Articles

Travel Cost Models of the Demand for Rock Climbing

W. Douglass Shaw and Paul Jakus

In this paper we estimate the demand for rock climbing and calculate welfare measures for changing access to a number of climbs at a climbing area. In addition to the novel recreation application, we extend the travel cost methodology by combining the double hurdle count data model (DH) with a multinomial logit model of site-choice. The combined model allows us simultaneously to explain the decision to participate and to allocate trips among sites. The application is to climbers who visit one of the premiere rock-climbing areas in the northeastern United States and its important substitute sites. We also estimate a conventional welfare measure, which is the maximum WTP to avoid loss of access to the climbing site.

Mountain and rock climbing had an estimated 4.2 million participants in the United States in 1991, and it is estimated that 100,000 new climbers try some version of the sport each year (*Economist,* 1995). The rapid growth of climbing has led to proposed rules by the U.S. National Park Service and the Department of Interior that may affect climbing on federal lands. As stated in the Federal Register (58, June 14, 1993), "the increased impacts to park resources because of this activity suggest that regulations and guidelines need to be developed to protect park resources." Despite its growing popularity and the apparent need for new management strategies, there are no published estimates of the basic value of climbing, the impacts of site quality changes, or the proposed regulations on rock climbing. Previous research efforts have focused on why individuals become attracted to climbing or on the risk aspects of the sport. Except for the unpublished work by Ekstrand (1994), however, no research has been expressly devoted to *economic* modeling of the demand for rock climbing or mountaineering.

This paper serves to fill that void. After a description of rock climbing and our data, we present the three models used to estimate demand for rock climbing: a multiple site choice model, a trip frequency model for one site, and a combined multiple site choice/total seasonal trips frequency model. The final model represents an extension of current travel cost methods by combining the site choice model with a double hurdle count data model. We present all three models because of the need to explore differences in welfare estimates from each approach and because there has been little previous work to suggest the most appropriate type of empirical model. Next we present the empirical demand models and consumer surplus estimates; finally, we summarize the paper and offer suggestions for future research.

Background on Rock Climbing and the Data

The Sport of Rock Climbing

Rock climbing differs from "mountain" climbing in that the former most frequently involves climbing a rock cliff in good weather and does not involve negotiating ice and snow. Rock climbers are often interested in a shorter, extremely technical section of the cliff, and their goal of climbing this section in good form is quite different from the mountaineer's goal of reaching a summit. The sport is sometimes construed by the general public as a hazardous activity, but climbers can exercise

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some control over the risks they personally assume by using the proper equipment and judgement (Jakus and Shaw 1996).

Technical rock climbing on smaller cliffs or ''crags'' involves the choice of specific routes up the rockface, where routes differ in the degree of difficulty, length, and hazard. Falling is a part of the sport for most climbers, but equipment is used to protect the climber from hitting the ground or the side of the cliff after falling. This equipment varies from metal devices placed permanently in the rock (such as a bolt or piton), to devices that can be temporarily inserted into cracks and fissures and removed as the climbers advance upward (called chockstones or nuts). (Recently there has been a growing distinction between climbing areas that primarily offer permanent bolted protection and those that primarily offer temporary protection, requiring the climber to place nuts and chockstones. Areas that offer mostly temporary protection are called ''traditional'' areas, while areas with permanent protection are called ''sport climbing'' areas.) As the ''leader'' climbs, using only the features of the rock, the rope is threaded through these devices. Because the second climber is holding (belaying) the rope from below, the devices act as potential pivot points in the event of a fall. The climbing equipment is used only to protect against the consequences of a leader's fall that would otherwise result in injury. After belaying the leader, the second advances upward, but he or she is well protected by the rope above.

Climbing routes are subjectively rated according to technical (gymnastic) difficulty and risk. Ratings are published in readily available guidebooks (for popular areas) or spread by word of mouth (for less popular areas). Guidebooks note the location and length of a route, its technical difficulty, and whether the climb can be well protected or not (the hazard scale).[1] Many guidebooks feature ''maps'' of the specific route, showing rock features and permanent protection points.

