The Welfare Effects of Restricting Off-Highway Vehicle Access to Public Lands

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Off-highway vehicle (OHV) use is a rapidly growing outdoor activity that results in a host of environmental and management problems. Federal agencies have been directed to develop travel management plans to improve recreation experiences, reduce social conflicts, and diminish environmental impacts of OHVs. We examine the effect of land access restrictions on the welfare of OHV enthusiasts in Utah using Murdock's unobserved heterogeneity random utility model (Murdock 2006). Our models indicate that changing access to public lands from fully "open" to "limited" results in relatively small welfare losses, but that prohibiting access results in much larger welfare losses.

Key Words: off-highway vehicles, recreational access, unobserved heterogeneity, random utility model

The use of off-highway vehicles (OHVs) is one of the most rapidly growing outdoor activities in the United States and in Utah.[1] Nationally, participation by residents aged 16 years and older has grown from 17 percent in 1999 to just under 20 percent in 2007 (Cordell et al. 2008). This means that some 44 million people engaged in OHV recreation in 2007. The Mountain West states as a group (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming) have an OHV participation rate of 28 percent, well above the national average. Indeed, Wyoming, Idaho, and Utah all rank in the top five states based on OHV participation. This popularity is reflected in the sharp growth of OHV registrations, with vehicle registrations in the state of Utah growing 233 percent during the 1998-2006 period (Burr et al. 2008).

Concomitant with the growth in OHV participation has been a host of management problems for stewards of public land. In 2003, then U.S. Forest Service Chief Dale Bosworth declared that "unmanaged recreation," of which OHV use is an important component, was one of the top four threats facing national forests (Bosworth 2003). Chavez and Knap (2004) outline the reasons why unmanaged recreation by OHV users was declared an ecological threat: OHVs can result in unplanned roads, soil erosion, degradation of water quality, destruction of habitat, the spread of invasive species, and conflict with nonmotorized users, among other problems. Opponents of OHV use also emphasize safety problems and user conflicts between motorized and nonmotorized visitors (Havlick 2002). Proponents argue for the social and psychological benefits of the activity, and the economic benefits for recreationists and local communities (Blahna 2007).

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[1] Off-highway vehicles are defined as four-wheel drive vehicles, motorcycles, all-terrain vehicles (ATVs), and other specially designed vehicles such as dune buggies and sandrails. We do not include snowmobiles in this definition, nor in any of the statistics reported in the study.

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In response to the increasing demand and the potential problems posed by unmanaged recreation, federal agencies have been directed to develop travel management plans as part of an agency's planning process (Stern et al. 2009). The purpose is to improve recreation experiences and reduce social conflicts and environmental impacts by designating specific roads, trails, and areas that are open to motorized uses. In general, land management agencies such as the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM) are moving away from current policies that generally allow OHV access to both roadways and cross-country travel, with only a few areas where access is prohibited, to proposed policies that have tighter restrictions on cross-country travel and that designate larger amounts of land where OHV access is strictly prohibited (see, for example, USDI BLM 2001, USDA Forest Service 2005). Many OHV users object strenously to more restricted access to public lands, and frequently local officials suggest that reduced OHV use will result in significant reductions in local economic activity. In contrast, many environmental groups indicate that these restrictions are insufficient to prevent damage.

Relatively few studies have estimated an economic value for OHV recreation, and none have been estimated for Utah. Further, in 2008, six BLM Field Offices in Utah completed and released for public comment new Resource Management Plans (RMPs) under which OHV access to BLM lands was affected. In general, the amount of BLM land classified as "open" to trail and cross-country use was decreased, while the amount of BLM land on which OHV use was limited or prohibited was increased. This study estimates the welfare implications of proposed access restrictions to federally owned land in Utah.[2] Using a sample of OHV owners in Utah who have registered their vehicles, a travel cost model is developed to link access to public lands to locations where OHV owners choose to recreate. Our statistical models are constructed at the county level, but defining sites in this manner raises concerns about unobserved heterogeneity across sites, so we use Murdock's recent variant of the random utility model to adjust for this problem (Murdock 2006). Our models indicate that changing access to public lands from fully "open" to "limited" or "closed" has negative welfare impacts on OHV enthusiasts.

