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National Park Service Visibility Valuation Study: Pilot Survey Results

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EXECUTIVE SUMMARY

To support its mission under the Organic Act, and its consultative role on regulatory measures to achieve Clean Air Act requirements, the National Park Service is conducting a visibility valuation study. Following focus groups and a peer review of survey materials a pilot study was conducted in late summer and early fall of 2012. A mail survey was administered to a random sample of 4,000 households in the southwestern and southeastern U.S. Response rates for the southwest and southeast surveys were 38.6 and 32.5 percent, respectively. Telephone and mail follow-up surveys of nonrespondents were also conducted. A comparison of "benchmarking" question responses to well-established public opinion survey results, as well as respondent characteristics to Census data, indicates that survey respondents are similar to, but not fully representative of, the general populations of these regions. Analysis of valuation question responses indicates that the magnitude of visibility improvement and the occurrence of related ecological and human health improvements are significant determinants of program choices. Household willingness-to-pay (WTP) for visibility improvements increases with programs that reduce the number of lowest visibility days and increase the number of highest visibility days over the course of a year. Models based on data weighted to reflect general population parameters result in WTP estimates that are generally between +/- 10 percent of unweighted estimates. Overall, the pilot study results indicate that the survey instrument is functioning properly and is ready for full implementation with minor revisions.

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INTRODUCTION & BACKGROUND

To support its mission under the Organic Act, and its consultative role on regulatory measures to achieve Clean Air Act requirements, the National Park Service (NPS) is conducting a visibility valuation study. The study is designed to elicit the general population's willingness-to-pay (WTP) for visibility improvements in Class I areas that would arise from reductions in haze from human sources.[1] While the study is designed specifically to estimate the benefits of improvements anticipated due to the Regional Haze Rule (40 CFR Part 51), the results may be applied to assess the benefits of other programs or policies that improve visibility conditions in national parks and wilderness areas.

The study team includes the following individuals:

- Robert Paterson, Principal, IEc- Project Director
- Dr. Kevin Boyle, Virginia Tech- Co-Principal Investigator
- Dr. Richard Carson, University of California, San Diego- Co-Principal Investigator
- Dr. Barbara Kanninen, BK Econometrics LLC
- Dr. Christopher Leggett, Statistics and Economics Consulting
- John Molenar, Vice-President, Air Resource Specialists

This report describes the procedures and results of a pilot study conducted in the late summer and early fall of 2012. The study involved administration of a mail survey in two multi-state regions, with telephone and mail follow-up surveys of nonrespondents. The following sections discuss survey design and pre-testing procedures, pilot design and implementation, survey responses and WTP estimates, and associated implications for the full survey.

SURVEY DESIGN & PRE-TESTING

The survey design process comprised four phases. The first involved a comprehensive review of existing visibility valuation literature to identify key issues and challenges. The review included an inventory of stakeholder comments on the Chestnut and Rowe (1990) study, the current basis for regulatory analyses involving recreational visibility. The review identified four principal issues:

[1] Specific visibility provisions were included in Sections 169A, 169B, and 110(a)(2)(j) of the Clean Air Act that directed the Environmental Protection Agency, the states, and federal land managers to prevent any future, and remedy any existing, human-induced visibility impairment at mandatory Federal Class I areas. Mandatory Federal Class I areas ("Class I areas") are defined as national parks exceeding 6000 acres, wilderness areas and national memorial parks exceeding 5000 acres, and all international parks that were in existence on August 7, 1977. There are 156 Class I areas throughout the country.

- **Collateral benefits.** To avoid double counting health and ecological benefits in regulatory analyses, estimates of WTP for visibility improvements must exclude any health and ecological concerns.
- **Depiction of visibility changes.** Improvements brought about by a pollution reduction program will vary over the course of a year. Reducing changes to a simplified measure (e.g., a change in average conditions) does not accurately portray visibility improvements and may not be sufficient to describe changes in visibility to survey respondents.
- **Isolating WTP for improvements in Class I areas.** Residential and urban visibility changes are measured separately in regulatory analyses; therefore, development of a plausible scenario that focuses respondents' valuation responses on Class I areas only is necessary.
- **Geographic coverage.** Baseline and improved visibility conditions, as well as the number, type and characteristics of Class I areas, vary by region of the country. Thus, multiple survey versions may be required to reflect these differences.

The second phase entailed development of a study plan that identified strategies for addressing the above issues. The plan envisioned the use of attribute-based or choice modeling techniques to present respondents with alternative visibility improvement programs that would vary with respect to the extent of improvement, health and/or ecological benefits, timing of the improvements, and cost. Baseline visibility conditions would be described to respondents as a distribution of days over the course of the year using multiple photographs, and improvements would be described as changes in the distribution of days associated with each photo. Improvements would be described as occurring within a "visibility improvement region"- geographic regions containing sets of Class I areas that are roughly homogenous with respect to current visibility levels and potential visibility improvements. The regions would exclude large cities in order to minimize the potential for respondents to inadvertently include consideration of improvements in urban visibility.

In the third phase, five sets of focus groups were conducted in different regions of the country: Atlanta, GA; Chicago, IL; Sacramento, CA; Denver, CO; and, Boston, MA. Four focus group sessions (two, two-hour sessions per evening on two consecutive evenings) were held in each location, for a total of 20 groups. All respondents were recruited at random from listed telephone numbers (i.e., not facility panel members) and the groups were led by a professional moderator who is an economist. The target was to have 8 to 10 participants per group.

The first groups were conducted in Atlanta and explored concepts, terminology, images and graphics in an open-ended format. The focus group effort concluded in Boston with participants responding to the full questionnaire.

In the fourth phase, all survey materials were peer reviewed by Dr. Vic Adamowicz (Department of Rural Economy, University of Alberta) and Dr. William Schulze (Department of Applied Economics and Management, Cornell University). Comments from these experts were incorporated and final materials for the pilot survey were developed.

