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Trip Response Modeling of Rock Climbers' Reactions to Proposed Regulations

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Study results contribute to the recreation benefits literature for the sport of rock climbing. Also, reported is an application of a hybrid or trip response modeling approach. Respondent reactions (intended behavior) to regulatory changes in management plans at Crowder's Mountain State Park, North Carolina, are assessed. The proposed regulations address (a) the quality of rock climbing conditions, (b) variations in climbing areas to accommodate the different skill levels, (c) limiting the number and size of groups, (d) rationing of rock climbing at certain areas, involving either area modifications, restrictions or closures, and (e) requiring users to attend education programs and perform park service projects. Intended changes in annual climbing participation, attributable to the proposed regulations, are displayed along with losses in recreation benefits. Our point estimate of consumer surplus is $125 per trip, which compares favorably with other reported estimates. Finally, an on-site climbing choice model is estimated and the resulting distributions of demanded state park trips among the seven climbing areas resulting from four regulatory change are evaluated.

KEYWORDS: *Trip response modeling, outdoor recreation, recreation modeling, rock climbing.*

Literature Review

There are currently over 500,000 active climbers in the United States (Williamson, 1999). The increased interest in the adventure sport of rock climbing has contributed to the ecological damage of public lands in the United States (Attarian & Pyke, 2000). Studies report the adverse effects of human impacts to soil, damage to vegetation, harassment to wildlife, the growing presence of litter, noise, bolting practices, damage to historic and cultural sites, and such practical concerns as legal liability, climbers lacking the appropriate technical skills, and the compositions of groups (Cavlovic, Berrens, Bohara, Jakus, & Shaw, 2002; Pyke, 2001; Schuster, Thompson & Hammitt, 2001; Vaske, & Donnelly, 1999; Camp & Knight, 1998; Farris, 1998; Archer, 1995). All conclude by stating an urgent need for managing agencies to better integrate the growth of climbing with the requirements of preserving and administering public lands.

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Often, public land managers are required to acquire users' reactions prior to implementing regulations. In this regard, hybrid methods of augmenting past trip data with intended trip data from recreation surveys show promise in estimating future demand as an input into regulatory decisions (Grijalva, Berrens, Bohara, & Shaw, 2002; Whitehead, Haab, & Huang, 2000). We apply the *trip response method* (hybrid model) to proposed regulatory changes (Loomis & Walsh, 1997). The trip response model supplements past trip counts from the travel cost method with individual responses about their intended trips in reaction to proposed regulations (Loomis & Walsh). First, respondents are asked the number of trips taken during the past 12-months to a park under *existing* conditions. Next, respondents are asked to indicate the number of trips they would take during the next 12-months to that park under either positive or negative *altered* conditions (Siderelis, Moore, & Lee, 2000).

In theory, the true demand for a park should be reflected in both the respondent's past and intended trip responses on the survey questionnaire. Although studies have shown intended behavior questions to be both reliable and valid, their empirical consistency can be determined with hypothesis testing of the differences in past and intended trips (Loomis, 1993). Grijalva et al. (2002) conclude that climbers do not appear to overstate changes in trips when presented with hypothetical questions about climbing area restrictions by performing a *validity test of scope* in studying the pre and post changes in rock climbing policies and rules at Hueco Tanks State Park, Texas. In fact, Grijalva et al. found intended trip behavior a valuable supplement to revealed preference data when regulatory proposals were outside the range of historical conditions. Cameron, Shaw, Ragland, Callaway, and Keefe (1996) when studying the varying effects of lake level on boating the Columbia River Basin combined the past and intended trip data for each survey respondent at different times (summer months, rest of year, annual) and found that the empirical models accommodated the natural heteroskedasticity that resulted in the data.

Our motivation for reporting is to contribute to the recreation benefits literature for the adventure sport of rock climbing and to assess the credibility of the trip response method. The empirical application involves proposed regulations at Crowder's Mountain State Park, North Carolina. Crowder's Mountain is very popular with climbers because of its easy driving access and proximity to a large metropolitan area (Charlotte, North Carolina). Potential regulations address (a) the quality of rock climbing conditions, (b) variations in climbing routes to accommodate the different skill levels, (c) limiting the number and size of groups, (d) rationing rock climbing at certain areas that may involve either site modifications, restrictions or closures, and (e) requiring participation in climber education programs and service projects. Study results will simulate the consequences of proposed regulations in rock climbing, and thus, avoid implementing the regulations in an *ad hoc* manner.