Past Studies

While a few authors have estimated the economic value of off-highway recreation (see Bowker, Miles, and Randall 1997, Loomis 2006, Englin, Holmes, and Niell 2006, and Silberman and Andereck 2006), only one other study has tackled the issue of restricted access to public lands (Deisenroth, Loomis, and Bond 2009). Given the rapid growth of OHV recreation, it is perhaps surprising to find so few studies measuring the economic value of OHV use. Bowker, Miles, and Randall (1997) examined OHV use in Florida; their negative binomial travel cost models found per-trip economic values between $13 and $66. Silberman and Andereck (2006) used an open-ended contingent valuation question to estimate the economic value of OHV recreation in Arizona. They found enthusiasts' willingness to pay (WTP) to be about $54 to $96 per trip, depending upon the type of off-highway vehicle used. Loomis (2006) used the travel cost method to value recreation in a remote region of northwestern Colorado, finding a consumer surplus estimate of $29 per day trip. Englin, Holmes, and Niell (2006) use a demand systems approach to measure the economic value of OHV recreation at four sites in North Carolina. The authors utilized two different assumptions regarding the statistical distribution of the model and two assumptions regarding the appropriate restrictions implied by economic theory, for a total of four different demand models. The authors argue that the data suggest the negative binomial distributional model is appropriate; the estimated compensating variation for the least restrictive model ranged from $27 per trip for the least valued site to $131 per trip for the highest valued site. The more restrictive model yielded per-trip welfare estimates ranging from $587 to $996, depending on the site visited.

To our knowledge, Deisenroth, Loomis, and Bond (2009) provide the only study that tries to

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[2] Only one other study (Deisenroth, Loomis, and Bond 2009) has attempted to estimate the welfare effects of changing access conditions, but that study simply eliminated trail use and allowed no substitution to alternative sites.

address the problem of access restrictions. Using an intercept survey of OHV users at three sites in Larimer County, Colorado, the authors use a contingent valuation approach to estimate a per day trip WTP of $78. The payment vehicle for the CVM question was an increase in travel costs for that day's trip. The authors use this estimate to calculate a consumer surplus estimate for each of the three OHV trails studied, stating that this allows them to make "educated policy decisions" regarding trail closures. However, the approach used does not directly measure the impacts of trail closures. The authors' analyses imply that travel costs are high enough to prevent visits to any site, but do not allow substitution by OHV users to closer, less expensive sites. This implies that welfare losses of trail closures are over-estimated.

Methods

Sampling

A randomly selected group of OHV owners in the state of Utah was sampled from a list of registered owners maintained by the state (Burr et al. 2008). Some 181,500 vehicles were registered during the spring of 2007. Eliminating duplicate names (many people own more than one vehicle) yielded a population of about 113,700 OHV owners, from which some 1,500 names and addresses were drawn for participation in the mail survey. The survey materials (cover letter, survey, and state map) were designed in consultation with representatives of the Utah Governor's Public Lands Policy Coordination Office and Utah State University's Institute for Outdoor Recreation and Tourism, which had conducted a number of OHV surveys in the past. Burr et al. (2008) provides details of the survey on which this study is based, whereas Fisher, Blahna, and Bahr (2001) provide details of the surveys conducted in 2000 and 1994.

The initial mailing date was June 2007, with all survey activities completed by August 2007. Eighty-four surveys were classified as undeliverable. Following Dillman (2000), five attempts were made to elicit a response: the initial mailing of the survey, a reminder postcard, a second full survey mailing, a second reminder postcard and, finally, a third mailed survey. Of the 1,416 "deliverable" addresses, responses were received from 600 for a response rate of 42.4 percent.[3] The representativeness of the sample can be evaluated by comparing our statistics to those yielded by the National Survey of Recreation and Environment (NSRE) for the state of Utah. The two samples are not entirely comparable in that the NSRE is a general population survey of overall participation in various recreation pursuits (including OHV recreation), whereas our survey is limited to those residents who own and register OHV vehicles. The NSRE sample includes, for example, friends and family members who participate in OHV recreation but do not own a vehicle, and those who rent OHVs. The reasons for not owning a vehicle are many (e.g., a lack of sustained interest in OHV recreation, income constraints, etc.) so we did not expect an exact correspondence across the two samples.

