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Climate Change and Recreation Benefits in an Alpine National Park

Robert B. Richardson
Galen University (Belize)
John B. Loomis
Dept. of Agricultural and Resource Economics
Colorado State University (USA)

Weather conditions may affect the quality of an outdoor recreation experience. Quality of the recreation may be reflected in the visitor's willingness to pay or their net economic benefits of recreation. We used the contingent valuation method to measure the effects of weather on net willingness to pay (WTP) for trips to Rocky Mountain National Park in Colorado. We used a visitor survey to elicit responses to a dichotomous-choice WTP question and to gather information about recreation activities. Results were analyzed with daily weather data to test for climate effects on recreation benefits. We found that temperature and precipitation were statistically-significant determinants of WTP. We estimated increases in recreation benefits of 4.9% and 6.7% for two climate change scenarios.

KEYWORDS: *Recreation, climate change, willingness to pay, national parks.*

Introduction

The recreation benefits to a consumer are a measure of how much satisfaction or utility the consumer obtains from the recreation experience (Loomis & Walsh 1997). The level of particular weather variables may influence the benefit or utility derived from the recreation experience. The effect of weather on the visitor's experience may affect recreation choices, utility maximization, and net amenity benefits. The purpose of this paper is to measure the influence of weather conditions on recreation benefits—measured as net willingness to pay (WTP) for the recreation experience of a national park visit. The results of this analysis have implications for the measurement of the economic value of weather forecasts for recreation, in

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Address correspondence to: John B. Loomis, Dept. of Agricultural and Resource Economics, Colorado State University, B-320 Clark Building, Fort Collins, CO 80523-1172. Email: *John.Loomis@colostate.edu*

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order to maximize value (utility) to visitors. The effect of weather conditions on recreation benefits also has implications for climate change policy. In particular, a complete accounting of the benefits and costs of climate change includes consideration of non-market effects such as recreation. If there are substantial gains or losses in recreation due to climate change this may influence the overall economic assessment of policies for slowing global climate change. Management plans that address the effects of climate change on recreation benefits can incorporate adaptation or mitigation strategies that take into account the predicted welfare impacts of climate forecasts.

The measurement of recreation benefits is based on comparing the utility of additional trips with the cost of additional trips. Consumers will continue to take trips as long as the added utility (or benefits) of another trip exceeds the price (or costs). If the marginal benefit of one more trip is greater than the price, the visitor is made better off by taking the trip. Information about the number of trips taken per year under different price levels allows for the valuation of consumers' willingness to pay for trips as well as the estimation of a demand curve. The residual benefit to consumers who are willing to pay higher amounts than the price is known as consumer surplus, or net willingness to pay. It is the area under the demand curve and above the actual costs of making the trip. Consumer surplus for non-market benefits such as recreation can be measured using the contingent valuation method, a survey-based technique.

Climate change represents a systematic shift in the entire distribution of daily weather. We are using natural variations in the current daily weather to estimate the relationship between WTP and weather variables, in order to make inferences about a long-term, permanent change in the level of weather variables associated with global climate change.

Background

The effects of climate on individual well-being are well-documented (Cline 1992). Precipitation, temperature, wind, and sunshine were shown to affect location choices for migration (Blomquist, Berger, & Hoehn (1988). Madison (2003) estimated that average temperature increases of 2.5°C would result in net amenity benefits for high latitude countries. Changes in weather and climate significantly affect recreation participation (Perry 1997). Temperature and precipitation may affect recreation opportunities as well as the utility obtained from recreation. Many recreation activities are dependent on specific natural resources—for example, snow depth may facilitate cross-country skiing but may hinder hiking opportunities. Rainfall and water levels may affect opportunities for boating, wildlife viewing, or picnics. Tourism-based economies such as winter recreation destinations may be particularly vulnerable to climate variability due to warmer temperatures and less snowfall (Wall 1992; IPCC 2001; Scott, McBoyle, & Mills, 2003).

