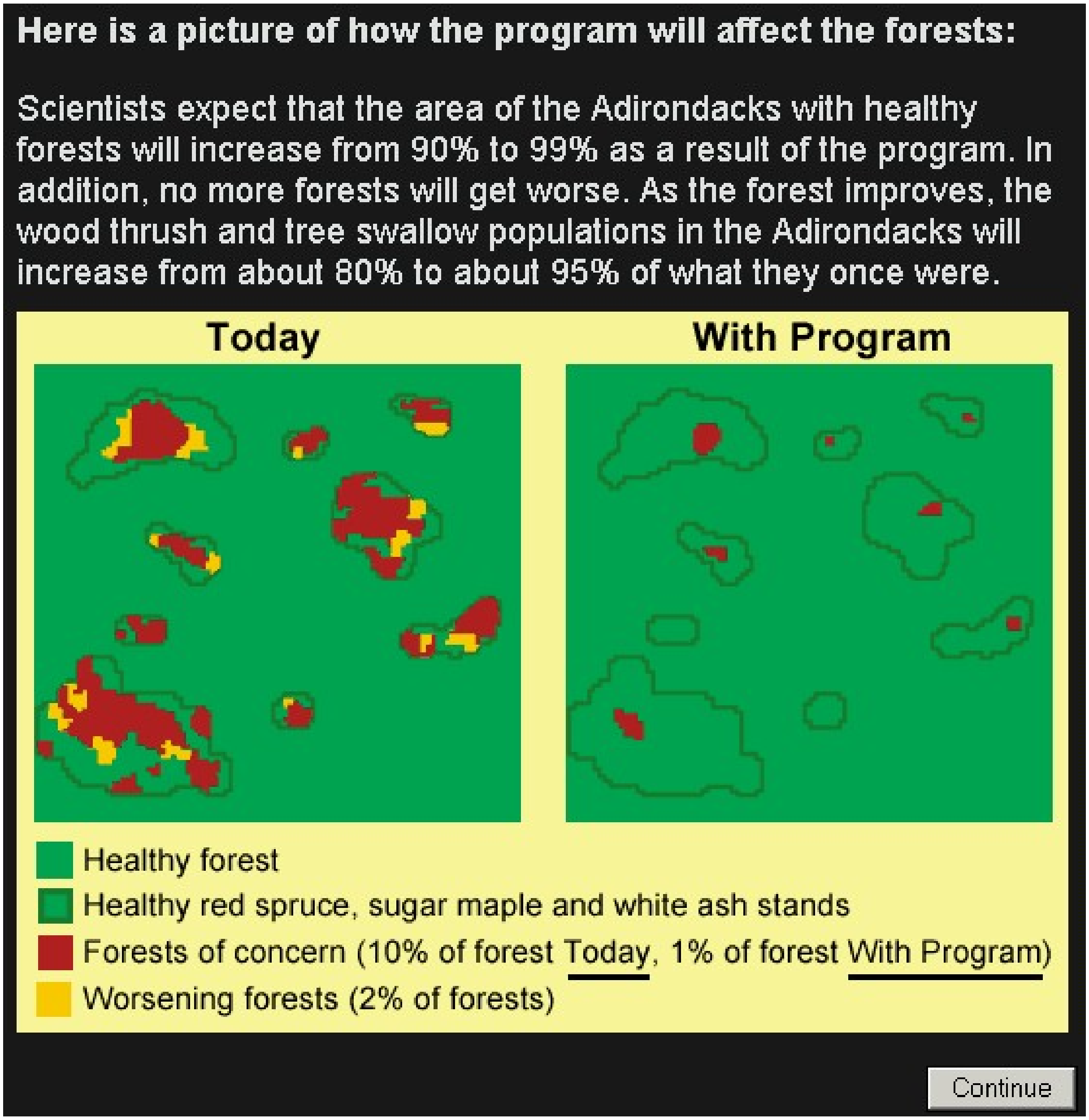


This map illustrates one small part of the Adirondack State Park. This part is located where the red dot is on the inset map. Most of the lakes affected by past air pollution are small; they are typically much smaller than Central Park in New York City. The large lakes that you may have heard of (such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

b. Chart representing how the program will affect the lakes.



c. Representation of forest improvement.



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