PILOT STUDY DESIGN & IMPLEMENTATION

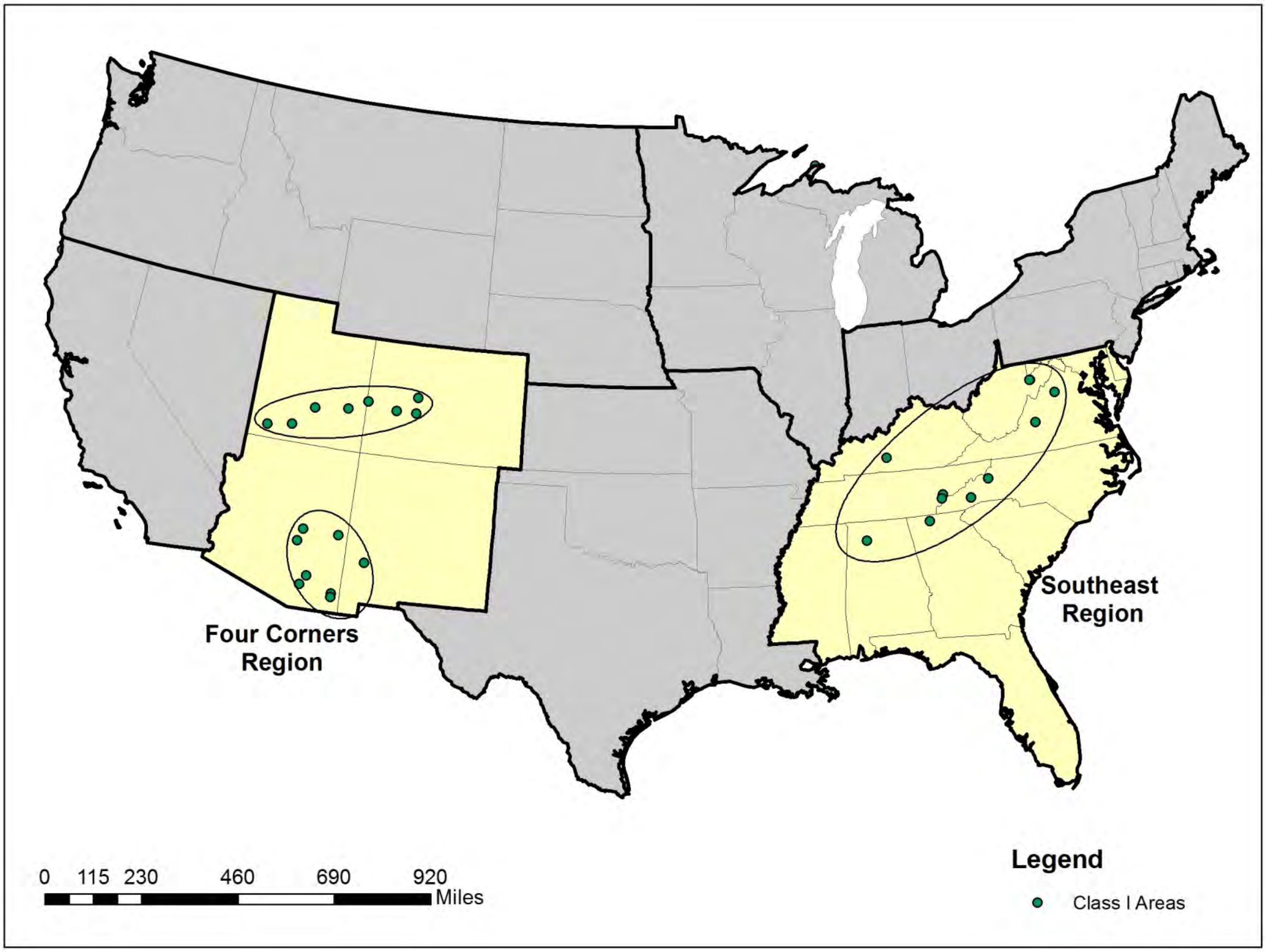
Based on the geographic distribution of current and potential improved visibility conditions, the contiguous 48 states were divided into seven survey regions. Two regions were selected for pilot implementation (Exhibit 1): "Four Corners" (Utah, Arizona, New Mexico and Colorado) and "Southeast" (Delaware, Maryland, Virginia, West Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Mississippi and Florida). These regions were selected because they cover a range of current and expected future visibility conditions, and are areas where previous visibility valuation research has been conducted (e.g., Chestnut and Rowe, 1990; Balson et al., 1990).

The survey was administered by the Center for Survey Research at Virginia Tech and overseen by its director, Dr. Susan Willis-Walton. For each region a sample of 2,000 addresses from the U.S. Postal Service Computerized Delivery Sequence File was acquired from Survey Sampling International. The mailing sequence was as follows:

1) A personalized pre-survey contact letter (Appendix A)
2) Main survey, including a fold-out picture set, map, cover letter, $2 bill and pre-paid return envelope (Appendices B and C)
3) Reminder postcard
4) Replacement survey (if no response received)

As part of the survey administration, a nonrespondent follow-up was conducted approximately six weeks after the initial survey mailing. All nonrespondent households where a telephone number could be matched to the address (431 in the Four Corners region and 576 in the Southeast region) were contacted to complete a short nonrespondent survey (Appendix D). In addition, a sample of 600 of the remaining nonrespondent households in each region without matched phone numbers was sent a nonrespondent survey, via Priority Mail, with the same set of questions (Appendix E).

EXHIBIT 1 PILOT STUDY SURVEY AND VISIBILITY IMPROVEMENT REGIONS



MAIN SURVEY

The main survey contained seven sections:

1) Section A contained two background questions intended to orient the respondent to the context of implementing and funding public programs and to gauge their confidence in various institutions; these questions were adapted from the National Opinion Research Center General Social Survey.
2) Section B provided information on haze and its effects on visibility.
3) Section C provided background information on national parks and wilderness areas. Respondents were referred to an enclosed fold-out map that displayed the visibility improvement region(s), Class I areas contained within the region(s), and major sources of haze.
4) Section D provided information on the sources of haze affecting the region(s).
5) Section E provided information on current visibility conditions portrayed in an accompanying picture set, and example visibility improvement programs.
6) Section F provided information on each of the choice question attributes- ecosystem impacts, health impacts, program timing and cost (visibility improvements were addressed in the previous section) and the six valuation choice questions.
7) Section G contained follow-up and standard demographic questions.

All sections of the survey contained questions that were designed to help respondents focus on the information being presented or to collect data to be used in statistical analyses.

Representation of Baseline and Improved Visibility Conditions

The framework for presenting baseline and improved visibility conditions within the survey derives from the Regional Haze Rule (“Rule”), which requires states to develop and implement plans for making “reasonable progress” toward achieving natural visibility conditions in Class I areas by 2064.

Natural visibility conditions are defined as the distribution of visibility that would exist in the absence of human-induced impairment. The Rule requires that states focus on improving visibility on the haziest days of the year, defined as the "worst 20 percent days," or all days falling below the 20th percentile of the visibility distribution. This improvement must occur while preventing any degradation in visibility on the clearest days of the year, defined as the "best 20 percent days," or all days falling above the 80th percentile of the visibility distribution. For the mean of the worst 20 percent days, the Rule requires that states consider visibility goals that would be consistent with a uniform rate of progress (i.e., linear through time) in visibility improvement toward the mean of the worst 20 percent days under natural visibility conditions. The Rule stipulates that visibility goals should be expressed in "deciview" units. An increase in deciviews corresponds to an increase in haze (and a decrease in visibility).