Table 1 shows that the sample of Utah residents who own and register their OHVs is older than the general population engaging in OHV recreation. Further, our sample is less ethnically diverse and has greater household income. Educational questions were not asked in an identical manner across the two surveys: we combined our "some college" and "technical degree" categories into the "some college" category of the NSRE. Our sample has fewer respondents in both the lowest and highest educational categories. In general, this demographic pattern across the two surveys appears to correspond well with our expectations: OHV owners were expected to be older and have larger incomes than the general population of OHV recreationists.

Primary survey data were supplemented with data from secondary sources. Our statistical model, based on the cost of travel from one's home to a destination, required that we identify both the origin of the trip (where the rider left home) and the destination of the trip (exactly where he or she recreated). Origins were identified using the respondent's home zip code. Destinations were elicited by first asking the name of the destination (trailhead) for the respondent's most recent trip and then asking for the county in which this destination is located. This

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[3] Our analysis is conducted using the 534 respondents who provided complete data; using this number as the numerator yields a response rate of 37.7 percent.

Table 1. A Comparison of this Survey and the National Survey of Recreation and the Environment (NSRE Study, Cordell et al. 2008)

Category	This Survey	NSRE (Utah)
Age		
Less than 30	6.9%	26.4%
30 – 50	49.0%	38.8%
Over 50	45.0%	34.9%
Ethnicity		
White	98.4%	90.0%
Other	1.6%	10.0%
Income		
Less than $49,999	19.6%	55.0%
$50,000 - $74, 999	27.6%	24.2%
$75,000 - $99,999	25.5%	10.2%
$100,000 - $149,999	17.7%	7.5%
Over $150,000	9.6%	3.1%
Education		
Less than High School	2.3%	6.5%
High School Graduate	20.8%	23.5%
Some College	48.5%	36.7%
Bachelor's Degree	19.0%	20.4%
Post-graduate Degree	8.7%	12.9%

information was used to develop a list of recreation sites that correspond to a set of latitude and longitude coordinates. Respondents were also asked to estimate the number of trips made to each county in Utah over the previous 12-month period.

Most sites were relatively easy to locate; site names provided by respondents were input into the search procedure in the All Topo CD-ROM map set for Utah.[4] After locating the site, coordinates for latitude and longitude were recorded. Other sites, such as the "West Desert," refer to an expansive geographical region, and there was little we could do to identify the trailhead visited. Our final data set consisted of 235 identifiably distinct destinations. Unfortunately, identifying 235 choice destinations for a recreation activity such as OHV riding presents empirical difficulties. The site location is merely a trailhead from which riders depart for recreation, yet the analyst must somehow define site attributes (e.g., miles of trail or acres of public land) for the area accessed from a trailhead. How large should the area around the trailhead be? Is it the mean daily distance traveled on the OHV (say, a 60-mile radius around the trailhead, or an 11,300-square-mile area) or the median distance (a radius of 40 miles, or 5,000 square miles)? Why would a circle define the area around the trailhead? Would not the appropriate area and shape of a region differ depending upon the terrain at the site? Analysts have found no clear answers to questions such as these (see Karou, Smith, and Liu 1995, Lupi and Feather 1998).

In addition to these empirical difficulties, issues associated with state and federal land administra-

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[4] All Topo (iGage Mapping Corporation, Salt Lake City, Utah) is a CD-ROM product that includes digitized 7.5-minute maps for the entire state. The "map search" feature identifies the 7.5-minute quadrangle on which a given site name appears, as well as providing a location "tag." Scrolling the cursor to the tag (or anywhere on the map) provides the geographic coordinates.

tion also affect our site definition decision. The jurisdiction of one land agency may overlap with those of many other jurisdictions. Our primary interest is the proposed land management policies of six U.S. BLM Field Offices (FOs). In some cases the overlap of jurisdictions is relatively clean—the Price BLM FO has responsibility for all of Carbon and Emery counties—but in other cases the overlap is quite messy, as is the case with the Richfield BLM FO, which has responsibility for all BLM land in four counties and a portion of BLM land in two other counties. Further, none of the BLM FOs coincides with counties grouped in any of the seven Associations of Governments (AOGs, the standard planning unit used in Utah) or the nine official travel regions of the state's Office of Tourism. The state of Utah sponsored our study, and results were to be aggregated to county combinations specified by the sponsor, including aggregation to the AOG level. In view of these empirical issues, individual sites were aggregated to the county level (again, see Karou, Smith, and Liu 1995).