Framework Addressing the Effects of Climate on Recreation Benefits

Climate change is expected to affect recreation in three ways (Mendelsohn & Markowski 1999). First, longer summer seasons and shorter winter seasons affect the availability of certain recreation opportunities. Second, changes in climate may affect the overall comfort and enjoyment of outdoor activities. Third, global warming may alter the ecological systems of an area and ultimately, the quality of the recreation experience. Mendelsohn and Markowski used a travel cost approach to measure changes in recreation benefits for a 2.5°C increase in temperature and a 7% increase in precipitation. They estimated a welfare increase ranging from 7% with a linear demand model to 9% using a loglinear demand model. Welfare impacts were greater for a 5°C increase in temperature. They estimated substantial benefits to fishing and boating, which offset losses to skiing, camping, and wildlife viewing.

Other studies have considered the effects of climate on recreation benefits. Loomis and Crespi (1999) estimated a 3.1% increase in economic value for eight groups of recreation activities (1990 use levels) and a 1.2% increase (2060 use levels) when impacts of effective CO_2 doubling are expected. Substantial losses to downhill and cross-country skiing were offset by gains to reservoir, beach, golf, and stream recreation. They estimated a 2% decline in benefits from forest-based recreation (based on a mid-level estimate of forest cover loss); greater declines were estimated from scenarios depicting larger losses of forest cover. In quantifying the WTP for beach use, McConnell (1977) and Silberman and Klock (1988) found temperature to have a positive and statistically significant effect on net benefits of beach recreation.

Theoretical Framework to Measure Climate Effects on Willingness to Pay

This paper contributes to the sparse literature on climate change and recreation benefits, and the empirical analysis focuses on a resource that has not been studied previously in this context—an alpine national park, specifically Rocky Mountain National Park (RMNP) in Colorado.

The contingent valuation method (CVM) has been used extensively to measure changes in recreation benefits under varying levels of particular amenities, and is an accepted method of valuing recreation benefits as well as other benefits for which no market exists (Cummings, Berger, & Schulze, 1986; Loomis 1987). The U.S. Department of Interior (1986), which oversees the National Park Service, has approved CVM for valuing natural resource damages. CVM is one of two preferred approaches for valuing outdoor recreation in Federal benefit-cost analyses (U.S. Water Resources Council 1983). The most recent and prominent endorsement of CVM has come from the National Oceanic and Atmospheric Administration's blue ribbon panel chaired by two Nobel Laureates, Kenneth Arrow and Robert Solow. These economists along with survey specialists concurred that if a CVM survey is carefully constructed and implemented the result would be reliable enough to be used in judicial and administrative decision making (Arrow, Solow, Portney, Leamer, Radner, & Schuman, 1993).

The premise of CVM is based on a hypothetical market for the use or preservation of a natural resource for which there is no market for the exchange of a good. This hypothetical market includes the description of a good (*e.g.*, recreation experience), a payment vehicle (*e.g.*, travel costs), and a procedure for the elicitation of value (*e.g.*, dichotomous-choice approach) (Loomis 1987). In this study, the good is the most recent recreation trip to RMNP, and the payment vehicle is a hypothetical increase in travel costs. The dichotomous-choice approach asked the respondent to answer yes or no to a randomly assigned bid amount. This approach was utilized because it was suitable for a mail survey and it corresponds to the manner in which consumers make choices in a true market (*i.e.*, based on price, they decide to buy or not). An open-ended question could be used as an alternative, but the process of stating the price is unlike most markets and therefore unfamiliar to most visitors. The NOAA panel (Arrow et al. 1993) recommended closed-ended CVM formats such as the dichotomous-choice approach due to their potential for being incentive-compatible—that is, giving respondents no incentive to misrepresent their preferences or WTP.

Theoretical Foundation of Dichotomous-Choice Contingent Valuation

The theoretical representation follows Hanemann's approach (1984). We assumed that an individual's utility is a function of a recreation experience at RMNP (represented by R) and the consumption of all other goods (represented by income I). The utility function can be represented as:

$$U = f(R, I) \tag{1}$$

Consumption of the recreation good may depend on an individual's income as well as personal preferences known only to the individual, and thus, a portion of the utility function is not observable. Therefore, some components of each individual's utility function are treated as stochastic, resulting in an indirect utility function and a random element, as follows:

$$U = f(R, I) = v(R, I) + e \tag{2}$$

where e represents an independent identically-distributed error term with a zero mean.