As shown in Appendix B and C, respondents were provided a set of five photos from a representative Class I area. The photographs were developed by John Molenar of Air Resource Specialists and the specific scenes (Canyonlands in the Four Corners Region and the Great Smokey Mountains in the Southeast Region) were chosen from available options that (1) presented a view that a visitor would actually experience from a given vantage point, (2) provided features at varying depths within the photo, and (3) could be reproduced with sufficient resolution for accurate and consistent presentation in a 4” by 6” format for the picture sets. The photographs were digitally manipulated and set at the deciview mean of each quintile of days under current (baseline) conditions, from the 20 percent best days in Photo A to the 20 percent worst days in Photo E. Current conditions were based on monitoring data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network for the period 2000 to 2004.

For improved visibility conditions, respondents were provided bar charts that depicted distributions with days reallocated from the lower visibility photos to higher visibility photos. These scenarios differed between the Four Corners and Southeast surveys and were derived from U.S. Environmental Protection Agency estimates of “natural conditions” for these same Class I areas.

Choice Questions and Experimental Design

The valuation questions were presented as a series of binary choices comparing current conditions to a potential visibility improvement program with varying levels of five attributes, as described in Exhibit 2.

EXHIBIT 2 CHOICE QUESTION ATTRIBUTES AND LEVELS

ATTRIBUTE	DESCRIPTION	LEVELS
Visibility Improvement	Bar chart depicting number of days in the year associated with each of five photographs in picture set	6 or 7 Programs Ranging Between 5% and 100% Progress Toward Natural Conditions
Ecosystem Impacts	Particles that form haze can affect water quality, soil, plants, and in turn, the growth and variety of plants and animals	• No Change • A Small Reduction
Health Impacts	Some park visitors who have respiratory problems may experience coughing or shortness of breath on days with high levels of human-caused haze	• No Change • A Small Reduction
Timing	Number of years until specified program improvements are realized	• 10 Years • 20 Years
Cost	Recurring annual cost to household	$15, $35, $65 or $115

The initial ecosystem and health impact attributes were defined based on discussions with NPS scientists, with subsequent refinement based on focus group participant feedback. These attributes were included in the design so that these potential benefits could be explicitly excluded from estimation of values for visibility improvements, thereby avoiding potential double-counting in policy analyses. The timing attribute was included to investigate preferences for the speed at which specified program improvements would take place. The levels of the cost attribute were assigned based on data from draft choice questions administered to focus group participants.

The visibility attribute levels were developed to support two approaches to estimating values for visibility improvements. The first approach was to define full visibility programs with the percentages of days associated with each of the five visibility photos, A, B, C, D, and E. Each unique set of percentages would be represented by a different program variable in the econometric analysis of responses to the choice questions, which would allow for calculation of WTP for the program. A key advantage of this approach is that it facilitates the estimation of values for specific programs, at specific points in time, along the projected visibility improvement paths defined by the Rule.

The second approach was to define the programs as additive functions of the number of days associated with each of the photos. The advantage of this approach is that it allows for estimation of values for changes in the number of days represented by specific photos, and in turn a great deal of flexibility in valuing alternative visibility distributions.

To support estimation of models using both approaches, an experimental design of the attributes and their levels (Exhibit 2) was developed. To derive choice sets, a 24-row, orthogonal, main-effects design matrix was drawn from a well-regarded, on-line catalog of orthogonal matrices by Warren Kuhfeld.[2] The size of this design matrix allows for orthogonal placement of the three two-level attributes (health impacts, ecological impacts, and time), one four-level attribute (program cost), and one six-level attribute (the visibility programs).

To ensure adequate variation across and within choice sets for the defined programs and photo percentages, three programs taken directly from the Rule, representing 5, 50 and 100 percent progress toward natural conditions, were specified for each region. Second, four additional programs (three in Four Corners) were created by "perturbing" the 50-percent program in the following four ways: increase (decrease) the percentage occurrence of Photo A one-third up (down) the improvement path, and orthogonally increase (decrease) the percentage occurrence of Photo E one-third up (down) the improvement path. In all cases, the amount of increases and/or decreases are added and/or subtracted from Photo C. This process resulted in a total of six to seven visibility programs.[3,4] The design contained 24 choice sets, which were divided among four

[2] http://support.sas.com/techsup/technote/ts723_Designs.txt

[3] Because two programs turned out to be very close for the Southeast region, only six programs are used in the final experimental design for that region.

[4] Since the design matrix only accommodates a six-level attribute, variation over the seven programs is manufactured by mixing information from two additional two-level columns from the design matrix into the perturbation routine.

different survey versions with six questions per survey and randomly assigned to respondents.

To verify that the experimental design would identify all parameters, simulations were run on the Four Corners experimental design with 1,000 replications. Each replication assumed a sample size of 400 (100 responses to each of the four survey versions) and utilized representative utility parameters from focus group data. Results indicated that all parameters could be estimated precisely.

MAIN & FOLLOW-UP SURVEY RESPONSES

Overall response rates for the Four Corners and Southeast surveys were 38.6 and 32.5 percent, respectively.[5] Exhibits 3 and 4 present the geographic distribution of respondents to the main survey by zip code for each region. Complete response frequencies and summary statistics are embedded in the questionnaires in Appendices B and C. A summary of responses to the open-ended question (#25) is also included at the end of each survey.

The response rates for the phone follow-up survey for the Four Corners and Southeast regions were 17 and 13.3 percent, respectively (Appendix D), while the response rates for the mail follow-up survey were 7.5 and 3.2 percent (Appendix E).

The phone and mail follow-up surveys were conducted to investigate if there was a systematic difference between those who did or did not respond to the main surveys. As noted, questions were also included in the main survey that could be compared to results from existing public opinion surveys. The following sections provide summaries of responses to selected questions in the main surveys for each region and responses to comparable questions from the General Social Survey and American Community Survey.[6]

GENERAL SOCIAL SURVEY BENCHMARKING QUESTIONS

The General Social Survey (GSS) is a highly regarded in-person survey conducted annually or biennially since 1972 by the National Opinion Research Center at the University of Chicago. Recent GSS survey questionnaires were reviewed by the study team and three questions were selected from the 2010 questionnaire for replication in the main surveys (as Questions 1, 2, and 28) for comparison purposes. The results of these comparisons are presented in Exhibits 5-7 below. The GSS Southeast region is identical to the Southeast pilot survey region. In addition to UT, AZ, CO and NM, the GSS Mountain region also includes MT, ID, WY and NV.