A county-level "aggregate site" was created using a weighted average of the latitude and longitude coordinates for all destinations within that county. Weights were defined by the number of people visiting each site, such that the most heavily visited site in a county received the greatest weight, while the least visited site received the smallest weight. As a final step in the process, travel distances were measured from the center of each origin zip code to the geographic coordinates for each of the twenty-nine aggregate county-level sites using the USDA computer program ZIPFIP. The cost of travel to these sites was calculated by multiplying by a constant per mile cost of vehicle operation, 20.1 cents per mile, the AAA estimated variable cost of operating a sport utility vehicle in the year 2006.

The most important attribute for our purposes is the amount of area available for OHV activities. The State of Utah Automated Geographic Reference Center provides relevant Geographic Information System (GIS) data for the entire state. These GIS databases were used to construct measures of current land use by county. The key GIS categories for the purposes of this study are the total amount of land in a county, the total amount of public land in a county, and the amount of public land on which OHV use is limited or prohibited. While the first two categories were easily determined from GIS data, we did not have access to an exact measure of public lands from which OHVs are currently prohibited. Public lands used for military purposes, designated wilderness areas, and wilderness study areas have OHV access prohibited, and we were able to calculate the amount of land within these categories. Similarly, six BLM FOs have published draft resource management plans (RMPs) that report acreage and provide maps on which OHV use is currently prohibited or limited. Table 2 shows acreage for the Kanab, Moab, Monticello, Price, Richfield, and Vernal FOs.[5]

Each BLM RMP reported land management acreage for the entire Field Office. The RMPs also included maps of land on which OHV use is permitted, limited, or prohibited under current and proposed management alternatives. Because all six BLM Field Offices encompass more than one county, it was necessary to convert this information to correspond to our designation of recreation sites (counties). The published maps were digitized to allow calculation of acreage in the open, limited, and closed categories under the current and preferred management alternatives. Our measure of "closed" public lands in a given county includes not only closed BLM land, but also land administered by the military, designated wilderness, and wilderness study areas, all of which are off-limits to OHVs. Unfortunately, we did not have access to the amount of acreage closed to OHV use by other state and federal management agencies (e.g., the USFS or the National Park Service), or for BLM Field Offices that have not yet developed an RMP. This means we are undercounting the amount of public land on which access is prohibited or limited under current management conditions.[6] Other attributes such as the presence of a well-known sand dune destination (Kane and Juab counties) or red

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[5] These six offices are located in the central and eastern counties of Utah, which account for roughly half of the state's acreage. The remaining BLM Field Offices in Utah have not yet been required to update their current RMPs.

[6] This introduces the problem of measurement error into the statistical model. The result is that our parameter estimate for, say, "closed acreage," will be attenuated toward zero. That is, we will be underestimating the effect of closed acreage on visitation (Greene 2008).

rock country (the broad swath of counties across southern and eastern Utah) may also be important. These influences were captured using dummy variables for the presence of major dune or red rock destinations within a county.

A key attribute that is unavailable for this analysis is the miles of trail that can be accessed by OHV users. The numbers of miles of "A50" road (four-wheel drive) in each county can be obtained from census data, but these data do not correspond very closely with trail data published in the draft BLM RMPs. Further, the miles of trail are likely to be correlated with the amount of acreage in a county, causing collinearity problems in the statistical model. We have chosen to treat this as an important unobserved site attribute, a decision that drives our choice of statistical model.

A Random Utility Model with Unobserved Heterogeneity Across Sites

Our basic approach is to use the random utility model to measure OHV visitation patterns within Utah. Our hypothesis is that if a federal agency restricts OHV access to public lands, OHV users are more likely to choose alternative sites for recreation, i.e., to recreate in other counties. The random utility model (RUM) version of the travel cost model allows the analyst to estimate the impact of changing access policies on use patterns. The RUM is a probabilistic modeling approach, in which the demand for a given recreation site is measured through the probability that the site will be visited (Morey 1999). Sites with more desirable characteristics (for OHVs these characteristics could be low travel cost, abundant public lands, and the opportunity to travel through spectacular red rock country) will be chosen with greater frequency relative to sites with less desirable characteristics. The theoretical basis for the model is that the recreationist will compare the utility (satisfaction) associated with one site j, U_j, to the utility of visiting an alternative site k, U_k. The recreationist will choose the site that yields the most satisfaction, choosing site j if

$$U_j > U_k, \text{ for all alternative sites } k$$

Put simply, a person will choose to go where he or she derives the most satisfaction, relative to all available choices.