The Data

Relative to other recreationists such as hunters and anglers, it is very difficult to collect data on climbers. An intercept survey method raises objections about whether those intercepted at the site are representative of the general population of climbers (Shaw 1988). A sample drawn from the general population would be extremely costly because most households contain no climbers. As an alternative, one can find known groups of climbers such as members of established climbing clubs or subgroups of large environmental and outdoor groups.

Our data were collected using a survey of members of the Mohonk Preserve (MP) in New York State. The preserve is New York State's largest nonprofit nature preserve and is about sixty-five miles from the New York City metropolitan area. The MP receives a large number of visitors, particularly on good weather weekend days. Visitors can become annual members of the MP (a nonprofit organization) by paying an annual fee entitling them to free entry for the year, or they may forgo membership and purchase a daily entry pass. Not every preserve visitor is a climber (many hike, view nature, bike, and do other outdoor activities), but the MP is an international climbing destination and is arguably the most important climbing area in the northeastern United States. (The land containing the climbing cliffs at the preserve is also known as the ''Gunks,'' frequently featured or mentioned in articles on climbing, even in the *Economist*.) Among national climbing areas, it is somewhat unusual in that it offers virtually no bolted climbing.

The MP staff initiated and conducted the survey to elicit management preferences. The survey questionnaire was sent once by mail by preserve staff in an envelope along with the preserve's Fall 1993 newsletter to approximately twenty-five hundred members. The survey budget did not allow follow-up methods, as suggested by many. Because of controversial management policies relating to congestion, access, and conflicts between different users, direct WTP questions were excluded from the questionnaire. Eight hundred and ninety two usable surveys were obtained, yielding an approximate response rate of 36%.

Of members returning the survey, 220 said they used MP primarily to climb. Data were collected from this group of climbers. Information included the number of trips taken to the preserve in 1993, as well as the total number of trips taken to important substitute climbing areas. Usable trip and travel cost data were obtained from 183 respondents. We do not have complete information on each specific trip that each of these 183 climbers took in 1993, and several self-described climbers did not take a climbing trip to any destination in 1993. (In our final estimating sample, almost 10% of the climbers took zero climbing trips in 1993.)

[1] For more on the hazard scale see Jakus and Shaw (1996). The difficulty scale in the United States runs from the easiest technical climb (5.0) to the most difficult (5.14). The technical rating is akin to the difficulty rating assigned to dives in diving competitions. Rating reported in a guidebook are a combination of ratings by experts and feedback on routes from other climbers.

In modeling demand for climbing, we recognize the potential bias in using just a sample of members.[2] There is no way to know how our sample differs from the general climbing population because no data have ever been collected for the latter group. We can, however, compare our mail survey respondent characteristics with those of a separate on-site sample conducted in Fall 1993, which unfortunately does not contain information on the individual's residence location. The mail (members only) sample climbers have incomes, age, and climbing expenditures similar to those of the on-site (nonmember) climbers. Members and nonmembers also visited other northeastern climbing areas in similar patterns. On average, members visited MP more often than nonmembers (seventeen trips versus five trips), and there is a higher proportion of males among the members. Although we do not infer that our sample is representative of *all* rock climbers in United States, we believe the sample could be representative of climbers in the northeast.

Measuring Site Characteristics

Site characteristics are important in modeling the demand for recreational area, but existing travel cost literature does little to aid us in selecting an appropriate site characteristic for rock climbing areas, and we must draw on our own experience for selection. (The authors are both climbers, each with over fifteen years of experience.) We hypothesize that an appropriate characteristic is the number of routes available to the climber, where the limiting factor is the individual's technical ability. Technical ability dictates the hardest route level that can be climbed; climbing any harder than one's ability may result in frustrating failure or bodily harm. While climbers do sometimes attempt routes harder than current technical ability as a means to improve, they most often choose those near their current limit. Climbers also do not generally seek out routes well beneath their ability because these offer little in the way of a physical or mental challenge. Thus, if a climber can lead 5.10 routes and there are 200 such routes at area A, then that is the site characteristic of interest when choosing among sites. Our site characteristic is similar to the ability-specific characteristic Morey (1985) constructs for skiers and ski area choice and, like Morey, we assume ability is exogenously determined, being based on long-run acquired skill through experience, practice, and a climber's natural physical gifts.