Trip Response Model

A climber's demand for a rock climbing site is dependent on the planned quantity of day-trips the climber is willing to consume at various travel costs within a 12-month period, when all other factors apart from travel costs are held constant. A climbing site is associated with a place like a state park, whereas a climbing area refers to an on-site wall (i.e., rock formation) or a route taken to the wall. The demand curve relates this quantity of annual trips to the various travel costs. It is derived by maximizing the climber's satisfaction (utility) from consuming a planned number of annual trips, subject to monetary and time constraints. This is the travel-cost framework. To obtain the planned number of annual trips, the respondent is asked: "How many trips have you taken to this park during the past twelve months?" To obtain the intended number of trips, we add the following contingent behavior question to the survey: "How many trips are you planning to take to this park during the next twelve months?" The trip response model now consists of one past trip response and one intended trip response (Loomis & Walsh, 1997). Realistically, the number and scope of trip responses are a function of the number of contingent behavior questions, corresponding to the number of proposed changes under evaluation.

Assume the number of trips has a marginal impact on income, the demand for rock climbing trips and the determinants of demand are specified as, $\text{TRIPS}_k = f(\text{TC, S, X, A, D}_{k-1})$, where the subscript k represents the two observations per climber (one for the observed data and one for the intended data). The dependent variable, TRIPS, consists of the past trips and the intended trips that correspond to contingent questions about regulatory changes. The remaining determinants of demand do not vary between the past trips and intended trips. TC is the travel cost or the price a user must pay to access the site. The computation of the travel cost includes the round-trip milage cost from an origin to the destination climbing site, opportunity cost of round-trip travel time, and access fees, if any. S is the price of visiting a substitute site, X is a vector of individual respondent characteristics, and A is a vector of park-specific attributes. D is a dummy variable that differentiates the past number of trips from the intended trips for the two observations (Englin & Cameron, 1966).

Empirical Application

Crowder's Mountain State Park is a mature climax forest of hardwoods. At an elevation of 1,625 feet, it is a registered natural heritage area in North Carolina that features sheer vertical cliffs ranging from 100 to 150 feet in height. The park landscape peaks at 800 feet above the surrounding countryside. The park is one of the most popular sites in North Carolina, recording 11,508 visits per year for rock climbing (Crowder's Mountain State Park, 2002). The park's popularity is attributable to the short but steep walls, providing a variety of rock climbs.

Methods

The names, addresses, and party sizes were taken from permits (October 2001 to May 2002) and entered into a spreadsheet. One member of a climbing party must obtain permission to climb at Crowder's Mountain by completing a climbing and rappelling permit for that day prior to rock climbing. Park personnel estimate that compliance with the permit system is at least 90% (M. Derstine, personal communication, October 11, 2001). Duplicate names on the permits were filtered from the sampling frame prior to generating a random sample with Excel spreadsheet functions. Four hundred and forty-one climbers were sent survey questionnaires to mail-back. The questionnaire was designed to collect information about travel behaviors to climbing sites, managing rock climbing areas, attitudes toward a series of guided climbing issues, important factors considered when choosing a climbing area, and demographic information. Reminder postcards were sent to survey non-respondents two weeks after the original mailing. One hundred and eighty-eight survey questionnaires were returned and 170 were completed and suitable for statistical analysis, yielding a response rate of 39%.

Ninety percent of the respondents were male. Respondents were on average 30 years old, had a mean annual household income of $62,789, worked approximately 38 hours per week, and had an average of 8.2 years of climbing experience. Respondents were asked to self-rate their climbing ability and chose the climbing system they used: traditional, sport, and/or top-rope. Traditional climbing involves protecting the rock features with equipment that climbers place as they ascend the climb to safeguard themselves from falling. The equipment is then removed once the climb is completed causing no harm to the rock face. Our sample of traditional climbers had a mean ability of 5.70 (YDS). The Yosemite Decimal System (YDS), used to judge climbing accents, ranges from 5.0 (easy) to 5.14 (very difficult). Sport climbing involves climbs that have anchors pre placed and tend to be shorter in length and technically more demanding than traditional climbs. Sport climbers had a mean ability of 5.95 (YDS). Top-rope climbing involves clipping the middle of the rope to an anchor at the top of the climb. Both ends of the rope reach the bottom of the climb. As one climber ascends, the other climber holds the rope from below and gathers the remaining rope. Since the climber is always protected with a rope overhead, any falls will be short. It is popular among beginning climbers and commonly practiced in indoor climbing gyms. The mean climbing ability of top-rope climbers was 5.97 (YDS).

Proposed Regulations

Climbers were asked and responded to a series of potential regulations for Crowder's Mountain.[1] Many of the regulatory scenarios involved park

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[1]The regulatory changes are proposed, but the questions about intended behaviors are hypothetical.

conditions that the rangers and analysts knew were familiar to the respondents (Loomis & Walsh, 1997). Alternatively, several of the regulatory actions in Table 1 extended the domain of the demand function by suggesting regulations never experienced before by respondents (Englin & Cameron, 1996).