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5 Calculated as Response Rate = Complete / (Complete + No Response + Refused + Incomplete)

6 http://www3.norc.org/gss+website/; http://www.census.gov/acs/www/

EXHIBIT 3 GEOGRAPHIC DISTRIBUTION OF RESPONSES- FOUR CORNERS REGION

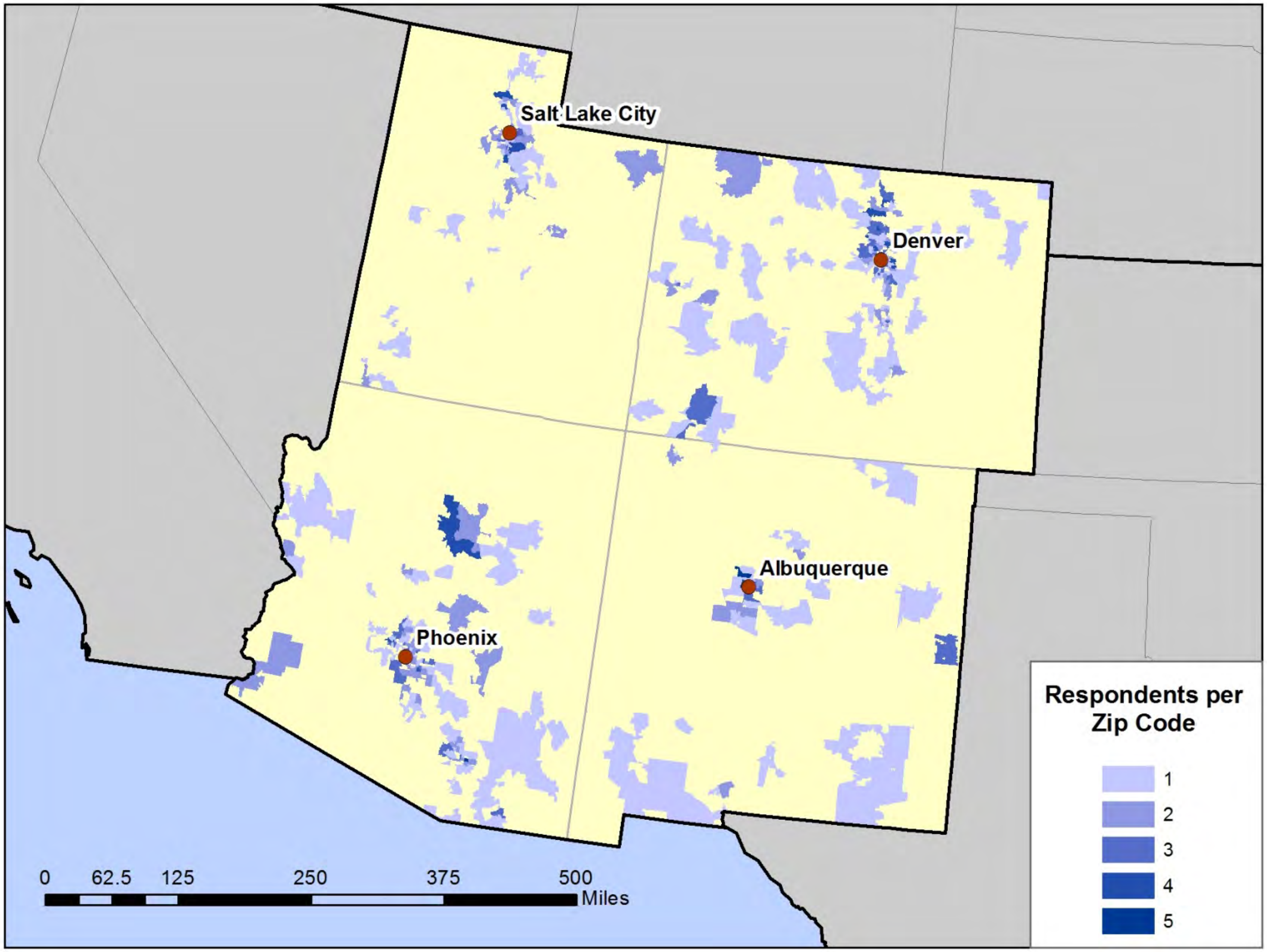

EXHIBIT 4 GEOGRAPHIC DISTRIBIBUTION OF RESPONSES- SOUTHEAST REGION

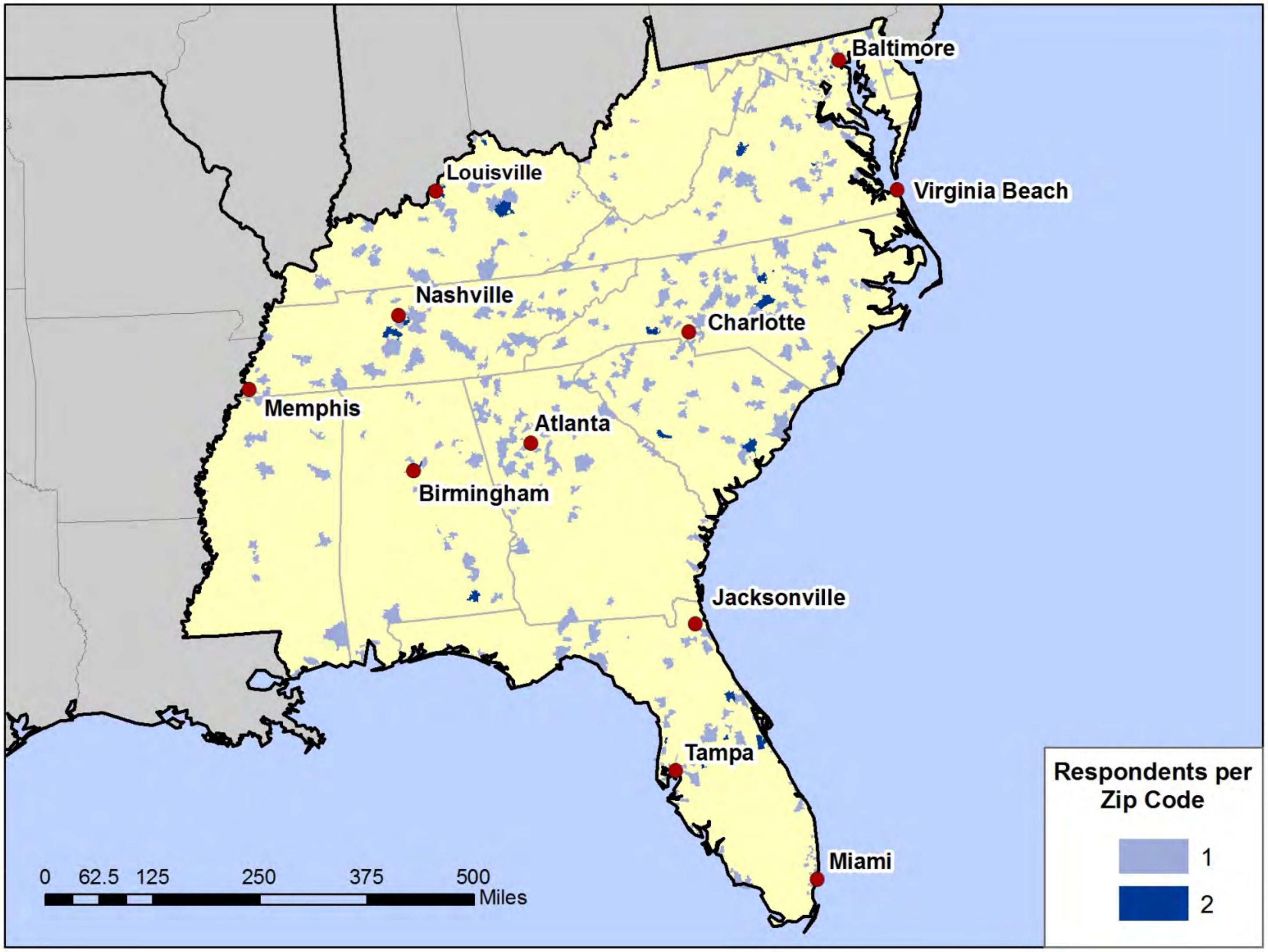

EXHIBIT 5 GOVERNMENT SPENDING

"We are faced with many problems in this country, none of which can be solved easily or inexpensively. Listed below are some of these problems. For each one circle whether you think we're spending too much money on it, too little money, or about the right amount."

	N	TOO LITTLE	ABOUT THE RIGHT AMOUNT	TOO MUCH
THE ENVIRONMENT				
Pilot Four Corners	641	51.3%	34.2%	14.5%
GSS Mountain	73	58.9	29.3	11.8
Pilot Southeast	548	58.6	33.4	8.0
GSS Southeast	287	61.9	26.7	11.4
SPACE EXPLORATION				
Pilot Four Corners	639	24.1%	42.4%	33.5%
GSS Mountain	71	20.1	56.0	23.9
Pilot Southeast	547	21.6	40.8	37.7
GSS Southeast	275	17.2	40.9	41.9
EDUCATION				
Pilot Four Corners	639	69.6%	21.4%	8.9%
GSS Mountain	74	79.4	14.9	5.7
Pilot Southeast	543	70.6	22.1	7.3
GSS Southeast	286	80.2	16.8	3.1
HEALTH				
Pilot Four Corners	635	44.6%	33.4%	22.0%
GSS Mountain	74	61.3	12.1	26.6
Pilot Southeast	543	56.2	28.9	14.9
GSS Southeast	286	62.1	15.0	22.9
ASSISTANCE TO OTHER COUNTRIES				
Pilot Four Corners	636	2.5%	17.0%	80.5%
GSS Mountain	73	8.3	11.1	80.6
Pilot Southeast	550	2.0	16.2	81.8
GSS Southeast	284	4.3	29.8	65.9

EXHIBIT 6 CONFIDENCE IN INSTITUTIONS

"Listed below are some institutions in this country. As far as the people running these institutions are concerned, would you say you have a great deal of confidence, only some confidence, or hardly any confidence at all in them?"

	N	A GREAT DEAL	ONLY SOME	HARDLY ANY
BANKS & FINANCIAL INSTITUTIONS				
Pilot Four Corners	643	7.2%	47.4%	45.4%
GSS Mountain	98	3.9	41.2	54.9
Pilot Southeast	553	7.8	51.5	40.7
GSS Southeast	381	12.6	44.5	42.9