The Models and Consumer's Surplus

Our data permit several variants of the travel cost model to be estimated, particularly the random utility (RUM) and count data models (see Bockstael, McConnell, and Strand 1991 for a recent review of recreation demand models). Both the RUM and count data models have limitations. For example, the conventional multinomial logit (MNL) model cannot easily be used to estimate the total number of trips an individual takes in a season and therefore leads to difficulties in estimating a seasonal or annual welfare measure.[3] In contrast, the count data approach handles seasonal demand for a single recreation site but cannot easily be used to examine decisions to allocate among two or more sites simultaneously (Shonkwiler 1995). In addition, the single-site count data model is not as rich as the RUM in how it incorporates site substitution because of difficulties in correctly specifying the model with cross price terms in a way that is consistent with utility maximization. This in turn has implications for welfare measures.

Many recent efforts theoretically or econometrically link the total number of trips an individual takes in the recreation season to the choice of a recreation destination on any given trip (Yen and Adamowicz 1994; Hausman, Leonard, and McFadden 1995; Feather, Hellerstein, and Tomasi 1995; Parsons and Kealy 1995). Such models rely on mixing a RUM with a trip frequency model to neatly obtain seasonal, rather than per-trip, welfare measures. These models also allow the individual to adjust total trips taken during the season in response to site quality changes rather than assuming the individual's total trips stay constant, thus restricting possible reallocations of the constant total trips to the various destinations only. The site choice model demands are conditional on the total trips taken, but the latter can be jointly estimated with the former.

Because our application involves a rapidly growing recreational activity demanding new management strategies, we have chosen to employ

[2] Additional bias introduced by failure to return any questionnaire or to provide complete responses to one or more questions is also possible. This bias can be corrected for using an independent source of data such as census data for zipcode origins (Cameron et al. 1996); however, we do not have access to the zipcodes for those who did not return the survey.

[3] By making several strong assumptions, versions of the "repeated" logit or nested logit models do allow exploration of the participation decision and allow derivation of seasonal welfare measures (see for example, Morey, Shaw, and Rowe 1991).

three models that highlight different dimensions of the demand for climbing and are suitable to meet different policy objectives.

The Multinomial Logit (MNL) Site Choice Model

The data reveal how often climbers went to the four most important sites throughout the northeastern United States, so a site choice model can be estimated. In addition to the preserve, the three other climbing areas are Ragged Mountain (RM) in Connecticut, the Adirondacks (A) in upstate New York, and the White Mountains around Conway, New Hampshire.[4] RM differs from the other three in that it offers only short climbs, virtually all of which may be climbed by first taking a trail to the top and then hanging a rope down the cliff (a practice known as "top-roping").

If the usual assumptions about the distribution of the error vector are made, an MNL model can be estimated via the log likelihood function:

$$\ln \mathcal{L} = \sum_{j=1} y_j \ln \pi_j \tag{1}$$

where y_j is the number of trips to site j and the probability of visiting site j is π_j, or:

$$\pi_j = \frac{\exp(X_j\beta)}{\sum_{k=1} \exp(X_k\beta)}. \tag{2}$$

Here $\mathbf{X_j}$ is a vector of explanatory variables that explain site allocation, which can also vary for the individual (i), and $\boldsymbol{\beta}$ is the corresponding vector of parameters. Per trip consumer's surplus (CS) measures can be calculated for the MNL model, and are the exact compensating and equivalent variation, as shown in Hanemann (1982). However, the simple multinomial logit model produces a CV equivalent to the EV, as in the standard MNL there are no income effects, and does not allow calculation of seasonal compensating or equivalent variation measures without imposing strong behavioral assumptions and using the resulting per trip CS.