Table 2. OHV Access to BLM Land: Current Management vs. Preferred Alternative (Acres)

	Category	Current	Preferred	Net Change
Kanab FO	Open	466,600	1,100	(465,500)
	Limited	66,200	524,000	457,800
	Closed	21,200	28,900	7,700
Moab FO	Open	620,212	1,866	(618,346)
	Limited	1,196,920	1,481,334	284,414
	Closed	5,062	339,298	334,236
Monticello FO	Open	611,310	2,311	(608,999)
	Limited	895,380	1,362,142	466,762
	Closed	276,430	418,667	142,237
Price FO	Open	754,193	0	(754,193)
	Limited	1,590,540	2,076,096	485,556
	Closed	9,689	403,181	393,492
Richfield FO	Open	1,636,400	8,400	(1,628,000)
	Limited	277,600	1,909,200	1,631,600
	Closed	214,000	210,400	(3,600)
Vernal FO	Open	787,859	6,202	(781,657)
	Limited	887,275	1,643,475	756,200
	Closed	50,388	75,845	25,457

The satisfaction derived from any site j is a function of the cost to gain access to the site (the "travel cost") as well as other attributes of the site. For any site j, let TC_j be the travel cost to the site, O_j be the measure of public land open for ATV recreation at the site, L_j be the measure of public land with limited ATV access at the site, and C_j be the measure of public land closed to ATV recreation at the site. D_j and R_j are zero-one dummy variables indicating the presence of sand dunes and red rock at site j, respectively. Further, multiple trailheads were combined into a single aggregate destination so the analyst must include a variable, S_j , measuring the number of trailheads within the aggregate. Whereas all factors influencing site choice are known by the recreationist, some may remain unknown to the analyst, thus introducing random error, ε_j, into the choice problem. Again, the recreationist will choose to visit the site yielding the greatest utility, choosing to visit site j rather than site k if,

$$U(TC_j, O_j, L_j, C_j, D_j, R_j, S_j) + \varepsilon_j > U(TC_k, O_k, L_k, C_k, D_k, R_k, S_k) + \varepsilon_k$$

If the errors are assumed to be additive and independently and identically distributed according to a type I extreme value distribution, the probability that a person will choose site j over all other $K-1$ alternative sites is given by,

$$\text{(1)}\quad P(\text{choose site } j) = \exp\{U(TC_j, O_j, L_j, C_j, D_j, R_j, S_j)\} \,/\, \Sigma_{k=1}{}^{K} \exp\{U(TC_k, O_k, L_k, C_k, D_k, R_k, S_k)\}$$

The model is made operational by specifying the form of the U(•) function; for example, a common specification is linear,

$$\text{(2)}\quad U(TC_j, L_j, R_j, S_j) = \alpha_j + \beta\, TC_j + \gamma\, A_j + \ln(S_j)$$

where α is an intercept term, β is the travel cost parameter, the γ vector consists of parameters for the vector of site attributes A_j, and the parameter on the site aggregation term is fixed equal to one.[7] The parameters can be estimated via the method of maximum likelihood using equation (1) as the basis for the likelihood function. Economic theory indicates that we should observe a negative sign for β and positive signs for elements of the vector **γ** if the site attributes are desirable; negative if the attributes are undesirable.

Other factors may also influence the site choice of an individual recreationist, but the standard RUM model cannot capture all possible attributes of a site; Murdock (2006) demonstrates that welfare measures are biased downward (upward) for sites with desirable (undesirable) yet unobserved attributes. For example, we do not have a good measure for miles of off-road trails, yet we know this to be an important determinant of site choice. Failure to account for the unobserved attributes leads to biased standard errors that tend to overstate the precision of the estimates of a standard RUM model. Murdock proposes a simple two-stage estimation procedure that mitigates these problems. At the first stage, one simply estimates a standard RUM model using site-specific constants, attributes that vary across individuals and sites, such as the travel cost variable, and our site aggregation adjustment,