CONGRESS				
Pilot Four Corners	643	1.9%	33.4%	64.7%
GSS Mountain	95	4.2	48.9	46.9
Pilot Southeast	553	3.8	29.5	66.7
GSS Southeast	377	9.0	48.4	42.6
SCIENTIFIC COMMUNITY				
Pilot Four Corners	643	41.8%	49.9%	8.2%
GSS Mountain	92	52.7	44.1	3.2
Pilot Southeast	544	32.4	55.3	12.3
GSS Southeast	365	42.1	52.3	5.6
EXECUTIVE BRANCH OF THE FEDERAL GOVERNMENT				
Pilot Four Corners	644	9.9%	39.6%	50.5%
GSS Mountain	96	8.4	55.1	36.6
Pilot Southeast	551	9.8	39.6	50.6
GSS Southeast	377	17.0	44.7	38.2
MAJOR COMPANIES				
Pilot Four Corners	642	9.3%	56.1%	34.6%
GSS Mountain	95	10.1	59.6	30.3
Pilot Southeast	553	8.1	57.5	34.4
GSS Southeast	373	14.9	60.0	25.1
ORGANIZED RELIGION				
Pilot Four Corners	641	17.5%	42.7%	39.8%
GSS Mountain	94	18.1	54.1	27.8
Pilot Southeast	552	20.8	50.0	29.2
GSS Southeast	366	21.6	53.8	24.6

EXHIBIT 7 INCOME TAXES

"Do you think the amount of federal income tax you have to pay is too high, about right, or too low?"

	N	TOO HIGH	ABOUT RIGHT	TOO LOW
Pilot Four Corners	662	46.5%	48.0%	5.4%
GSS Mountain	90	32.0	63.3	4.6
Pilot Southeast	564	51.6	45.2	3.2
GSS Southeast	353	56.8	42.4	0.8

As shown, the pilot results are generally similar to those from the 2010 GSS. It is important to note that minor differences would be expected, given the difference in survey years (2012 versus 2010), target populations (the GSS Mountain region includes more states than the Four Corners region), and survey modes (mail versus in-person).

DEMOGRAPHIC COMPARISONS

Demographic questions in the main survey and in the mail and phone follow-up surveys were designed to facilitate direct comparison to American Community Survey (ACS) data. The ACS is an ongoing statistical survey implemented by the U.S. Census Bureau. It is viewed as the definitive source for data on the characteristics of U.S. households. The ACS summary statistics in Exhibits 8-11 below are from the 2011 survey. Note that the ACS data are based on samples of adults, while the pilot and follow-up survey data are based on samples of heads of household.