Modeling Annual Climbing Trips: Count Data Approaches

The trip-taking data are also well suited for one or more variations of the count model. Count data travel cost models are increasingly popular (e.g., Hellerstein 1992; Creel and Loomis 1990). They can be used to estimate seasonal demand for one site, or total seasonal demand across a group of sites. The frequency of the climber's total trips (y) to the MP can be modeled using the basic Poisson model distribution with location parameter $\boldsymbol{\lambda}$. $\boldsymbol{\lambda}$ can be parameterized as:

$$\lambda = \exp(w'\tau) \tag{3}$$

where the vector of variables in $\mathbf{w}$ explain the frequency of total trips taken to the MP, and $\boldsymbol{\tau}$ is the corresponding vector of parameters.

There are many variations on the basic Poisson model. For our purposes, the most important deal with excess zeros (Greene 1994) and, related to the problem of excess zeros, the participation decision (i.e., the decision to enter the market at all). Because our sample of members includes many who do not take a climbing trip to the preserve, we use a hurdle model, which helps explain the participation decision.

A Double Hurdle Count Data Model. A hurdle mechanism can be introduced to explain the decision to enter the market (in our case, whether to climb during 1993). The discrete choice double hurdle (DH) Poisson model (as laid out by Shonkwiler and Shaw 1996) allows for two kinds of zero values for the dependent variable, or two types of individuals for whom $y = 0$. Some climbers do not climb anywhere and do not get over the first hurdle. Others do climb elsewhere (they are in the market) but for some reason optimally choose not to climb at a specific site like the preserve. These climbers do not get over the second hurdle. The DH model is consistent with the zero modified Poisson (ZMP) discussed in Johnson and Kotz 1969 (this point is noted in Haab and McConnell 1996) and is essentially the same as the "zero altered Poisson" (ZAP) discussed by Greene (1994). The model is *not* the same as the single hurdle model; moreover, neither Johnson and Kotz nor Greene explains these models as "double" hurdles (Shonkwiler and Shaw 1996).

Define D_i to be equal to the latent decision to consume trips (desired trips are equal to y^*). If consumption is positive, then observed consumption equals desired consumption, or $y_i = y^*_i$, and $E(y^*_i) = \boldsymbol{\lambda}$, as defined in equation (3). If we adopt a discrete distribution for D_i (one certainly could adopt a continuous distribution, if the data-generating mechanism warrants this), then $\text{Prob}(D_i = 0) = \exp(-\boldsymbol{\Theta})$, and $\boldsymbol{\Theta}$ can be parameterized as:

$$E(D_i) = \theta_i = \exp(z_i'\gamma) \tag{4}$$

[4] Another important climbing area in the northeast is located near Bar Harbor, Maine, but it is so distant from any major population center (except perhaps Boston) that it is not as important as a major destination site.

where the vector of variables that explain participation (go or not) is **z**, and γ is an unknown vector of parameters. The variables in *z* describe personal or demographic characteristics (these may or may not include variables in the vector *w*, which explain trip frequency).

With two hurdles, the outcome of no consumption (nonparticipation) can be observed for two reasons: the desired consumption is nonpositive or, if it is positive, an additional hurdle (*D* less than or equal to zero) still can prevent participation. If the two hurdles are independent of one another, the Poisson likelihood function for the double hurdle (suppressing the individual subscript *i*) is:

$$(5) \quad \mathcal{L} = \prod_{y=0} [\exp(-\lambda) + (1 - \exp(-\lambda)) \exp(-\theta)] \cdot \prod_{y>0} (1 - \exp(-\theta)) \exp(-\lambda) \frac{\lambda^y}{y!}.$$

The log likelihood for (5) will be assured of being well behaved because the parameterization of $\boldsymbol{\Theta}$ assures us that $\exp(-\boldsymbol{\Theta})$ will lie between zero and one.