$$\text{(3)}\quad U(TC_j, S_j) = \alpha_j + \beta\, TC_j + \ln(S_j)$$

The basic intuition is that the site specific constants, α_j , capture all observed and unobserved attributes that vary across sites. Thus, measurement error is removed and an unbiased parameter for travel cost is estimated with precision. Site attributes are not included in the first stage because they cannot be identified separately from the vector of constants. At the second stage, one runs a simple OLS regression of the constants on site attributes, yielding the taste parameters for the observed characteristics of the sites. Using the attributes in our example, the OLS regression appears as,

$$\text{(4)}\quad \alpha_j = \eta + \gamma\, A_j + \zeta_j$$

where η is a constant and ζ_j represents unobserved attributes. In a very real sense, one can think of the Murdock approach as being akin to a varying parameters approach.

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[7] The site attribute vector A includes the variables O_j , L_j , C_j, D_j, and R_j. Setting the parameter of the site aggregation variable follows the standard approach in dealing with aggregated sites (Lupi and Feather 1998).

Results

The travel cost model presented below focuses on the trip-making behavior of 534 owners of OHVs who supplied complete data on trips to Utah destinations.[8] Of this group, the average OHV owner took 9.3 trips in Utah with their OHV during the 12 months preceding the survey. Trips were dispersed across the state, with the most popular sites for the most recent trips being in Utah, Juab, Tooele, and Washington counties, with these four counties accounting for nearly 25 percent of in-state trips during the 12-month period. Some 76 percent of OHV owners reported spending most of their riding time traveling along established roads and trails, although a sizable minority (24 percent) reported spending more riding time off established trails.

Travel Cost Modeling

Our random utility models for OHV trips to twenty-nine Utah counties appear in Table 3. Columns (2) and (3) present coefficients and t-statistics for the standard RUM, whereas columns (4) and (5) show the first stage RUM of the Murdock approach. In the standard model, all the parameters follow expectations. The *Travel Cost* parameter is negative, implying that, all else being equal, closer sites are preferred to sites located farther away. The greater the *Proportion of Open Acreage* in a county, the more likely ATV enthusiasts are to choose the site. Similarly, the greater the *Proportion of Limited Acreage*, the more likely that the site will be chosen. One should note the magnitude of these last two parameters: open acreage is preferred to limited acreage. In contrast to open and limited acreage at a site, as the *Proportion of Closed Acreage* grows, the site is less likely to be chosen. The presence of *Red Rock* at a site also increases the likelihood that the site will be visited, whereas the *Dunes* measure was insignificant.

Turning now to the two-stage model that controls for unobserved heterogeneity across sites, the first stage is reported in columns (4) and (5) of Table 3. Here we see that the *Travel Cost* parameter is negative, as expected. The site-specific constants follow a pattern consistent with expectations. The site-specific constants for Utah, Juab, and Tooele counties are relatively small, but these sites are located either in or immediately adjacent to the four most populous counties of the Wasatch Front (home to 59.5 percent of Utah's OHV owners) and have relatively small travel costs. The largest site-specific constants are for counties that are home to Utah's spectacular red rock country (Grand, Washington, San Juan) or in a county that provides the primary trailheads of a hugely popular complex of high-elevation trails located in the central portion of the state (Piute).

Our second-stage model uses the site-specific constants appearing in Table 3 (along with the implied "zero" for the county omitted at the RUM stage, Weber county) on the left-hand side of an OLS regression against observable site attributes. The second-stage models (Table 4) perform quite well.[9] Again, our key variables concern the proportion of acreage in a county that is open for cross-country travel, the proportion limited to trail travel only, and the proportion closed to OHV users. In Specification #1, the coefficient on the *Proportion of Open Acreage* is positive and statistically significant, implying that as the amount of open acreage in a county increases, the site is more likely to be selected as a place to visit. The coefficient on the *Proportion of Limited Acreage* is also positive and statistically significant. This is consistent with data indicating that about 75 percent of riders in our sample preferred to recreate on trails as opposed to cross-country travel.[10] The coefficient on *Proportion of Closed Acreage* is negative and statistically significant, implying that as the amount of "closed" acreage in a county increases, the site is less likely to be selected as a place to visit. Finally, the effect of *Dunes* in a county is not a significant determinant of site choices, whereas the presence of *Red Rock* country is a positive and significant factor in determining where OHV recreationists choose to visit.