Scripts preceded each set of intended trip questions to provide respondents with background information about the regulations (Table 1). The scripts were pretested with climbers at Crowder's Mountain to insure their meanings would be realistic and credible to survey respondents. Scripts were written to encourage respondents to react contingently in reporting their trip responses since the respondents would be familiar with park conditions at Crowder's Mountain.

Respondents were asked to indicate the effects of the regulations on their future travel plans. This was done by having respondents indicate changes in future trips with the following format:

____ I would take MORE trips. (If so, about how many MORE? _____ Trips)
____ I would take FEWER trips. (If so, about how many FEWER? ____ Trips)
____ I would take the SAME NUMBER of trips.

Specification and Statistical Analysis

The trip response model was specified as a Poisson regression because the annual trip counts were entirely nonnegative integers and included climbers' responses of zero intended trips.[2] Taking advantage of the twelve repeated trip responses by each respondent (case), the model was incorporated into a count-data panel estimator (see Stata, Version 7, 2001). The

[2]Two points here. The first deals with endogenous stratification and on-site sample surveys, where the likelihood of being sampled is related to the number of trips taken annually. The second is truncation, which means that no nonusers were sampled and the number of trips is truncated at one the lowest number of past trips reported in this study. Englin and Shonkwiler (1995) present a method of subtracting one from the number of past trips to correct the problems of truncation and endogenous stratification in the Poisson count-data estimator. The Poisson count process assumes the conditional mean of climbing trips is equal to the variance. The data were not treated because climbers were not intercepted and interviewed on-site. Instead, the sample was drawn from the collection of permits and the duplicate names of permit holders were filtered from the sampling frame.

The next step was to test for over-dispersion in the process. There was over-dispersion ($\alpha = 0.75$) in respondents' trip counts for the past 12 months (likelihood ratio test $\alpha = 0$: $\chi^2(01) = 581.17$, $pr > \chi^2 = 0.0$). During the preliminary analysis of the *panel-data,* negative binomial (over-dispersion) and Poisson regression, estimates of expected trips were compared to trip counts from the sample data ($M = 11.38$, $SD = 13.48$). Estimates from the negative binomial over predicted trips ($M = 189.97$, $SD = 87.26$), whereas the Poisson gave predictable results ($M = 11.56$, $SD = 5.56$). A common reason to use an extension (negative binomial) to the Poisson regression on cross-sectional panel-data is to control for unobserved heterogeneity (Cameron & Trivedi, 1998). The panel-data methods already controlled for heterogeneity, and the Poisson model was sufficient (Cameron & Trivedi).

TABLE 1
Regulatory Changes and Intended Trip Questions

On a typical weekend, anywhere from three to five guided groups may be seen rock climbing in the park. Suppose that state park management decides to reduce the number of guided rock climbing groups to a maximum of two for the primary area you climb.

R1 If this were the case, how many trips would you probably take to Crowder's Mountain State Park during the next twelve months?

Currently, park management limits rock climbing group size to 20, including leaders. Suppose the state park management decides to reduce the size of guided rock climbing groups in the primary area you primarily climb.

R2 If the maximum rock climbing group size were reduced to 15 climbers, how many trips would you probably take to that area during the next twelve months?

R3 If the maximum rock climbing group size were reduced to 10 climbers, how many trips would you probably take to that area during the next twelve months?

Currently, there are four primary areas open to rock climbing at Crowder's Mountain. Suppose that park management decides to reduce the number of climbing areas open to climbing.

R4 If Practice Wall were closed to rock climbing, how many trips would you probably take during the next twelve months?

R5 If David's Castle Wall were closed to rock climbing, how many trips would you probably take during the next twelve months?

R6 If Fortress Wall were closed to rock climbing, how many trips would you probably take during the next twelve months?

R7 If Middle Finger Wall were closed to rock climbing, how many trips would you probably take during the next twelve months?

Group leaders have the responsibility for both the safety of the group and the protection of the environment. Suppose that all rock climbing guides and group leaders at Crowder's Mountain were required to attend an annual orientation session on Leave No Trace and safe climbing practices.

R8 If this requirement were initiated, how many trips would you take to Crowder's Mountain during the next twelve months?

The quality and naturalness of Crowder's Mountain rock climbing areas are being threatened by increasing numbers of rock climbers unknowingly creating adverse ecological impacts upon rock climbing areas. Suppose that ecological impact issues (damage to vegetation, routes and site erosion) at Crowder's Mountain rock climbing areas could be reduced but involved restricting area access.

R9 If these impacts were reduced and access restricted, how many trips would you probably take to Crowder's Mountain during the next twelve months?

Many rock climbers see it as their responsibility to "give something back" to the climbing resource so that future generations can enjoy these same climbing areas. Suppose that all guided rock climbing groups at Crowder's Mountain were required to perform at least two days of trail maintenance (or other service) for every ten days of climbing in the park.

R10 If this plan were implemented, how many trips would you probably take to Crowder's Mountain during the next twelve months?