The CS measure from the DH count data model reveals the approximate WTP for a trip to a site rather than lose access to it (Shonkwiler and Shaw 1996). However, if a site characteristic of interest does not significantly explain the hurdle portion of the model, then the value of a characteristic change cannot be isolated. Because the site characteristic likely affects the frequency of visits to the site more than the decision to go at all (the participation hurdle), the DH welfare measure is not likely to be relevant in estimating welfare measures for changes in characteristics.

A Joint Multinomial Logit–Double Hurdle Poisson Model

RUMs are rarely used to model the demand for trips across all sites for an entire season as they assume that trips to a site are conditional on seasonal trips having been allocated outside of the model. Following the expanding empirical literature (including Terza and Wilson 1990, Yen and Adamowicz 1994, and Hausman, Leonard, and McFadden 1995), we combine and jointly estimate the multinomial logit (MNL) four-site choice model and a count data model for total seasonal trips to four important climbing sites. We know of one other study that independently develops the likelihood function for the double hurdle (DH) combined with the MNL as we do here (see Feather and Hellerstein 1995), but that study focuses on issues quite different from ours. We first develop probabilities of visiting site *j*, conditioned on participation. Assuming the multinomial distribution for the probabilities of visiting site *j* to be conditional on total seasonal trips (t), we have:

$$(6) \qquad P(y_1 y_2, \ldots, y_J | t) = t! \prod_{j=1}^{J} \pi_j^{y_j} \Big/ \prod_{j=1}^{J} y_j!$$

where $t = \Sigma y_j$. If we also assume that the $\boldsymbol{\pi}_j$ stem from a random utility model where the error term follows the extreme value distribution, these conditional probabilities can be specified and estimated using the multinomial logit model, as above. Note that equation (6) expresses these MNL probabilities conditional on t, and t can be equal to 0. Put simply, if $t = 0$, then the actual probability that individual i takes a trip to site j is 0, but the MNL will produce predicted nonzero probabilities based on site characteristics and travel costs. Further, if actual trips are zero to any given site, this is taken into consideration in the link to the total demand model (see the discussion of the aggregate price index below).

Though earlier we introduced the double hurdle Poisson form to handle the demand for trips to one site, we can also use this form to model the demand for total trips across all sites the individuals visits, or in our case a subset of four important sites. Thus we have

$$(7) \qquad E(t_i | t_i > 0) = \frac{\lambda_i}{1 - e^{-\lambda_i}} \quad \text{and} \quad E(t_i) = \lambda_i(1 - e^{-\theta_i}).$$

This total trip demand equation is similar to the total trip equation used by Hausman, Leonard, and McFadden (1995), though they use panel data and do not use any hurdle. Combining equation (6) with the double hurdle Poisson leads to the following joint frequency outcome, denoted MNL-DH (adopting the notation from equations above):

$$(8) \qquad g(y_1, y_2, \ldots, y_J) = \exp(-\lambda) + (1 - \exp(-\lambda))\exp(-\theta) \text{ for } t = 0$$

and for positive seasonal trips, $t > 0$,

$$(9) \qquad = \frac{(1 - \exp(-\theta))\exp(-\lambda)\lambda^t \prod_{j=1} \pi_j^{y_j}}{\prod_{j=1} y_j!}.$$

Define $d = 1$ for those who take no trips to the sites during the season ($t = 0$) and $d = 0$ for those who do ($t > 0$). The joint frequency distribution in equations (8) and (9) leads to the log likelihood function:

where (10) represents that (8) and (9) are estimated simultaneously. Obtaining the total consumer's surplus in the joint MNL-count data model using the total trip demand equation [see the equations in (7)] is consistent with two-stage budgeting (Hausman, Leonard, and McFadden 1995). The CS is theoretically the integral under the total trip demand function and Yen and Adamowicz (1994) suggest estimating the total consumer's surplus using two steps.

$$(10)\quad \mathcal{L} = (d)\sum_{0} [\ln\{\exp(-w'\tau) + (1 - \exp(-w'\tau)\exp(-\exp(z'\delta))\}] + (1 - d)\sum_{+} [\ln(1 - \exp(-z'\delta)) - w'\tau + w'\tau\sum_{j}^{J} y_j + \sum_{j}^{J} y_j \ln(\pi_j) - \sum_{j}^{J} \ln(y_j!)]$$

Empirical Application and Results

Specification and Parameter Estimates

Site Choice Model. For the simple MNL model we assume that the explanatory variables include the site's implicit price (travel costs) and the site characteristic. A site-specific intercept term for Ragged Mountain is also included because, as noted previously, this site is different from the other three. Table 1, provides the results of this simple model.