EXHIBIT 8 AGE

	FOUR CORNERS				SOUTHEAST			
	MAIN	NR MAIL	NR PHONE	ACS	MAIN	NR MAIL	NR PHONE	ACS
18-29	6.8%	2.4%	3.9%	23.4%	6.6%	17.7%	8.3%	21.3%
30-39	14.9	14.3	9.6	18.0	12.8	11.8	10.0	16.5
40-49	16.4	19.1	13.5	17.4	19.6	23.5	18.3	18.4
50-59	21.4	31.0	15.4	17.2	24.7	17.7	26.7	17.8
60-69	22.4	11.9	21.2	12.7	18.3	29.4	11.7	13.6
70-79	13.7	11.9	15.4	7.0	10.4	0.0	11.7	7.7
80+	4.4	9.5	21.2	4.2	7.5	0.0	13.3	4.8
N	630	42	52		546	17	60	

EXHIBIT 9 ETHNICITY AND RACE

	FOUR CORNERS				SOUTHEAST			
	MAIN	NR MAIL	NR PHONE	ACS	MAIN	NR MAIL	NR PHONE	ACS
Hispanic, Latino, Spanish Origin	8.5%	19.5%	11.8%	23.1%	5.7%	11.8%	5.1%	9.5%
N	622	41	51		542	17	59	
American Indian or Alaskan Native	1.3%	0.0%	2.1%	3.6%	0.9%	0.0%	1.8%	0.4%
Asian	1.8	5.1	0.0	2.6	1.1	11.8	3.5	2.8
Black or African American	2.1	2.6	2.1	3.5	10.7	11.8	10.5	22.0
Native Hawaiian or Other Pacific Islander	0.7	2.6	0.0	0.3	0.0	0.0	0.0	0.0
White	92.2	89.7	93.8	86.7	84.7	76.5	82.5	72.7
Two or More Races	2.0	0.0	2.1	3.2	2.6	0.0	1.8	2.2
N	612	39	48		542	17	57	
Note: ACS covers all individuals while pilot survey covers individuals 18 and over								

EXHIBIT 10 EDUCATIONAL ATTAINMENT

	FOUR CORNERS				SOUTHEAST			
	MAIN	NR MAIL	NR PHONE	ACS	MAIN	NR MAIL	NR PHONE	ACS
No schooling	0.2%	0.0%	1.9%	1.0%	0.0%	0.0%	0.0%	1.2%
Some schooling < grade 12	1.9	16.7	5.7	11.4	4.7	11.1	1.7	13.6
High school graduate	15.5	16.7	18.9	24.0	20.8	11.1	33.9	29.8
Some college	23.7	21.4	34.0	25.0	24.8	38.9	17.0	20.9
Associate's degree	7.2	14.3	7.6	8.3	8.0	11.1	3.4	7.7
Bachelor's degree	26.2	26.2	20.8	19.2	21.6	27.8	28.8	16.7
Master's degree	16.0	4.8	7.6	7.9	12.7	0.0	11.9	7.1
Professional degree beyond bachelor's	4.7	0.0	1.9	1.7	4.0	0.0	0.0	1.8
Doctoral degree	4.7	0.0	1.9	1.3	3.4	0.0	3.4	1.2
N	638	42	53		552	18	59	
Note: ACS data for education are for individuals 25 and over								

EXHIBIT 11 HOUSEHOLD INCOME

	FOUR CORNERS				SOUTHEAST			
	MAIN	NR MAIL	NR PHONE	ACS	MAIN	NR MAIL	NR PHONE	ACS
$10,000 or less	3.8%	5.0%	11.1%	7.8%	6.8%	5.6%	4.0%	8.7%
$10,001 to $20,000	7.8	15.0	6.7	10.7	10.5	5.6	12.0	12.4
$20,001 to $30,000	7.3	17.5	6.7	11.1	10.3	11.1	26.0	11.9
$30,001 to $40,000	9.5	7.5	8.9	10.5	13.7	16.7	0.0	10.7
$40,001 to $50,000	11.7	10.0	13.3	9.5	8.0	22.2	10.0	9.2
$50,001 to $60,000	9.6	15.0	6.7	8.4	8.0	16.7	8.0	8.1
$60,001 to $75,000	12.9	7.5	6.7	10.5	9.3	0.0	14.0	9.7
$75,001 to $100,000	14.3	2.5	20.0	11.9	10.5	22.2	18.0	11.0
$100,001 to $125,000	8.5	7.5	8.9	7.6	8.8	0.0	6.0	6.9
$125,001 to $150,000	5.2	7.5	2.2	4.3	4.4	0.0	0.0	3.9
$150,001 or more	9.5	5.0	8.9	7.8	9.9	0.0	2.0	7.5
N	614	40	45		526	18	50	

The percent of male respondents in the Four Corners and Southeast regions was 62.7 and 51.4 percent, respectively, compared to 49.5 and 48.1 percent of adults in the ACS. As shown above, there are relatively modest differences in age (older), ethnicity (white), education (higher) and income (higher) between pilot respondents and the general population in both regions. In some cases there are larger differences between main survey and phone and mail follow-up respondents; however, these statistics are based on a relatively small number of responses. We investigate the impact of differences between main survey respondent characteristics and ACS statistics on WTP estimates in the next section.

ANALYSIS OF CHOICE QUESTION RESPONSES & WTP ESTIMATION

Summaries of all choice question responses are provided in Appendix F. Formal analysis of responses is based on the random utility framework (e.g., see Haab and McConnell, 2002). Under this approach, individual *i*'s utility associated with a particular visibility program *j*, which is defined by a set of K attributes, can be expressed as:

(1) $$U_{ij} = \beta_y(y_i - C_j) + \sum_{k=1}^{K} \beta_k X_{jk} + \varepsilon_{ij}$$

where y_i is individual *i*'s money income, C_j is the cost of visibility program *j*, and X_{jk} is the level of attribute *k* that is offered in visibility program *j*.

The β_k's are the marginal utilities for each of the *K* visibility attributes and β_y is the marginal utility of income. Under the random utility specification, and given individuals' stated responses to binary choice questions comparing program *j* to no program, these parameters are estimated using a conditional logit model. Once estimated, the marginal value of any particular attribute *k* can be computed as:

(2) $$WTP_k = -\frac{\widehat{\beta_k}}{\widehat{\beta_y}}$$

As discussed earlier, the experimental design was tailored to allow estimation of two principal types of models: one in which visibility programs were identified individually by separate binary variables, and one in which the number of days associated with various photographs were included as continuous variables. For comparison with previous research, a third model was estimated using mean annual visibility. Mean annual visibility is calculated as a weighted average, where the weights are equal to the percentage of days associated with each photo. The specific equations estimated for each region were as follows:

(3) $$U_{ij} = \alpha + \beta_{Adays} Adays_j + \beta_{Edays} Edays_j + \beta_H HEALTH_j + \beta_E ECO_j + \beta_T TIME_j + \beta_{cost} COST_j + \varepsilon_{ij}$$

(4) $$U_{ij} = \sum_{x=1}^{6\ or\ 7} \beta_{progX} PROG_{jx} + \beta_H HEALTH_j + \beta_E ECO_j + \beta_T TIME_j + \beta_{cost} COST_j + \varepsilon_{ij}$$

(5) $$U_{ij} = \alpha + \beta_{vis\_mean} MEAN_j + \beta_H HEALTH_j + \beta_E ECO_j + \beta_T TIME_j + \beta_{cost} COST_j + \varepsilon_{ij}$$

where *Adays* and *Edays* are the number of days in photos A and E, respectively, in program *j*; *PROG* are binary variables identifying the seven programs in the Four Corners region and six programs in Southeast region; *MEAN* is the weighted deciview average for program *j*; *HEALTH* is the binary health attribute; *ECO* is the binary ecological attribute; and, *COST* is the annual household cost of program *j*.