Under the dichotomous-choice approach, survey respondents were asked whether or not they would still take their most recent trip to RMNP if travel costs were $\$X$ higher. The respondent answered YES if utility from the recreation experience with the associated loss of X in income would be greater than or equal to the individual's original utility level without having taken the trip. The "YES" respondent would hypothetically take the trip ($R = 1$) at the higher travel cost, and the "NO" respondent would choose not to take the trip ($R = 0$). Therefore, the probability of a YES response is represented as follows:

$$P(\mathrm{YES}|X) = P[f(R = 1, I\text{-}X) \geq f(R = 0, I)] \tag{3}$$

Since the individual's utility function is not observable to the researcher, it is common to assume that the utility function has a stochastic element, which results in the following transformation of the probability function:

$$P(\mathrm{YES}|X) = P[v(R = 1, I\text{-}X) + e_1 \geq v(R = 0, I) + e_2] \tag{4}$$

where e_1 and e_2 are error terms with means of zero (Hanemann 1984). The distribution of the difference in the error terms was assumed to be a standard logistic function (Hanemann 1984; Loomis 1987). The responses to the dichotomous-choice question are analyzed using a binary logit model in order to estimate WTP.

For the empirical analysis, we assumed that WTP was associated with weather conditions on the day of the recreation visit. The empirical model is represented as:

$$WTP_{it} = f(T_t, P_t, W_t, C_t, A_{1i}, A_{2i}, \ldots, A_{ni}, DIST_i, D_{1i}, D_{2i}, \ldots, D_{ni}) \tag{5}$$

where

WTP_i = net benefits (willingness to pay) from recreation experience
T_t = daily temperature (maximum, minimum, and mean)
P_t = daily precipitation
W_t = daily average wind speed
C_t = daily average cloud-cover
$A_{1i}, A_{2i}, \ldots, A_{ni}$ = activities in which the visitor participated during the visit
$DIST_i$ = distance traveled
$D_{1i}, D_{2i}, \ldots, D_{ni}$ = demographic characteristics of the visitor, including gender, age, level of education, annual income, employment status, and membership in an environmental organization
i = individual respondent to survey
t = date

Methods

Econometric Specification

Primary data collected in a visitor survey at RMNP were used along with weather data to estimate the effects of daily weather on economic benefits of recreation. In the survey, visitors responded to a dichotomous-choice question regarding WTP a single bid amount. The probability that a respondent would pay a given amount was statistically estimated using a qualitative choice model in the form of a logit equation (Hanemann 1984). We used the following econometric specification:

$$\text{Probability (YES)} = 1 - \{1 + \exp[\beta_0 - \beta_1(X) + \beta_T(T) - \beta_P(P) - \beta_W(W) - \beta_C(C) + \beta_A(A) + \beta_{DIST}(DIST) + \beta_D(D)]\}^{-1} \quad (6)$$

where

β_0 = the intercept,
β_1 = the coefficient on the bid variable,
X = the given bid amount,
β_T = the coefficient on the temperature variables (T^{max}, T^{min}),
β_P = the coefficient on the precipitation variable (P),
β_{WS} = the coefficient on the wind speed variable (WS),
β_C = the coefficient on the cloud cover variable (C),
β_A = the coefficient on the activity variables (A_n),
β_{DIST} = the coefficient on the distance variable ($DIST$), and
β_D = the coefficient on the demographic variables (D_n).

Next, the empirical model was estimated to measure the coefficients on the climate variables of concern:

$$[\log(\text{YES})/(1\text{-YES})] = \beta_0 - \beta_1\ (\$X) + \beta_T\ (T) - \beta_P\ (P) - \beta_{WS}\ (WS) - \beta_C\ (C) + \beta_A\ (A) + \beta_{DIST}\ (DIST) + \beta_D\ (D) \quad (7)$$

Finally, Equation 7 was converted to a WTP equation by dividing each slope coefficient except β_1 (the coefficient on the bid amount) by β_1, according to Cameron's (1988) reparameterization:

$$\text{WTP} = \beta_0/\beta_1 + \beta_T/\beta_1\ (T) - \beta_P/\beta_1\ (P) - \beta_{WS}/\beta_1\ (WS) - \beta_C/\beta_1\ (C) + \beta_A/\beta_1\ (A) + \beta_{DIST}/\beta_1\ (DIST) + \beta_D/\beta_1\ (D). \quad (8)$$

This specification allows for the interpretation of how the coefficients on the climate variables (β_T, β_P, β_{WS}, and β_C) represent the impact of daily weather on a visitor's WTP.