Table 1. Results of Mutinomial Logit Estimation[a]

Variable Definition	Parameter Estimate (asymptotic standard errors)
Site-specific constant term for Ragged Mountain	−0.436 (0.023)**
Implicit price divided by 100	−1.30 (0.048)**
Number of climbs in the climber's ability range divided by 100	0.274 (0.046)**
Log likelihood at convergence	−2472

NOTE: N = 183 climbers.
[a]Estimates obtained using Gauss statistical package.
**Significant at the 5% level.

Overall results are reasonable—a modified R^2 for the model is approximately .53—and each variable is significantly different from zero. Because utility is linear in the explanatory variables, the sign can be easily interpreted, and we note that the number of climbs at the maximum level of the climber has a positive influence on site choice.

Double Hurdle Model. For the double hurdle model of trips to one site, the Mohonk Preserve, we partition the variables into those that explain the frequency and the participation decisions. We assume that the frequency of climbing trips is a function of the site price and the site characteristic. Table 2 provides basic results of the Poisson count with the double hurdle model. A modified R^2 shows that the model explains about 31% of the variation in total trips. As can be seen in the frequency portion of the table, the price term is negative and significantly different from zero while the characteristic is positive and significant. The constant term captures some systematic positive effect.

The survey was not designed to address specifically the decision to take at least one climbing trip, so there were few variables from which to

Table 2. Double Hurdle Count Data Model of Trips to Mohonk Preserve[a]

Variable	Parameter Estimate (standard errors)
Participation hurdle	
Ability (leading level)	0.282 (0.077)***
Importance of environmental education	0.181 (0.084)**
Frequency: positive trips portion	
Constant term	0.066 (0.006)***
Implicit travel price to MP divided by 100	−0.358 (0.046)***
Number of climbs in the climber's ability range divided by 100	1.11 (0.018)***
Log likelihood at convergence	−2103.7

NOTE: N = 183.
[a]Estimates obtained using Gauss statistical package.
**Significant at the 5% level. ***Significant at the 1% level.

choose for the participation hurdle. (Shonkwiler and Shaw 1996 suggest several possible variables on which to solicit information in a survey questionnaire that may help to explain the decision to stay home for the season.) The variables included in the participation hurdle portion are limited to leading ability and a taste variable indicating the importance of the preserve's environmental education programs that influence the decisions to become a member (an integer from 1 = most important through 5 = least important). Our hypothesis is that, all else equal, climbers who can lead harder climbs are more likely to go climbing at least once, and so are those who do not focus on environmental education. The variable has the expected influence in the empirical model.

Joint Model. Results from the joint multinomial-Poisson model of trips to four important sites are presented in table 3, estimated using full-information maximum likelihood (FIML). The site choice model is specified identically to the MNL model above. The double hurdle specification is also similar to the simple single-site double hurdle model above, with one key difference. For the joint model, we must develop a price index for all trips to the four sites under consideration (this is one of the variables that explain total trip demand and are in the vector w which explains trip frequency). Following Bockstael, Hanemann, and Strand (1984) and more recently Hausman, Leonard, and McFadden (1995) and others, the price index is the inclusive value from the MNL. The sign of the index parameter, unlike that of a conventional price term, is expected to be positive in the combined model.[5] This is because the index is a preference weighted measure of costs and site characteristics (we note that Parsons and Kealy 1995 and Feather, Hellerstein, and Tomasi 1995 derive a different index theoretically, splitting the site travel cost and characteristics effects). In our model it is important in the frequency, rather than the participation portion, of the double hurdle model. Because most previous authors have only one portion of the count data model, this differentiation does not occur.

