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# Valuing Ecosystem Improvements in the Adirondacks

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The Adirondack Park is the name given to the large collection of public and private lands in central New York that is protected from development. The park covers 20 percent of New York State and is nearly three times the size of Yellowstone National Park. It is primarily mountainous, encompasses six major river basins, contains almost 3,000 lakes, and holds the largest assemblage of old-growth forests east of the Mississippi.

The park has featured prominently in air quality policy debates over the past few decades. The watersheds in the park are sensitive to the deposition of sulfur and nitrogen, which make the ecosystem more acidic. The source of these pollutants is typically the combustion of fossil fuels. About one-half of the park's lakes are affected by acid deposition, which reduces the ability of these lakes to support plant and animal life. Forest health, particularly at high elevations, and bird populations may also be compromised by acid deposition.

Federal and state initiatives to reduce air pollution, including the 1990 Clean Air Act Amendments and the recently promulgated Clean Air Interstate Rule, have cited reduced acid deposition as a benefit of reductions in sulfur and nitrogen emissions. But these policies have proceeded despite a missing link between the ecological science and the social science necessary to enable economic valuation of the benefits of these emissions reductions. In particular, no one knows how much people value the Adirondacks ecosystem improvements that may result from these policies. This knowledge is required for a full accounting of the benefits and costs of reducing these pollutants.

Our study is the first to examine the total (use and nonuse) value people place on broad ecosystem improvements expected from further reductions in air pollution in the park. Previous studies only examined values for changes in recreation opportunities affected by acid deposition (Englin et al. 1991; Morey and Shaw 1990; Mullen and Menz 1985). While only a relatively small fraction of New Yorkers actually visits the park, however, the political saliency of the Adirondacks in air pollution debates suggests that nonusers may value the park highly. Furthermore, the benefit estimates from these other studies do not necessarily correspond to an ecological outcome that would be reasonably expected from forthcoming emissions reductions.

In the following description of our study, particular attention is paid to how the survey characterizes broad ecosystem improvements. The study is described in greater detail in Banzhaf et al. 2004 and 2006. We found that New Yorkers—both users and nonusers alike—place

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significant value on rectifying damages from acid rain in the park. Our preferred estimates of mean willingness to pay (WTP) vary from $80 to $154 per household each year (2004 $). With 7 million households in the state, this amounts to benefits of $560 million to $1.1 billion annually. The benefits to nonusers are a large percentage of these totals.

**Details of the Study**

The study targeted households living in New York State in part because they likely would hold a large share of the benefits of any park improvements. We estimated societal WTP for improvements to the park using a contingent valuation survey, which asked whether households are willing to pay for a specific hypothetical program or intervention that, in this case, would lead to ecosystem improvements in the Adirondacks. Specifically, respondents were asked if they would vote for programs to improve the park's ecosystem if it would increase their state income taxes each year for the next 10 years, given that if the majority of voters agree, the program would be adopted. Four possible tax payments were randomly assigned: $25, $90, $150, $250. The first hypothetical referendum question was followed up by a second referendum question with either a higher or lower tax payment depending on the respondent's response to the first referendum.

To assure that the ecosystem changes being valued mapped closely to the current and expected future condition of the park, we performed a detailed survey of the natural science literature (Cook et al. 2002). Armed with this information, we conducted numerous focus groups to identify ways to accurately and meaningfully distill this complex information in the survey. Understandably, there is considerable scientific uncertainty as to how the ecosystem may change with further emissions reductions. In response, we developed two versions of the survey to span the range of scientific opinion about the future status of the park both with and without further emissions reductions. These two versions also permitted a "scope" test to verify whether greater improvements to the resource generate a higher WTP, which is considered to be an important validation of the study design.

One version of the survey depicted the future status of the park's ecosystem as unchanging absent any intervention and as improving with an intervention. In this version, the intervention yields the improvement of 600 lakes (of about 1,500 currently damaged) over a 10-year period, along with small increases in the populations of two bird and one tree species. The other version depicts the ecosystem as worsening without any intervention; with intervention, 900 lakes improve with significant increases in the population of four bird and three tree species over the same 10-year time period.

We convened 31 focus groups and conducted two major pretests to develop and extensively assess alternative text, debriefing questions, and graphics. For example, in explaining the harm to the lakes, we needed language that would convey that environmental consequences, not human health, are at issue. To do this, we likened the acidity of the affected lakes to that of orange juice—possibly affecting wildlife relying on the lakes, but harmless to humans.