From Equation 6, we used *t*-tests to test the null hypothesis that climate variables (representing temperature, precipitation, wind speed, and cloud cover) had no effect on the respondent's recreation benefits. The null and alternate hypotheses were as follows:

$$\begin{aligned} &H_0\colon \beta_T = 0 \qquad H_A\colon \beta_T \neq 0 \\ &H_0\colon \beta_P = 0 \qquad H_A\colon \beta_P \neq 0 \\ &H_0\colon \beta_{WS} = 0 \qquad H_A\colon \beta_{WS} \neq 0 \\ &H_0\colon \beta_C = 0 \qquad H_A\colon \beta_C \neq 0 \end{aligned} \quad (9)$$

To reject this hypothesis implies that climate did influence the visitor's utility from the recreation experience at RMNP.

In order to test the joint significance of all the climate coefficients collectively (i.e., whether they are all equal to zero), we employed a likelihood ratio test. The likelihood ratio test involved applying the logit regression without the any of the four climate variables (the restricted equation), and comparing its log likelihood to the log likelihood of the original unrestricted equation. The likelihood ratio test is -2^*(LogLikelihood-restricted minus LogLikelihood-unrestricted) and is distributed chi-square with 4 degrees of freedom (since four variables are dropped). If we found statistical significance of the climate variables individually or jointly, then future changes in climate would therefore affect WTP and utility maximization in the consumption of recreation. This would suggest policy implications of climate change for the management of public recreation sites and ecological preserves such as national parks.

Empirical Application

The study site for the empirical analysis was Rocky Mountain National Park (RMNP) in north-central Colorado. RMNP's diverse wildlife population, scenic alpine meadows, conifer forests, aspen groves, and high mountain peaks attract over three million visitors per year from throughout the U.S.A. and the world. The statistical analysis required both primary and secondary data. A survey of visitors to RMNP was used to gather primary information about visitors' recreation experience and their willingness to pay for visits. Since weather conditions vary from day to day, secondary daily climate data collected from the National Park Service for the survey period were related to economic benefits.

The contingent valuation analysis required response data to a survey question about WTP as well as daily weather data for the sampling period (explanatory variables). Visitor data were collected through visitor surveys at RMNP for the survey period of June 21-September 12, 2001. In the survey, respondents were asked if they would have made their trip if travel costs had been higher. Bid payment amounts were randomly chosen, and respondents were asked the following dichotomous-choice contingent valuation question:

> *As you know, some of the costs of travel such as gasoline have been increasing. If the travel cost of this most recent visit to Rocky Mountain National Park had been \$____ higher, would you have made this visit?*
> *Circle one: YES NO*

Bid amounts ranged from \$1 to \$495. This range was selected in order to estimate a well-behaved logit model. It is important to have a dollar amount low enough that every visitor asked to pay this amount would respond YES and at the opposite extreme, a dollar amount high enough that every visitor asked to pay this amount would respond NO (Cooper & Loomis 1992). To select the dollar amounts that would meet these requirements, we reviewed bid patterns from a dichotomous choice CVM study of recreation in Jackson Hole, Wyoming and in national forests in Colorado.

Surveys were tested with focus groups for content, clarity, and length, and the design was modified according to the focus group comments. The final survey version was pre-tested with RMNP visitors before the sampling period.

In addition, the visitor survey included questions about the activities in which the visitor participated during the most recent visit. This allowed for the test of how much particular recreation activities affected a respondent's WTP. The activities include picnic (*PICNIC*) and driving over the scenic high-elevation Trail Ridge Road (*DTRROAD*), among several others (*e.g.*, hiking, camping, backpacking, and sightseeing). Activities were represented as dummy variables and had values equal to 1 when visitors indicated that they participated in particular activities and 0 if not. Also included were questions about the respondent's distance traveled and demographic characteristics (*e.g.*, age, education, income).