Notes. The letter R and a number precede each question to indicate a management action. When introduced into statistical analysis, the dummy variable (R) indicates whether the trip response pertains to that specific hypothetical question or not.

panel estimator dealt explicitly with multiple trip observations (one past trip and eleven intended trips) for each respondent (case), and specified that the responses were independent across cases but not within cases.

A random-effects model, as opposed to a fixed-effects model, is generally preferred because it allows the analyst to recover the coefficients on the independent variables, like travel costs, that do not vary within cases. Further, all randomness is assumed to stem from the Poisson process, and all systematic variations in demands across cases (respondents) would be captured by the independent variables. The random-effects estimator assumes that the independent variables are uncorrelated with the regression errors and the fixed-effects model does not (Greene, 1993). We tested this assumption with the following steps. First, we estimated the fixed-effects model. Next, we estimated the random-effects model. We, then, compared the two models with the Hausman's specification test to test the null hypothesis that the differences in the coefficients between the fixed-effect and random-effect models were not systematic. Our failure to reject the null hypothesis indicated that the trip response model was correctly specified, and the determinants of demand were uncorrelated with the errors ($\chi^2 = 0.07$, $p > \chi^2 = 1.00$). Consequently, the expected number of trips was estimated with the following trip response function:

$$
\begin{aligned}
E[\text{TRIPS}] = \exp[&\alpha 0 + \alpha 1(D) + \alpha 2(\text{R1}) + \alpha 3(\text{R2}) + \alpha 4(\text{R3}) + \alpha 5(\text{R4}) \\
&+ \alpha 6(\text{R5}) + \alpha 7(\text{R6}) + \alpha 8(\text{R7}) + \alpha 9(\text{R8}) + \alpha 10(\text{R9}) \\
&+ \alpha 11(\text{R10}) + \beta 0(TC) + \beta 1(S) + \beta 2\,(EQS) + \beta 3(TRC) \\
&+ \beta 4(GT) + \beta 5(\text{R4} \times TC) + \beta 6(\text{R5} \times TC) \\
&+ \beta 7(\text{R6} \times TC) + \beta 8(\text{R7} \times TC) + u].
\end{aligned}
$$

The expected quantity of trips, E[TRIPS], were estimated by integrating the past and intended trips into the dependent variable.[3] The random-effects estimator included a constant ($\alpha 0$) and eleven slope shift parameters ($\alpha 1, \ldots, \alpha 11$) to distinguish among the ten trip responses to regulatory actions (R1, . . . , R10) and the dummy variable (D) that differentiated the reported trips for the past 12 months (= 1) from the intended trips (= 0). The indicator dummy variables (R's) differentiated the proposed regulations R4 through R7, which are the area closures (see Table 1 for a complete list of proposed regulations). The remaining determinants of demand included travel costs (TC), substitute prices for another popular climbing site, Stone Mountain State Park, North Carolina (S), past equipment spending (EQS),

[3]A subtle but an important point about expected values (see King, Tomz, & Wittenberg, 2000). Expected trips when estimated with Poisson regression are different from predicted trips. Predicted trips contain both fundamental and estimation uncertainty. Expected trips are averaged over the fundamental variability arising from sheer randomness, leaving only the estimation uncertainty caused by not having an infinite number of observations (King, Tomz, & Wittenberg). Predicted and expected trips are the same in linear models, but can differ in nonlinear cases. However, the values are often close, if the nonlinearity is not severe.

top rope climbing achievements (ranged from 5.0-5.14), and whether trips were guided ($GT = 1$).[4] Also, four interaction terms were introduced into the trip response analysis by multiplying the travel costs (TC) with each of the regulatory actions to close selected areas (i.e., indicators R4 through R7), allowed the slopes of the demand curves to differ across climbing areas. The error term, u, has a mean of one and variance of the alpha from statistical analysis (Greene, 1993). The panel was balanced, which meant that the statistical analysis was restricted to respondents answering the complete set of twelve questions for a sample size of 2,040 (12 observations per case × 170 complete cases).[5]

Results

Statistical modeling results are displayed in Table 2. The Wald chi-square (χ^2) was statistically significant ($p < 0.001$), signifying that the random-effects estimator adequately modeled respondents' trip behaviors (Table 2, Summary Statistics). The remaining summary information included a log-likelihood ratio to compare the panel estimator with a corresponding pooled estimator. Pooling is a technical term to describe the separation of the twelve observations in the data set by *not* grouping the observations for each respondent into a case. The panel estimator was statistically different from the pooled Poisson regression, meaning there was significant gains in estimation from grouping the observations for each respondent into cases.

The effects of the proposed closures of rock climbing areas (R4, R5, R6, and R7) were statistically significant ($p > |z| < 0.01$). The coefficients were negatively signed implying that the closures of an area would result in significant decreases in future trips. Similarly, reducing human impacts and restricting area access (R9) would result in a significant decrease in future trips.