Another challenge in constructing the survey was to describe the particular components of the ecosystem that are damaged and that would improve as a result of the intervention being proposed. The natural science literature does not explicitly identify, much less quantify, all of the harms associated with acidification. When describing the damages to the aquatic ecosystem we indicate the number of adversely affected lakes, which the survey refers to as "lakes of concern." A lake of concern is one with reduced or eliminated populations of six particular fish species that are otherwise common in the park's waters. While other aquatic species have been adversely

affected by acid deposition, the survey does not explicitly name these species. Rather, the survey states:

> "As you may know, fish are not the only organisms that depend on healthy lakes. A more complicated but accurate description of the problem is that pollution is damaging a lake's *ecosystem*.
>
> A lake ecosystem is defined as all of the living things that are directly connected to and depend on the lake. …
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> Along with fish, the ecosystem of an Adirondack lake includes such organisms as snails, frogs, insects, and tiny organisms that live in the water, called plankton. These organisms have been reduced or eliminated by previous pollution in the lakes of concern. Fish survival depends on many creatures and plants that live in the lakes. Thus fish populations are indicators of overall ecosystem health."

Although this is a more accurate description of the damages from acidification, it is admittedly imprecise as to the commodity being valued. We found that invoking broader ecosystem effects led some respondents to an overly expansive interpretation of the resources affected by acidification. In fact, our initial strategy was to have a version of the survey that only described damages and improvements to aquatic species and not to terrestrial species (birds and trees) as there is greater scientific consensus regarding the damages to aquatic species than terrestrial species from acidification. However, from the focus group testing, we learned that many respondents thought that terrestrial resources were harmed *and* assumed that the intervention would actually improve these resources.[1] This is a case of embedding on behalf of the survey respondents in that they ascribe improvements far beyond what is described in the survey. Our solution was to describe terrestrial damages to essentially validate the strong priors of some respondents that these resources must be harmed at some level, but then indicate that these resources would only see slight improvements as a result of the intervention being proposed. The focus-group testing suggested that respondents found the survey's characterization of the damages credible.

In proposing improvements, we needed to ensure that the intervention be plausible and understandable to respondents. Respondents also needed to be reasonably convinced that they would have to pay for the intervention if the majority of voters agreed to it. This was a major challenge as the way the park is likely to be improved—through a national policy for emissions reductions at eastern and midwestern power plants—would not primarily be borne by New York State residents. Our solution was to introduce a hypothetical intervention in which New York State would run a tax-financed program to drop lime from airplanes onto lakes and affected forests to neutralize the acidity. Respondents generally accepted this necessary ruse.

The survey was administered through multiple mode and sampling frame combinations from August 2003 through February 2004. One sample was drawn from a probability-based panel maintained by the firm that administered the survey. The panelists take surveys (primarily for marketing) on a regular basis in exchange for Internet access. Another sample had been on the panel in the past but was no longer on it for a variety of reasons. Both these samples were

[1] Some respondents may have also had some familiarity with the effects of acidification and thought that the scientific consensus regarding terrestrial effects is stronger than what it actually is. We did not try to determine which of these two more frequently explained the tendency of respondents to hold this more expansive view of the damages from acidification.

administered the survey on a computer. A third sample was recruited through random-digit dialing. This sample was mailed a paper copy of the survey. While there are some differences in the respondent characteristics across the samples (for example, the mail sample had the oldest average age), in general they display fairly similar average income, political attitudes, and other characteristics. More importantly, once these observable differences were controlled for, the WTP for the improvement described in the survey did not vary significantly across the three groups of respondents.

**Interpreting the Responses**

A common criticism of contingent valuation studies is that because of the hypothetical nature of the exercise, respondents may not consider whether they would be better off if the intervention were adopted and their taxes rose accordingly. Typically the concern is that the WTP estimates generated from the survey overstate true WTP for the described improvements.[2] The hypotheses underlying this concern is that respondents may vote for the program in a pro forma way, perhaps out of a desire to please the survey administrator, be generous, or support environmental causes, rather than out of desire for the specific improvements to the park. For this reason we followed a cautious approach in designing the survey and applying statistical methods so that our estimates of social WTP are likely less than the true WTP for the improvements described. For example, we frequently reminded respondents of the costs involved, used black-and-white photographs, and otherwise sought to avoid emotional triggers.

Another potential challenge for measuring WTP is those respondents who vote against the program for reasons extraneous to its benefits and costs—for example, because they are reflexively opposed to raising taxes or distrust the government on principle. In the literature these are referred to as protest votes in that the respondent rejects the market construct. This does not mean, however, that the respondent would not realize benefits greater than their tax payment for the environmental improvement. We used questions about respondents' feelings toward the government and taxes to econometrically control for respondent behavior or this type.[3] We performed similar adjustments to the estimates for respondents who felt the environment was worth protecting at any cost or that the intervention would somehow improve human health.

So who tended to value the environmental improvements most highly? Households with the highest WTP included those with the highest incomes, those that expected their future income to increase over the next 10 years, and those with children. Measures of personal stake were also important, with households that frequently visited the park (23 percent of our sample) willing to pay 70 percent more than those that visited less frequently or not at all. Those living farther from the park were willing to pay less, with WTP falling by about $.08 per kilometer from the household's closest vehicle entrance to the park. Self-classified environmentalists were more likely to vote for the intervention, just as self-proclaimed conservatives and those who think taxes are too high were more likely to vote against.