During the survey period, visitors were selected randomly in heavily-visited areas of RMNP at five specific locations (Bear Lake Parking Lot, Bear Lake Shuttle Bus, Sprague Lake, Alpine Visitor Center, and Long's Peak Trailhead). Visitors were selected in various locations in order to sample respondents participating in diverse activities. Survey dates were selected in order to obtain samples from weekdays, weekends, and holidays. Each of the five sites was sampled on four weekend days and four weekdays, for a total of 40 dates.

Using an intercept survey with a mail-returned questionnaire, visitors were approached randomly at the chosen sites, and questionnaires were distributed to willing respondents to be completed and mailed at a later date. Mail-returned questionnaires were chosen because the CVM question referred to the visitor's "most recent trip." This allowed the respondents to complete the questionnaire at the end of their visits. There were 1,378 attempts to distribute surveys during the sampling period, 112 were refused, for a total of 1,266 questionnaires. Of the questionnaires distributed, 967 surveys were returned, for a 70% response rate (or a 76% response rate, net of refusals).

Daily weather data were provided by the National Park Service's Weather Information Management System and included daily observations for temperature (TEMP), precipitation amount (PPTAMT), wind speed (WS), and state of weather (SOW). Mean, minimum, and maximum daily values for these variables during the entire sample period were provided in Table 1.

TABLE 1
Daily Weather Data for RMNP (June-September, 2001)

Variable	Definition	Mean Value	Minimum	Maximum
TEMP	Temperature (°F) (at 1:00 pm)	74.2	39.0	88.0
PPTAMT	Daily Precipitation Amount (inches)	0.0	0.0	0.4
WS	Wind Speed (mph) (at 1:00 pm)	5.2	0.0	12.0
SOW	State of Weather (see Table 2)	n.a.	0	7

The state of weather variable was recorded at 1:00pm and coded as 0-9, according to Table 2. Only one state of weather variable was recorded for each day. For the sampling period, there were no observations for the variable codes 4, 5, 7, or 8, so these variables were omitted from the analysis. Dummy variables (1, 0) were created for the *OVERCAST, RAIN,* and *TSTORM* variables.

Data Analysis

The analysis incorporated primary data collected through visitor surveys at RMNP, as well as daily weather data for the sampling period (June-September, 2001). Data analysis involved four steps. First, the survey and daily weather data were merged and aligned to coordinate a comprehensive dataset. Second, a binary logit statistical analysis was used to estimate the coefficient on the bid amount β_1 and all weather variables β_T, β_P, β_{WS}, and β_C from Equation 6 in order to test for statistical significance. Third, a reduced empirical model was specified to include all statistically-significant weather, activity, and demographic variables. Finally, a WTP equation was calculated by transforming (Cameron 1988) the logit coefficients into the reparameterized WTP coefficients (see Equation 8) which were used to draw conclusions about the incremental WTP associated with changes in the weather variables. When applied to future climate forecasts, the coefficients were used to calculate the WTP effects of climate change. Forecasts from two global circulation models were used in the estimation of future climate variables and their effects on visitor WTP.

Results

Results of a binary logit analysis of the dichotomous choice responses to the CVM question of willingness to pay are displayed in Table 3. Note that

TABLE 2
Definitions of State of Weather (SOW) Variables

Variable	Explanation
0	Clear (<10% clouds)
1	Scattered Clouds (10-50% clouds)
2	Broken (60-90% clouds)
3	Overcast (>90% clouds)
4	Foggy
5	Drizzle or misty
6	Raining
7	Snowing or Sleet
8	Showers/Isolated or Scattered Precipitation (in sight or at station)
9	Thunderstorm in progress (lightning seen or heard)

TABLE 3
Binary Logit Regression Results for CVM Analysis ($n = 618$)