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[4]We computed the travel costs for a substitute climbing site, Stone Mountain State Park, NC, and the destination site, Crowder's Mountain State Park, NC, as follows: $TC = [(d * .14) + (w * h * 0.33)] * 2$. A description of the notation follows:

d = distance in miles from zipcode origin to the state parks was multiplied by $0.14 per mile for fuel and upkeep, as reported by the American Automobile Association by Runzheimer International, for V6 automobiles adjusted from $1.20 a gallon gas in 1996 to $1.64 gallon in 2001 (Autoweek, April 1, 1996, p.9). We estimated one-way miles to Stone Mountain and Crowder's Mountain with the computer product ZIPFIP using the 2000 zipcode database (Hellerstein, Woo, McCollum, & Donnely, 1993).

h = time spent traveling to the state parks. One-way distance was divided by 55 mph.

w = household hourly wage rate as measured by annual household income divided by 52 (weeks) multiplied by the reported hours worked per week. If missing, household annual income was divided by 2080 work hours in a year and 0.33 is the fraction of the imputed wage rate to value time.

[5]Actually, an unbalanced design with cross section data (i.e., where respondents fail to respond to one or more of the contingent behavior questions) is not a statistical problem rather a sampling design issue (Cameron and Trivedi, 1998).

TABLE 2
Poisson Regression Model. Dependent Variable:
TRIPS (n = 170 cases × 12 obs. = 2,040).

Explanatory Variable		Coefficient	Std. Err.
Constant	α0	2.01921**	0.17740
Travel cost	β0	−0.00798**	0.00199
Substitute price—Stone Mountain State Park, NC	β1	0.00406**	0.00133
Annual equipment spending	β2	0.00027*	0.00012
Top-rope climber	β3	0.04937**	0.01568
Guided climbs	β4	−0.77368**	0.18428
D—Observed annual trips	α1	−0.28596**	0.03314
R1—Reduce guided trips to two climbers.	α2	0.04872	0.03033
R2—Reduce maximum group size to 15.	α3	0.04378	0.03036
R3—Reduce maximum group size to 10.	α4	0.06563*	0.03020
R4—Close Practice Wall to rock climbing.	α5	−0.10606**	0.03777
R5—Close David's Castle Wall to rock climbing.	α6	−0.11581**	0.03894
R6—Close Fortress Wall to rock climbing.	α7	−0.10087**	0.03751
R7—Close Middle Finger Wall to rock climbing.	α8	−0.11147**	0.03762
R8—Required to attend an annual orientation session.	α9	−0.00236	0.03071
R9—Reduce ecological impacts but restrict area access.	α10	−0.18468**	0.03221
R10—Perform 2 maintenance-days for every 10 climb-days.	α11	−0.03304	0.03095
R4 × Travel cost	β5	−0.00165**	0.00061
R5 × Travel cost	β6	−0.00299**	0.00069
R6 × Travel cost	β7	−0.00137*	0.00059
R7 × Travel cost	β8	−0.00135*	0.00059
Alpha (α) value		0.74922	0.07580

[a] *Summary statistics.* Log likelihood = −5,012.47; Wald χ^2 (20) = 376.45.
$^{**}p < .01$. $^{*}p < .05$.

The indicator variable (*D*) differentiated the past trips from the intended trips. The significance of this variable meant that the underlying past and intended trip-taking behaviors were different. Why is this important? Theoretically, there should be no hypothetical bias. However, respondents may overstate the number of intended trips due to optimistic future trip intentions. For example, we can speculate that enthusiastic respondents recently introduced to the sport of rock climbing might overstate planned trips. Also, unexpected monetary or time constraints can materialize in the future so that the full extent of climbers' good intention to take more trips at this point may not be realized. By maintaining the indicator variable in the panel estimator, we calibrated the hypothetical biases from combining the past and intended trips by accounting for the shifts in the demand curves. The indicator variable was negative. Respondents simply reported fewer past trips than intended trips for the next 12-months.[6]

Travel cost (M = \$43.03, SD = \$57.65), substitute price for Stone Mountain State Park (M = \$86.00, SD = \$90.29), annual equipment expenditures (M = \$456.22, SD = 600.31), and guided climbing (M = 15.88%, SD = 36.56%) variables were statistically significant (Table 2, column 2). Being on guided climbs did decrease the number of annual trips by 54% ($= 100 \times [\exp(-.77368) - 1]$), holding all other variables constant. Top-rope climbing achievement (M = 8.11, SD = 4.29), an ability-specific characteristic as a surrogate park characteristic, was statistically significant ($P > |z| = 0.002$) (Shaw & Jakus, 1996). The higher the top-rope climbing achievement, the greater the number of annual trips to Crowder's Mountain. Apparently, this is an indication of the popularity of top-rope climbing at Crowder's Mountain. Similar measures for sport and traditional climbs when introduced into statistical analysis were not significant and dropped from further analysis.