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[8] A referee has noted that restricting the choice set to sites within the state of Utah ignores the possibility of out-of-state trips, especially if these sites become more important as access to Utah sites becomes more restricted.

[9] The dependent variable in the second stage is measured with error. Although the parameter estimate is not biased, we use White's robust variance-covariance estimator to calculate the standard errors.

[10] An F-test of parameter equality for the *Open Acreage* and *Limited Acreage* coefficients was not rejected for either specification in Table 4.

Table 3. RUM Models of OHV Recreation

Variable	Coefficient	t-statistic	Coefficient	t-statistic
Travel Cost	−0.048***	−60.882	−0.061***	−52.369
Proportion of Open Acreage	1.721***	17.676		
Proportion of Limited Acreage	1.386***	8.298		
Proportion of Closed Acreage	−1.376***	−8.662		
Dunes	0.413***	8.767		
Red Rock	0.873***	14.821		
County Specific Constants				
Beaver			2.025***	10.728
Box Elder			−0.439***	−2.952
Cache			−0.077	−0.614
Carbon			1.267***	8.558
Daggett			0.730**	2.547
Davis			−0.667***	−4.962
Duchesne			−0.188	−1.253
Emery			1.573***	11.055
Garfield			1.707***	9.657
Grand			2.975***	17.576
Iron			2.220***	12.559
Juab			1.259***	10.090
Kane			2.370***	14.013
Millard			1.195***	8.277
Morgan			−0.558**	−2.525
Piute			3.321***	20.072
Rich			0.782***	5.305
Salt Lake			−0.196	−1.428
San Juan			2.762***	14.413
Sanpete			2.048***	14.102
Sevier			1.435***	10.391
Summit			0.027	0.215
Tooele			–0.200	–1.64
Uintah			0.694***	4.216
Utah			–0.313***	–2.600
Wasatch			0.191	1.505
Washington			2.613***	15.836
Wayne			1.397***	9.040
Weber			—	—
Log likelihood		−13,688.6		−13,164.2
Chi-square (β=0)		5,420.78		6,469.6

*** significant at 0.01; ** significant at 0.05

Table 4. Second Stage Regression for Unobserved Heterogeneity (n=29)

Variable	**Specification #1**		**Specification #2**	
	Coefficient	*t-stat*	*Coefficient*	*t-stat*
Intercept	0.714***	3.166	2.737	0.985
Proportion of Open Acreage	2.832***	5.289	3.190***	4.475
Proportion of Limited Acreage	2.484**	2.503	2.866***	2.821
Proportion of Closed Acreage	−2.915***	−3.129	−1.879	−1.439
Dunes	0.418	1.140	0.432	1.331
Red Rock	1.338***	5.526	1.373**	5.721
Ln(Area)			−0.266	−1.208
Adjusted R^2	0.675		0.682	

*** significant at 0.01; ** significant at 0.05

Our second specification (Table 4) controls for the size of the county by including the natural logarithm of the county size as an explanatory variable. Nearly all the variables retain the same sign, magnitude, and level of significance as in Specification #1, with the exception being the *Proportion of Closed Acreage*, which shows reduced magnitude and statisical significance. Overall, this specification was not as strong as the first.

Welfare Impacts of Access Restrictions

The model presented in Tables 3 and 4 can be used to estimate baseline measures of per-trip compensating variation and changes in welfare due to changes in land access. Evaluated at the mean travel cost and the current level of site attributes in each of the twenty-nine destination counties, the per-trip compensating variation using the standard model is \$80.41, whereas the estimate arising from the two-stage model is \$52.12.[11] Both estimates are at a midpoint between previous published estimates of the consumer surpus of OHV recreation. The estimate coming from the standard model is a bit higher than the estimates generated using contingent valuation, whereas the estimate from the two-stage model is a bit lower. The estimate of Silberman and Andereck (2006) for their pooled sample of all types of off-road vehicles (similar to our pooling of all vehicle types) was \$68, whereas the estimate in Deisenroth, Loomis, and Bond (2009) was \$78 per day trip (also pooled across all vehicle types). For those estimates derived from the travel cost methodology, both estimates are greater than that estimated by Loomis (2006) for a remote site in Colorado (\$29), or for three of the four North Carolina sites in Englin, Holmes, and Niell (2006).