In the joint model the site choice results are quite robust and parameters have the expected signs. The double hurdle portion of the model, as in the single-site model, is more problematic, but the price index has the expected positive sign. Greater technical ability leads to more annual trips, which is a nice intuitive result. The specification for the participation hurdle was somewhat problematic, as the survey was not designed to elicit variables to explain this, and we were able only to specify this portion using a constant term and an environmental importance variable. The latter has the expected sign, indicating that the less important the role of environmental education in becoming a member, the more likely the person will take a climbing trip (our reasoning stems from the converse: if environmental education is very important, this can be a reason for being a member that is independent of actual visitation).

Table 3. Results of Joint Multinomial–Poisson/DH Model for All Trips to Four Climbing Sites[a]

Variables	Parameter Estimate (standard error)
Double hurdle model	
Participation part of model	
Constant	0.596 (0.337)*
Importance of environmental education	0.398 (0.232)*
Trip frequency part of model	
Constant	1.87 (0.233)***
Ability	0.373 (0.083)***
Inclusive value	0.337 (0.154)**
Multinomial logit model	
Site-specific constant term for Ragged Mountain	−3.61 (0.431)***
Implicit price divided by 100	−1.42 (0.166)***
Number of climbs in the climber's ability range divided by 100	0.549 (0.124)***
Log likelihood at convergence	−2404

NOTE: N = 183.
[a]Estimates obtained using FIML program in Gauss.
*Significant at the 10% level. **Significant at the 5% level. ***Significant at 1% level.

Estimates of Consumer Surplus

The focus in this section is on welfare estimates for climbing at the preserve. While conventional CS measures for access to the MP can be estimated, the more policy-relevant questions are associated with changing the number of available climbs at the preserve. For example, climbing routes at the Sky Top area are off limits to preserve climbers during at least part of the season. These climbs are not actually on preserve grounds and are the property of the Mohonk Hotel, so access to these climbs may become at risk of being lost at some future time if the hotel decides to prohibit it. The seasonal cliff closure at Sky Top is similar to seasonal closures at many other U.S. climbing areas

[5] Hausman, Leonard, and McFadden (1995), the inclusive value term is positive in three of their four specifications, but they obtain the "wrong sign" in one. More discussion of the index can be found in Bockstael, McConnell, and Strand (1984), Yen and Adamowicz (1994), and Terza and Wilson (1990).

during times when birds of prey nest on cliffsides. Another reason to be interested in the number of available climbs stems from proposed regulations on climbing. The number of climbs at a given area can be increased by permanently bolting new routes. In the United States, federal guidelines banning the use of bolts in national parks and recreation areas under the jurisdiction of the Department of Interior are interpreted to exist already (Code Fed. Reg. 36, § 1,2), and new guidelines have been proposed. Movements to legislate stricter regulations could result in noticeable effects on climbing on federal lands.

It is impossible to do an exact simulation of route access restrictions at Sky Top but, because these routes are included in the site characteristic measure used in the demand models, the loss can be approximated using a percentage decrease in the number of routes available at the MP. The MNL model yields a per-trip estimate of welfare losses while the joint MNL-DHP model yields a seasonal estimate. Estimates for two reductions and two increases (10% and 50%) in the site characteristic appear in table 4. The reported MNL estimates are the exact CS measures, the compensating variations (CV). These CVs are very small (pennies per trip), and the averages for the sample should not be interpreted as being any different for the increase and decrease.