The sign on the *TC* coefficient was negative. As travel costs increased, the demand (i.e., quantity of annual climbing trips) decreased and vice versa. The price elasticity of demand was −0.3433 (i.e., the price elasticity of demand ranges in value from zero to a unity value of less than −1.00). In this instance, a 10% increase in price resulted in 3.4 % decrease in demand, which falls within the conventional range for travel cost models of demand for park visits. Continuing, those climbers who made higher annually equipment expenditures demand significantly more climbing trips (E_{EQS} = 0.1219). A 10% increase in annual equipment expenditure resulted in a 1.219% increase in demand.

Park Benefits

Park benefits are computed to compare the proposed regulations on climbing participation. We calculate the park benefits of Crowder's Mountain with the statistical results from Table 2 and the mean values of the independent variables. Since the functional form of the Poisson regression is semi-logarithmic, the point estimate of consumer surplus (i.e., park benefits to climbers), corresponds to a semi-logarithmic demand specification. It is calculated using the travel cost coefficient (β0) from Table 2 and the formula E[TRIPS]/β0 for all proposed regulations (Englin & Cameron, 1996). There are four exceptions. Items R4 through R7 include coefficients (β5, β6, β7, β8) on the interaction terms: (a) $E[\text{TRIPS}_{R4}]/(\beta 0 + \beta 5)$, (b) $E[\text{TRIPS}_{R5}]/(\beta 0 + \beta 6)$, (c) $E[\text{TRIPS}_{R6}]/(\beta 0 + \beta 7)$, and (d) $E[\text{TRIPS}_{R7}]/(\beta 0 + \beta 8)$.

[6]A reviewer made a good point in commenting on the overstatement of intended trips by survey respondents to the scenarios in Table 1. The reviewer suggested that an upward bias in intended trips may in part be due to our wording of the scenario responses as "How many trips would you probably take . . . " rather than the matter of fact, "How many trips would you take . . ." Although the reviewer felt that respondents might resist the implied certainty of their responses, this change in wording might reduce the upward bias.

The point estimate of consumer surplus for Crowder's Mountain is $125 per trip (1/−0.00798). This value compares favorably with Shaw and Jankus (1996) estimates of $70 to $90 ($82 to $105 adjusted to 2002 dollars) per trip for the Mohonk Preserve, NY, which is 65 miles from New York City. As displayed in Table 3, the total consumers' surplus for the *past trip data* is $1,179. In contrast, the *intended trip data* implies a annual consumer's surplus of $1,570.

TABLE 3
Observed Trips, Expected Trips, Consumer Surplus, and Regulatory Changes (n = 170)

	TRIPS	E[TRIP][a]	cs
	9.38	9.41	$1,179
Observed trips during past 12-months.	(8.94)[b]	(4.35)	
Intended trips during next 12-months.	12.49	12.53	$1,570
	(14.84)	(5.78)	
Proposed regulatory changes and trips during the next 12-months.			
R1—Reduced guided trips from five to a	13.11	13.15	$1,648
maximum of two.	(15.22)	(6.07)	
R2—Reduce maximum group size from 20 to 15.	13.05	13.09	$1,640
	(15.22)	(6.04)	
R3—Reduce maximum group size from 20 to 10.	13.34	13.38	$1,676
	(15.37)	(6.17)	
R4—Close Practice Wall to rock climbing.	10.62	10.64	$1,106
	(12.52)	(5.05)	
R5—Close David's Castle Wall to rock climbing.	10.08	10.08	$918
	(12.17)	(4.91)	
R6—Close Fortress Wall to rock climbing.	10.77	10.79	$1,155
	(13.06)	(5.09)	
R7—Close Middle Finger Wall to rock climbing.	10.66	10.68	$1,144
	(12.48)	(5.04)	
R8—Required to attend an annual orientation	12.46	12.50	$1,566
session on Leave No Trace and safe practices.	(15.17)	(5.77)	
R9—Reduce ecological impacts at climbing areas,	10.38	10.41	$1,304
but restrict area access.	(12.92)	(4.80)	
R10—Required two maintenance-days for every ten	12.08	12.12	$1,518
climbing-days.	(14.65)	(5.60)	

Notes. *E*[TRIPS] was the estimated trips and was estimated at the means of the independent variables. Consumer surplus (cs) was calculated as, *E*[TRIPS]/β0, for all response items with the exceptions of R4 through R7, which was *E*[TRIPS]/β0 + β5, *E*[TRIPS]/β0 + β6, *E*[TRIPS]/β0 + β7, and *E*[TRIPS]/β0 + β8, respectively.
[a]Paired *t* tests for differences between TRIPS and *E*[TRIPS] were not statistically significant.
[b]Standard deviations are in parentheses.