Other important tests of construct validity include whether respondents are sensitive to the tax level and the extent of the improvements (i.e., to scope). We found that indeed respondents who faced a higher tax payment were less likely to vote for the program. We also found that the propensity to vote for the program was higher at each bid level for the survey that describes greater improvements and that this difference is statistically significant. Also, estimated mean WTP was higher when distributional assumptions of WTP were made.

[2] Whether this concern is empirically valid is debatable. Mitchell and Carson (1989) argue that it is overblown.
[3] See Banzhaf et al. 2004 or 2006 for alternative WTP estimates based on samples that omit these respondents.

Interestingly, we also found that 24 percent of the respondents to the survey that described the situation in the park as stable absent intervention felt that the situation in the park was probably worse than described in the survey. However, for the survey that described a worsening situation absent any intervention, this percentage fell to 6 percent. This finding suggests that respondents were both familiar with acidification and were sensitive to the description of the resource and its condition.

To calculate the annual benefits of these improvements, we must discount both the future benefits and costs of this intervention. Recall that the payment vehicle involves an annual tax increase every year for 10 years. To convert these values to an annual value we assume a 5 percent discount rate (a lower discount rate would suggest lower annual benefits).[4] The mean annual household WTP estimate from the responses to the survey that describes smaller ecosystem improvements is $80 if WTP is assumed to have a Weibull distribution and $107 if a lognormal distribution is assumed. For the survey that describes greater improvements, the estimates are $90 and $154 for the Weibull and lognormal distributions. Multiplied by the 7 million households in the state, these values range from $560 million to $1.1 billion annually.

The benefit estimates this study yielded can be compared to abatement cost estimates to help decide if further emissions reductions are worthwhile. The U.S. Environmental Protection Agency has estimated the costs of its Clean Air Interstate Rule to be $1.91–$2.14 billion in 2010, rising to $2.56–$3.07 billion by 2015 (1999 $) (U.S. EPA 2005).[5] Given that we excluded populations outside of New York State and estimated benefits conservatively, it is clear that the ecosystem benefits from the improvements in the Adirondacks are a sizable fraction of the national costs.

**Concluding Thoughts**

Damage to the Adirondack Park has been the focus of decades-long debates regarding air pollution control. Further strategies to reduce emissions are being justified, in part, by how they will improve this unique resource. For the first time, results have been produced that show the total value people place on ecological improvements to the park expected from further reductions in acid deposition. The benefit of these improvements is large relative to their costs.

The purpose of this conference is to explore whether it is generally better to focus protection on a single threatened species or on ecosystems as a whole. Underlying this question is whether it is worthwhile to protect the species or ecosystem in the first place (i.e., if there is a better alternative use of the species or ecosystem than protecting it). As economists we feel our discipline is well suited to helping weigh these options of how and whether to protect a resource.

A few lessons from our study speak to these questions. First, we found that respondents were fairly sophisticated in understanding ecological function and the effects of acid deposition. Presumably in weighing the costs and benefits of protecting a single species, respondents will recognize that protecting the species will yield joint products (e.g., protecting the snail darter leads to protection of other species). For this reason, researchers using stated-preference studies to weigh the desirability of protecting a single species or the ecosystem in which it resides will find describing the commodity a challenge.

[4] We assume that the respondents believe that the improvements will phase in linearly over the 10 years of the program and after 10 years continue indefinitely.

[5] These amounts reflect resource costs in the form of increased pollution control and fuel expenditures and not welfare costs as an economist would measure them. Palmer et al. (2005) find that the reduction in consumer and producers surplus from CAIR totals $5.2 billion (2004 $) in 2020.

Second, it is important to keep in mind that we were not valuing the entire Adirondack Park. Rather, we were merely measuring the benefits of improvements to the ecological health of the park expected from reduced acid deposition. Indeed, to the casual observer very little would visibly change as a result of the improvements the survey describes. Even if one is considering the protection of an ecosystem, the alternative to protection is typically not elimination of the ecosystem. The implication is that articulating the conditions absent a particular preservation program are equally important and perhaps as difficult as describing the expected conditions with the program.

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For a brief history of the Adirondack Park, see: http://www.apa.state.ny.us/

For a more detailed description of the study described in the presentation, see: http://www.rff.org/rff/News/Features/Valuation-of-Natural-Resource-Improvements-in-the-Adirondacks.cfm

The Adirondacks study is continuing under the following funding: http://cfpub1.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/7726/report/0

The Adirondacks study is being considered for use as an ecosystem benefits case study for the Second Prospective Study (1990 to 2020) of the 1990 Clean Air Act Amendments: http://www.epa.gov/air/sect812/prospective2.html