For reference, Exhibits 12 and 13 below provide examples of the numbered improvement programs in each region.

EXHIBIT 12 FOUR CORNERS VISIBILITY IMPROVEMENT PROGRAMS

EXHIBIT 13 SOUTHEAST VISIBILITY IMPROVEMENT PROGRAMS

Logit models were estimated using STATA v.12. The "cluster" option that estimates standard errors accounting for correlation among choices made by the same respondent was utilized. Estimation results are reported in Exhibit 14.

Across all Four Corners models, program cost is negative and significant at the one-percent level. The health and ecological attributes are positive and also highly significant in all models. Consistent with expectations the number of photo A days is positive and significant and the number of photo E days is negative and significant. A variety of models containing different combinations of photo days were also estimated. Across these specifications the variables representing the number of days associated with photos A and E were generally significant, while other photos and combinations of photos in the distribution generally were not. Lack of sensitivity to changes in the interior of the distribution may be an artifact of the experimental design, which will be re-evaluated prior to full implementation. Five of the seven program binary variables in model (2) are positive and significant; program 7 is negative and significant. A likelihood ratio test indicates that equivalence of coefficients for programs 2, 3, 5 and 6 cannot be rejected (χ^2 = .02, df = 3). Finally, the coefficient on mean visibility in model (3) is negative as expected, since higher deciviews mean lower visibility, and significant at the one-percent level.

EXHIBIT 14 CHOICE MODEL ESTIMATION RESULTS

	FOUR CORNERS			SOUTHEAST		
	(1)	(2)	(3)	(4)	(5)	(6)
Photo A	.0082*** (.003)			.015*** (.002)		
Photo E	-.038*** (.008)			-.020* (.010)		
Program 1		.638*** (.153)			1.239*** (.141)	
Program 2		.317*** (.115)			.536*** (.134)	
Program 3		.306** (.145)			.792*** (.143)	
Program 4		-.056 (.138)			.586*** (.119)	
Program 5		.323** (.135)			.622*** (.131)	
Program 6		.319** (.155)			-.313*** (.119)	
Program 7		-.489*** (.110)				
Mean			-.407*** (.055)			-.211*** (.020)
Health	.244*** (.057)	.155*** (.063)	.206*** (.055)	.218*** (.067)	.214*** (.068)	.216*** (.068)
Ecological	.171*** (.083)	.220*** (.081)	.172** (.083)	.020 (.089)	.011 (.090)	.020 (.089)
Time	.023 (.057)	-.067 (.065)	.039 (.055)	-.150** (.067)	-.154** (.067)	-.152** (.066)
Cost	-.014*** (.001)	-.013*** (.001)	-.014*** (.001)	-.013*** (.001)	-.013*** (.001)	-.013*** (.001)
Constant	.055 (.186)		2.889*** (.410)	-.205 (.183)		4.063*** (.371)
N	3902	3902	3902	3351	3351	3351

Standard errors in parentheses
*** Significant at 1%, ** 5%, * 10%

Program cost is negative and significant in all Southeast models. The health attribute is positive and significant; however the ecological attribute is not significant in any of the three models. Program timing is significant at the five-percent level in each model and negative. The number of photo A days is positive and significant and the number of photo E days is negative and significant (though at the ten-percent level). All program variables are significant at the one-percent level in model (5), as is mean visibility in model (6).

EXAMPLE WTP ESTIMATES

For illustrative purposes, we calculate annual, per-household WTP estimates for the seven example improvement programs using the above results. The values are calculated as follows (a superscript of “0” represents baseline conditions and a superscript of “1” represents improved conditions):

<u>Photos A and E Models</u>:

$$(6) \qquad WTP = \left({}^{-1}/_{\beta_{cost}} \right) * \left[\beta_{Adays}(Adays^1 - Adays^0) + \beta_{Edays}(Edays^1 - Edays^0) \right]$$

<u>Program Models</u>:

$$(7) \qquad WTP_{progX} = \left({}^{-1}/_{\beta_{cost}} \right) * \left[\beta_{progX} \right]$$

<u>Mean Visibility Models</u>:

$$(8) \qquad WTP = \left({}^{-1}/_{\beta_{cost}} \right) * \left[\beta_{vis\_mean}(vis\_mean^1 - vis\_mean^0) \right]$$

Exhibit 15 presents mean WTP estimates and 95-percent confidence intervals by program and model.

EXHIBIT 15 ANNUAL HOUSEHOLD WTP BY PROGRAM AND MODEL

	PROGRAM						
	1	2	3	4	5	6	7
Four Corners							
Model 1 (A & E)	\$88 (69,109)	\$66 (50, 83)	\$51 (40, 64)	\$56 (40, 73)	\$54 (36, 74)	\$40 (28, 54)	\$6 (1, 11)
Model 2 (Program)	49 (28, 67)	24 (8, 39)	23 (2, 43)	(4) (-28, 16)	25 (5, 43)	24 (2, 47)	(37) (-58, -20)
Model 3 (Mean)	79 (61, 100)	50 (38, 62)	44 (33, 55)	37 (28, 47)	32 (24, 40)	26 (20, 33)	(1) (-1, -1)
Southeast							
Model 4 (A & E)	\$118 (93, 149)	\$78 (55, 105)	\$71 (53, 92)	\$62 (36, 89)	\$54 (36, 74)	\$8 (-2, 17)	
Model 5 (Program)	92 (72, 113)	40 (21, 57)	59 (38, 80)	44 (27, 60)	46 (29, 64)	(23) (-43, -5)	
Model 6 (Mean)	118 (94, 147)	86 (69, 108)	80 (64, 100)	68 (55, 86)	62 (50, 78)	7 (6, 9)	
Confidence intervals estimated using the Krinsky-Robb method, 5,000 iterations							

WEIGHTED MODELS

As noted above, there were modest differences between the demographic characteristics of survey respondents and the demographic characteristics of the adult populations in each region. As a result, weights were developed such that for each region, the weighted sample matched the population with respect to age, gender, Hispanic/Latino ethnicity, race, education and income. Models using weighted data were estimated for each characteristic independently and resultant WTP estimates were compared to the unweighted results. Of these, Hispanic/Latino ethnicity, education, and age resulted in the largest average changes in WTP estimates (in the range of \$2 to \$6).