Applying the intended trip data for the next 12-months as the baseline comparison against which to measure the regulatory proposals, we observe increases in park benefits for proposals' R1 (reduce the party size of guided trips to two climbers), R2 (reduce maximum group size to 15), and R3 (reduce maximum group size to 10). We see little differences in the recreation benefits from requiring climbers to attend annual orientation sessions on safe practices and the Leave No Trace practices (R8) and the requirement of two maintenance-days for every ten climbing-days (R10). The proposed closures of the four climbing walls (R4 through R7) and the restrictions of area access to reduce ecological damage (R9) are expected to negatively impact participation. Estimates of the annual economic losses in benefits from restricting access are as follows: Practice Wall, −$464 (−29.6%), David's Castle Wall, −$652 (−41.5%), Fortress Wall, −$415 (−26.4%), Middle Finger Wall, −$426(−27.1%), and the broader proposal to restrict access for area recovery, −$266 (−16.9%).

Modeling On-site Choices of Climbing Areas

The rationing of access by closing rock climbing areas raises the question, How would climbers reallocate their climbs among the remaining open

TABLE 4
Climbing Areas and On-site Choice Modeling Results

	Routes (Kelly, 1995)				
Areas	Beginner (5.0-5.4)[a]	Intermediate (5.5-5.9)	Advanced (5.10-5.13)	Protection Bolts	Top-rope Anchors
Practice Wall	2	2	8	3	8
David's Castle Wall	1	6	10	19	0
Fortress Wall	1	1	3	1	8
Middle Finger	3	12	9	5	9
Red Wall	1	11	6	17	4
Resurgence	0	5	6	10	4
Hidden Wall	0	8	23	34	9
Climbing choice model					
Coefficients	1.47743*	−2.34650*	−0.16662*	0.14528*	−0.01902
Standard Errors	0.23331	0.03752	0.05534	0.04533	0.04109
Summary Statistics:					
Log likelihood = −576.75					
Log likelihood $\chi^2(5)$ = 158.03					
$p > \chi^2(5) = 0.000$					

Notes. Many of the 170 respondents reported climbing multiple areas at Crowder's Mountain State Park during their last visit. Consequently, the number of observations for discrete choice analysis was 2,359 (= 7 areas × 377 reported climbs).
[a]Yosemite Decimal System (5.0 through 5.13).
*$p < 0.00$.

areas? The survey data revealed those climbing areas that respondents chose when visiting Crowder's Mountain. When the data consists of such characteristics (z), as displayed in Table 4, a conditional logit model can be estimated by the analyst where a climber's choices of climbing areas is conditional on that climber first deciding to visit the site (Greene, 1993, p. 668). An appropriate on-site logit model for predicting the probability of a climber selecting one of the seven climbing areas ($j = 1, \ldots, 7$) at Crowder's Mountain is

$$\pi_j, \text{ and } \pi_j = \exp(\beta' z_j)/\Sigma_j \exp(\beta' z_j).$$

Table 4 provides the coefficients (β's) for the simple discrete-choice model that correspond to the area's characteristics. Overall the choice model is statistically significant (log-likelihood $\chi^2(5) = 158.03$, $p > \chi^2(5) = 0.000$).[7] All of the independent variables, with the exception of top-rope anchors, are significantly different from zero. The signs on the coefficients imply that the beginner routes and protection bolts contribute to the popularity of areas, while the choice frequency of intermediate and advance routes tend to decrease.

We have chosen to demonstrate the impact on climbing participation by alternating the hypothetical closures of rock climbing areas with the scenarios, R4 (Practice Wall), R5 (David's Castle Wall), R6 (Fortress Wall), and R7 (Middle Finger) (see Table 1). We did this by having the simulation distribute the total expected trips to Crowder's Mountain among the remaining alternate rock climbing areas with each area closure. Knowing there was 11,508 climbing trips to Crowder's Mountain during the past year (July, 2001-June, 2002) from the permits, we divided the 11,508 trips by the expected (mean) 9.41 trips demanded per climber (Table 3, Column 3, Row

[7] A stringent assumption of our conditional logit model is that the alternate areas have the property of independence of irrelevant alternatives (IIA). Simply, this assumption requires that the inclusion or exclusion of areas does not affect the relative probabilities associated with the area characteristics in the remaining areas. We iteratively estimated the climbing choice model using Stata statistical software (Version 7, Special Edition, 2001) and the module by Jeroen Weesie that implements the specification tests for multinomial logit models (Hausman & McFadden, 1984, pp. 1377-1398). Under the IIA assumption, we expect no systematic change in the coefficients, if we excluded one of the areas from the choice model. Performing a Hausman test against the fully efficient full model, we stated a null hypothesis (H_0: difference in coefficients not systematic), and displayed the Hausman's test for the IIA assumption below:

Areas	*Groups*	*Obs*	*Hausman*	$p > \chi^2(5)$
Hidden Wall	237	1422	0.68	0.9838
Red Wall	256	1536	0.73	0.9811
David's Castle	282	1692	0.73	0.9812
Practice	287	1722	0.73	0.9814
Middle Finger Wall	306	1836	0.72	0.9821
Resurgence Wall	327	1962	0.72	0.9819
Fortress Wall	327	1962	0.73	0.9815

On examining the output from the Hausman specification tests, we see that there is no evidence that the IIA assumptions has been violated.