Table 4. Consumer's Surplus Estimates for Reductions and Increases in Available Climbs at Mohonk Preserve

	Estimation Method	
	Multinomial Logit (Site Choice Model Only)[a]	Joint Site Choice and DH Trip Number Model[b]
Per trip CV		
10% decrease, mean	$0.02	
Maximum, minimum	$0.04, $0.002	
50% decrease, mean	$0.10	
Maximum, minimum	$0.18, $0.01	
10% increase, mean	$0.02	
Maximum, minimum	$0.04, $0.002	
50% increase, mean	$0.11	
Maximum, minimum	$0.21, $0.01	
Annual/seasonal CS		
10% decrease, mean		$1.76
Maximum, minimum		$3.52, $0.00
50% decrease, mean		$7.85
Maximum, minimum		$16.00, $0.001
50% increase, mean		$10.35
Maximum, minimum		$20.33, $0.02

[a]CV is the multinomial logit "per trip" compensating variation.
[b]Seasonal E[CS] is averaged across the sample of 183 members for the increase and decrease in all available climbs at the Mohonk Preserve at a leader's ability level.

The seasonal measure from the joint model yields an individual maximum of a $16.00 loss for a huge (the 50%) decrease in the preserve's climbs, with a sample average of only $7.85.[6] In both route reduction scenarios, however, climbers still have, in total, more than three hundred routes available at the MP and all routes at the three substitute sites. Thus, our evidence suggests that cliff closures and bolt bans do not result in large welfare losses for members when a large set of substitutes is available.

Finally, it is useful to compare the per-trip benefits for rock climbing with other benefit estimates for sports such as recreational fishing, hiking, skiing, etc. Our comparable "per-trip" estimates are from the single-site Poisson/double hurdle model. Using the double hurdle model, we obtain benefit estimates in the range of $70 to $90 per trip, with the average CV being about $80. While we recognize that discussion of per trip measures should be treated carefully (Morey 1994), the estimate of WTP per-trip is in the range of "per-choice occasion" or "per-trip or per-day" estimates of WTP for special recreation, such as fishing for salmon in Alaska.

Only one other recreational rock-climbing study provides results with which ours can be compared. Though his is a mail survey, Ekstrand (1994) originally intercepted climbers for his sample at Eldorado Canyon State Park, an internationally known climbing area near Boulder, Colorado. Using four different versions of the travel cost model (he estimates OLS, truncated OLS, Poisson, and negative binomial models), CS was between $39.51 and $48.73 per trip. These estimates were made assuming CS reflects the average climber who is taking only one-day trips. Ekstrand also estimated CS using the contingent valuation questions posing current and future simulated conditions. For his current conditions, the CVM approach yields between roughly $11 and $26 per day, depending on whether the WTP obtained from the CVM is adjusted for the opportunity cost of travel time. Because his survey was conducted in 1991, we assume that the CS estimates are in 1991 dollars. Our single-site DH CS estimates (in 1993 dollars) are higher than Ekstrand's using any of his methods. As our sample consists of members of the preserve

[6] Again, the seasonal measure looks a small amount larger on average for the increase than for the decrease, but this difference is mostly the result of the transmission of the per trip CVs to full seasonal CS measures in the process of deriving the latter (see Yen and Adamowicz (1994).

and Ekstrand's is an on-site sample with no adjustment for on-site sample bias, neither may be representative of some climbing population at large.[7]

Summary and Conclusions

This paper provides the only estimates of a model of the demand for rock climbers other than the unpublished study by Ekstrand (1994). The travel cost methodology has been extended to allow for a double hurdle participation mechanism and for allocation of trips among many sites. We have provided the first estimates of consumers surplus associated with seasonal cliff closures at climbing areas. Except for our conventional measure of annual WTP, welfare effects of various policy scenarios are small. Because of the nature of our sample (many substitute sites, but all offering only traditional climbing) it should *not* be inferred that the general population of climbers is willing to pay only a small amount to prevent loss of existing climbs or to bring about bolting of new climbs. The magnitude of welfare losses is probably a function of available substitutes and the particular sample used in estimating the models, so more regional studies should be conducted. Until these areas are studied, however, this study contains the only available estimates of the benefits of site quality changes to rock climbers.

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[7] We caution against too much reliance on Ekstrand's Travel Cost Method estimates, however, because the travel cost functions include total days climbed in a season as right-hand side explanatory variables, but apparently no attempt was made to explore possible consequences of endogeneity.

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