Models using weighted data combining these characteristics were then estimated. Specifically, the weights were defined as: (1) Hispanic/Latino ethnicity, (2) percentage of respondents with bachelor's degree or higher, and (3) percentage of respondents age 40 or older. For each region, eight mutually exclusive and exhaustive categories were developed based on the binary ethnicity/education/age classifications (8 = 2 x 2 x 2). Next, an iterative procedure (i.e., raking) was used to identify a single weight for each of the eight categories such that the weighted percentage of respondents in each category equaled the population percentage. The final weights are shown in Exhibit 16.

EXHIBIT 16 POST-RAKING SURVEY WEIGHTS

	ETHNICITY	EDUCATION	AGE	WEIGHT
Four Corners	Hispanic/Latino	< Bachelor's	<40	5.51
			40+	2.30
		Bachelor's +	<40	2.50
			40+	1.04
	Not Hispanic/Latino	< Bachelor's	<40	2.19
			40+	0.92
		Bachelor's +	<40	0.99
			40+	0.41
Southeast	Hispanic/Latino	< Bachelor's	<40	3.62
			40+	1.35
		Bachelor's +	<40	1.64
			40+	0.61
	Not Hispanic/Latino	< Bachelor's	<40	2.60
			40+	0.97
		Bachelor's +	<40	1.18
			40+	0.44

Exhibit 17 presents estimation results for the weighted models. Patterns of sign, significance and magnitude of coefficients are similar to the unweighted models. However, several program variables and the ecological attribute in models (1) and (3) are now insignificant in the Four Corners models.

EXHIBIT 17 WEIGHTED CHOICE MODEL ESTIMATION RESULTS

	FOUR CORNERS			SOUTHEAST		
	(1)	(2)	(3)	(4)	(5)	(6)
Photo A	.008* (.005)			.013*** (.003)		
Photo E	-.034*** (.012)			-.032** (.013)		
Program 1		.672*** (.205)			1.361*** (.172)	
Program 2		.233 (.176)			.599*** (.152)	
Program 3		.212 (.189)			.804*** (.176)	
Program 4		-.121 (.182)			.780*** (.147)	
Program 5		.323* (.189)			.700*** (.168)	
Program 6		.338* (.202)			-.274* (.150)	
Program 7		-.422*** (.156)				
Mean			-.382*** (.075)			-.219*** (.024)
Health	.296*** (.086)	.214** (.089)	.262*** (.084)	.305*** (.086)	.297*** (.087)	.305*** (.086)
Ecological	.169 (.106)	.218** (.103)	.170 (.105)	.033 (.115)	.027 (.116)	.030 (.114)
Time	.064 (.086)	-.053 (.092)	.073 (.083)	-.195** (.087)	-.195** (.086)	-.195 (.086)
Cost	-.014*** (.002)	-.013*** (.002)	-.014*** (.002)	-.015*** (.001)	-.015*** (.001)	-.015*** (.001)
Constant	-.010 (.273)		2.674*** (.555)	.012 (.230)		4.293*** (.439)
N	3561	3561	3561	3056	3056	3056

Standard errors in parentheses
*** Significant at 1%, ** 5%, * 10%

Exhibit 18 presents a comparison of WTP estimates for the example programs from the weighted and unweighted models for the A and E photo models.

EXHIBIT 18 WEIGHTED VS. UNWEIGHTED MODEL WTP ESTIMATES- A & E PHOTO MODELS

	PROGRAM						
	1	2	3	4	5	6	7
Four Corners							
Weighted	$81 (55, 111)	$60 (39, 83)	$47 (32, 65)	$50 (30, 73)	$49 (24, 75)	$36 (20, 54)	$5 (-2, 12)
Unweighted	88 (69,109)	66 (50, 83)	51 (40, 64)	56 (40, 73)	54 (36, 74)	40 (28, 54)	6 (1, 11)
Difference	(8%)	(9%)	(8%)	(11%)	(9%)	(10%)	(17%)
Southeast							
Weighted	$114 (85, 149)	$82 (55, 114)	$71 (51, 95)	$69 (41, 101)	$58 (38, 82)	$12 (1, 24)	
Unweighted	118 (93, 149)	78 (55, 105)	71 (53, 92)	62 (36, 89)	54 (36, 74)	8 (-2, 17)	
Difference	(3%)	5%	-	11%	7%	50%	
Confidence intervals estimated using the Krinsky-Robb method, 5,000 iterations							

CONCLUSIONS & IMPLICATIONS FOR FULL SURVEY

This pilot study was designed to test a survey of the public's WTP for reductions in human-caused haze and resultant visibility improvements in designated Class I national parks and wilderness areas. The survey was fielded by mail in two regions and telephone and mail follow-ups were conducted with nonrespondents.

A number of important insights arise from the empirical analysis of the pilot survey data:

- The survey response rates for the Four Corners and Southeast administrations of the surveys (39 and 32 percent, respectively) are similar to those observed for surveys conducted for other environmental applications. However, these response rates are not sufficient to exclude the potential for survey nonresponse to affect WTP estimates.
- Comparisons with data from the mail and telephone follow-up surveys, and comparisons with national probability survey results, indicate that characteristics of people who responded to the pilot survey are not fully representative of the population that the pilot samples were drawn from. These results suggest that data analyses should consider weighted models that bring the sample into consistency with known population parameters.

- The estimated valuation question response equations differ between the Southeast and Four Corners regions. This indicates that it is important to implement final surveys in different regions of the country with baseline visibility and visibility improvements calibrated to each survey region.
- Health and ecological considerations are significant in explaining WTP in the Four Corners regions while only health considerations are significant in the Southeast region. These results imply that it is important to control for these effects to avoid double counting these effects in computing aggregate benefits of visibility improvements.
- The statistical results suggest that people are most concerned with reducing the number of lowest visibility days and increasing the number of highest visibility days. Prior to full implementation, the experimental design may be modified to increase variation in changes in the interior of the distribution across programs.
- Weighting data to account for sample nonresponse decreased estimated WTP in the Four Corners region and generally increased estimates in the Southeast. These results indicate that it will be important to provide the opportunity to weight survey data to representative population characteristics for each implementation region in the administration of the final survey.

Overall the pilot survey performed very well and the qualitative findings are largely consistent with similar environmental studies in the peer-reviewed literature. With minor editing to customize the survey to each of the remaining five survey regions and possible revision of the experimental design, the survey is ready for full implementation.

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