2) during the past 12 months to arrive at an estimate of 1,227 climbers per year.[8] As mentioned previously, with the close proximity of climbers to Crowder's Mountain we assume that climbers would choose alternative climbing areas at the state park if denied access to their more frequently visited areas. Further, remember that the reduced demand for annual trips to Crowder's Mountain results from the fewer annual trips demanded by respondents with trip response modeling results of the hypothetical closures of climbing areas (Table 3). We simulate the distribution of climbing trips (r) to the remaining areas (j) for scenarios R4 through R7 as follows: $rj = E[\text{Trips}] * \pi j * k$. (Information from Table 3 is combined with the probabilities of the respondents' choices of climbing areas surrounded by parentheses in Table 5.)

Shown in Table 5, Column 2, are the distributive shares of intended annual climbing trips among the seven climbing areas with no area closures. The regulatory action to close the Practice Wall (R4) for a time-period is evaluated by removing the wall from the choice set. For example, the annual count of climbers is multiplied by the 10.64 trips demanded for the state park with the hypothetical closure of the Practice Wall (Table 3, column 3) multiplied by the on-site probabilities of climbers visiting the remaining areas (Table 5). Without the Practice Wall, climbers are distributed to the remaining climbing areas (see Table 5, Column 3).

TABLE 5

Distribution of Trips Due to the Hypothetical Closures of Climbing Areas and Choice Probabilities in Parentheses

Rock Climbing Area	No Climbing Area Closures	Rock Climbing Area Closures and the Estimated Distribution of Trip Shares.			
		Practice Wall	David's Castle Wall	Fortress Wall	Middle Finger
Practice Wall	4,117 (.31)	Closed	4,245 (.40)	4,158 (.36)	4,072 (.36)
David's Castle Wall	3,135 (.04)	3,814 (.33)	Closed	3,166 (.28)	3,100 (.27)
Fortress Wall	2,044 (.15)	2,487 (.22)	2,107 (.20)	Closed	2,021 (.18)
Middle Finger	1,918 (.14)	2,333 (.21)	1,977 (.19)	1,936 (.17)	Closed
Red Wall	1,309 (.10)	1,592 (.14)	1,349 (.13)	1,322 (.12)	1,294 (.11)
Resurgence	445 (.03)	537 (.05)	455 (.04)	446 (.04)	437 (.04)
Hidden Wall	382 (.29)	465 (.04)	394 (.04)	386 (.03)	378 (.03)

[8]A running total of the monthly number of climbers to Crowder's Mountain is computed and maintained by State Park personnel from self-registration permit information regarding the party sizes and the quantity of permits that climber are required to complete on every trip to Crowder's Mountain.

There are several possible limitations with this strategy. The discrete-choice model is not linked to the Poisson regression.[9] The annual quantity of trips demanded by climbers are for Crowder's Mountain and not for the climbing areas remaining open with the hypothetical closure of one of the areas. Next, the increases in shares of intended trips among the remaining open climbing areas may lead to a reduction in recreation benefits per climber. Although climbers demand fewer trips under area closures (R4 through R7), the distribution of expected trips to Crowder's Mountain among the remaining open areas may increase congestion thereby reducing climber benefits.

In summary, a key issue with the trip response method is the obvious fact that the direct observations of the resulting behavioral impacts of the regulatory changes are not present in the observed survey data. Assuming the results from this study are consistent with the validity and reliability findings of other studies, respondents' reactions to the regulations and subsequent regulatory actions are credible in this study. Like Grijalva et al. (2002) and given the evidence, we too are confident that respondents will adopt the stated changes in trip behavior and return to their same preference structures after the implementation of regulatory initiatives.

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[9]The structural choice analysis followed a random utility maximization model (RUM) implemented with McFadden's logit modeling routine in Stata (Version 7, 2002). See Parsons and Kealy (1995) for linking the number of trips to dispersed lakes in a random utility model with preference weighted measure of trip costs and site characteristics, or Hausman, Leonard, & McFadden (1995) for combining discrete choice and count data models following a two-stage budgeting process, or Siderelis and Gustke (2000) for linking on-site travel times and choice preferences with a single-site recreation demand model.

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