Variable	Coefficient	Std. Error	*z*-Statistic	Probability
Intercept term	−3.069027	1.46504	−2.09483	0.0362
BIDAMT (Bid amount) ($)	−0.006463	0.00108	−5.98513	0.0000
TEMP (Temperature in °F)	0.032236	0.01724	1.86959	0.0615
PPTAMT (Precipitation in inches)	4.137818	1.99663	2.07239	0.0382
WS (Wind speed)	−0.025720	0.04320	−0.59528	0.5517
OVERCAST (=1 if recorded)	0.301792	0.46583	0.64784	0.5171
HIKE (=1 if participated)	−0.243548	0.38015	−0.64065	0.5217
DTRROAD (=1 if participated)	0.313704	0.22688	1.38265	0.1668
PICNIC (=1 if participated)	0.403966	0.21725	1.85939	0.0630
DIST (Distance traveled in miles)	0.001947	0.00030	6.34745	0.0000
DISTSQ (Distance in miles^2)	−2.68E-07	6.15E-08	−4.35509	0.0000
AGE (Age in years)	0.011524	0.00827	1.39236	0.1638
ENVORG (=1 if member of environmental organization)	−0.200881	0.25955	−0.77395	0.4390
INC (Income) ($)	8.75E-06	2.39E-06	3.658801	0.0003
S.E. of regression	0.388625	Mean—dependent variable		0.739482
Sum squared residuals	91.22193	S.D.—dependent variable		0.439273
Log likelihood	−282.2290	LR statistic (13 df)		144.5089
Restricted log likelihood	−354.4835	Probability(LR stat)		0.000000
McFadden R-square	0.203830	Total observations		618
Obs with YPAY=0	161	Obs with YPAY=1		457

the dependent variable in this case is *YPAY,* which is equal to 1 when respondents indicated that they would pay the bid amount and 0 when they indicated they would not pay.

The slope coefficients on both the temperature (*TEMP*) and precipitation amount (*PPTAMT*) variables were significant (Pr = 0.0382); the signs for *TEMP* and *PPTAMT* were positive, suggesting greater probability of responding YES to the CVM question with higher temperature and greater precipitation. While not shown in Table 3, the precipitation amount (*PPTAMT*) is not correlated with the dummy variables for rain (*RAIN*) or thunderstorm (*TSTORM*) (correlation coefficients are 0.18 and 0.10, respectively). The likelihood ratio test indicated that all four weather variables (*TEMP, PPTAMT, WS, OVERCAST*) were significantly different from zero as the calculated chi-square statistic ($\chi^2 = 103.18$) exceeds the 0.05 critical value (9.488). The slope coefficients on the variables representing bid amount (*BIDAMT*), picnic activities (*PICNIC*), one-way travel distance (*DIST*), distance squared (*DISTSQ*), and household income (*INC*) were significant at the 10% level and display the expected signs.

We repeated the regression analysis but eliminated insignificant variables. The results of this reduced binary logit model are displayed in Table 4. The coefficients were statistically significant, as evidenced by their prob-

TABLE 4
Specified Binary Logit Regression Model (n = 625)

Variable	Coefficient	Std. Error	z-Statistic	Probability
Intercept term	−2.679648	1.366754	−1.960593	0.0499
BIDAMT (Bid amount) ($)	−0.006505	0.001036	−6.281274	0.0000
TEMP (Temperature in (F)	0.028407	0.016824	1.688469	0.0913
PPTAMT (Precipitation in inches)	4.446690	1.846271	2.408470	0.0160
PICNIC (=1 if participated)	0.410945	0.210787	1.949570	0.0512
DTRROAD (=1 if participated)	0.370858	0.220514	1.681791	0.0926
DIST (Distance in miles)	0.001935	0.000301	6.438810	0.0000
DISTSQ (Distance in miles^2)	−2.62E-07	5.97E-08	−4.390011	0.0000
INC (Income) ($)	9.04E-06	2.37E-06	3.817378	0.0001
S.E. of regression	0.388229	Mean—dependent variable		0.739200
Sum squared residuals	92.84441	S.D.—dependent variable		0.439423
Log likelihood	−286.6003	LR statistic (12 df)		144.1643
Restricted log likelihood	−358.6825	Probability(LR stat)		0.000000
McFadden R-squared	0.200964	Total observations		625
Obs with YPAY=0	163	Obs with YPAY=1		462

abilities of 0.10 or less. We reject the hypothesis that the coefficients on temperature (TEMP) and precipitation (PPTAMT) are zero, along with that for the coefficient on certain recreation activities (*PICNIC, DTRROAD*), distance (*DIST* and *DISTSQ*), and demographic (*INCOME*) variables (see Equation 9). The overall logit model is significant at $P < .01$ as evidenced by the likelihood ratio (LR) statistics of 144. Based on the McFadden R-squared, the overall logit regression explains about 20% of the variation in individual WTP.