The welfare effects of restricting access to public land can be calculated by using the published BLM RMP maps to measure how much land is moving from one access category to another. Examining the magnitude of the coefficients for both the standard and the two-stage models allows one to see that moving land from “open” to “limited” will cause a relatively small loss in consumer welfare, but moving from “open” or “limited” to “closed” will cause a large loss in welfare. Conversations with BLM officials indicated that they were well aware of this, and the six BLM RMPs tended to move public land classified as “open” in recent years more to the

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[11] The welfare measure from the standard model, of course, follows the standard calculation. The welfare measure for the two-stage model is calculated by substituting in the right hand side attribute values for the twenty-nine sites using Specification #1 of Table 4 to obtain “α-hats.“ These twenty-nine predicted constants were then used in the first-stage model (Table 3), which again followed the standard welfare calculation of the RUM.

"limited" category rather than the "closed" category.[12] The proposed BLM RMPs are concentrated in eastern and central Utah, such that the effect of the new restricted access will be to shift some visitation from eastern and central Utah to western and northern Utah. The net change in compensating variation due to the access restrictions from the standard model is 88 cents per trip, or about $8.20 per season if the number of trips taken by the average OHV owner stays constant under the new restrictions. Under Murdock's two-stage approach, the estimates are a loss of $1.14 per trip if the restrictions are put into effect, for a seasonal loss of $10.60 if the number of trips remains constant. Using the results from the two-stage approach, and assuming our sample is representative of OHV owners for the state as a whole, welfare losses will total $1.21 million. Should recreationists decide to stay home or recreate at sites outside of the state, surplus losses will be larger.

The welfare losses estimated by the two models indicate that some degree of unobserved heterogeneity was present in the data. The BLM restrictions were primarily located in the south and east portions of the state, home to the internationally known OHV destination of Moab, as well as to millions of acres of spectacular red rock country. The fact that greater welfare losses were measured with the unobserved heterogeneity model than with the standard RUM supports our hypothesis that counties experiencing increased access restrictions had positive attributes that were not fully captured using the information and measurements available to us.

Conclusions

As noted in the introduction, OHV management is a complex issue with social, ecological, and economic aspects. While there are many potential management actions to address the issue—repairing and maintaining existing roads, building more roads and trails in ecologically resistant areas, adding mass transit options in national and state parks, and zoning conflicting uses—most agencies focus first on OHV road closures and OHV use restrictions (Havlick 2002). There is a debate in the literature about the social and ecological value of this approach (Blahna 2007), but there is only one study to date that evaluates the *economic* tradeoffs involved with use restriction policies (Deisenroth, Loomis, and Bond 2009). Our study adds to this relatively small but critical body of literature.

We have estimated a version of the random utility model that accounts for unobserved heterogeneity across sites, a situation that is likely to hold in our modeling. Our statistical models are relatively robust, indicating that open acreage is most highly valued by OHV users. The model indicates that limiting the use of motorized vehicles to trails only has a relatively small impact on consumer welfare, but the complete loss of access to public land has the potential to cause relatively large welfare losses. Our findings have implications for management of OHVs: the relatively small welfare losses associated with restricting OHV travel to existing trails and roadways suggest that agencies can assure access for OHV enthusiasts while simultaneously satisfying mandates for resource protection.

A wide variety of federal and state agencies have responsibility for the management of public land. In recent years, such agencies have been moving toward land management methods that acknowledge the complex interactions within an ecosystem (Grumbine 1994). Such ecosystem management approaches require that agencies integrate ecological, social, and economic factors in management decisions. While agencies can collect information regarding ecological impacts, visitor preference, and social conflicts relatively easily, there is often a dearth of information regarding economic values when making non-commodity management decisions. Thus, acheiving management goals is difficult because economic factors are rarely given as much weight as biological or social factors in decisions related to recreation access and use, aesthetics, and other nonmarket values of public lands. This study shows the relative economic implications of use restrictions for the state of Utah and provides an approach that could be adapted by other state and federal agencies as they develop travel management plans.

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[12] The exceptions were the Moab and Price Field Offices, which moved significant portions of land that had been fully open to OHV users to the closed category.

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