Following Cameron's (1988) approach, the logit model was converted to an equation that directly relates WTP as the dependent variable to the independent variables such as weather, activity, and demographic variables. The slope coefficients in Equation 7 were reparameterized by dividing the intercept and all coefficients other than that on the bid amount from Table 4 by the absolute value of the coefficient on the bid amount. This conversion for the logit function generated the following equation:

$$\begin{aligned} WTP = {} & -411.95 + 4.37\,TEMP + 683.60\,PPTAMT + 63.18\,PICNIC \\ & + 57.01\,DTRROAD + 0.30\,DIST - 4.03\text{E-}05\,DISTSQ + 0.0014\,INC \end{aligned} \tag{10}$$

Equation 10 allowed for coefficients to be interpreted in the same manner as the results of an ordinary least squares regression. A one-degree increase in temperature was associated with an increase in willingness to pay of $4.37. Individuals driving over Trail Ridge Road were willing to pay $57.01 more than those who did not. An increase in a visitor's income of $1,000 was associated with an increase in WTP of $1.40. We expect that the high coefficient estimate on precipitation was related to the coincidence of the late-summer monsoon season (which brings greater levels of rain to the region) and school-vacation summer months, when many families take leisure trips.

Discussion

Mean WTP was calculated using the mean values for each of the explanatory variables and is estimated to be $314.95 per trip. Survey results indicated an average group size of 4.3 persons and an average length of stay of three days. We estimated a net WTP per person, per day of $24.47. This value is within the range of past benefit estimates for hiking and similar recreation activities (Loomis & Walsh 1997).

Results from two global circulation models were used to estimate potential climate changes for the RMNP area. Both of the scenarios developed by the two models used a baseline time period of 1961 to 1990 for the assessment. The CCC (Canadian Climate Center) scenario tended to be more than 4° F warmer than the historical baseline period, and predicted a drier overall climate. The Hadley scenario predicted 2° F warmer and tended to estimate a wetter winter or off-peak season, and drier summer or peak season. In order to estimate the effect of climate change on the mean WTP, the 2020 temperature and precipitation forecasts from the CCC and Hadley global circulation models were substituted for mean temperature and precipitation amounts. The results indicated that mean WTP would increase 6.7% to $336.05 per trip under the temperature and precipitation forecast presented by the CCC model; mean WTP would increase 4.9% to $330.38 per trip under the climate forecast presented by the Hadley model. Findings in this study are of the same relative magnitude as previous estimates of economic effects of climate change on recreation benefits (Mendelsohn & Markowski 1999; Loomis & Crespi 1999).

We acknowledge that there may be differing climate change implications for the recreation benefits of particular activities. For example, since both the CCC and Hadley scenarios predict warmer temperatures along with less precipitation and snow depth for 2020, there may be gains to visitors participating in hiking, mountain climbing, and picnics, and associated losses to visitors participating in cross-country skiing or snowshoeing. A shorter winter season and less snow depth may mean that hiking trails and the popular Trail Ridge Road are passable for more months than at present.

The results of this analysis have implications for the value of weather forecasts for recreation planners, resource managers, and climate change policymakers. Measurable effects of weather on recreation benefits are relevant for economic efficiency analysis in terms of maximizing recreation value (or utility) to visitors. Improved weather forecasts would enhance the efficiency of the recreation visitation decision by minimizing uncertainty. The increasing recreation benefits with global warming also suggest that the economic benefits of investments in new recreation facilities should become more feasible in the future. Finally, the relatively small magnitude of the increase in recreation benefits with global warming for large alpine national parks such as Rocky Mountain (and perhaps for similar parks such as Yellowstone or Glacier National Parks) may suggest that recreation effects will likely not be a major factor in evaluating the economic feasibility of whether or not to slow the effects of climate change.

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