Happy (Hypothetical) Trails to You:
The Impact of Trail Characteristics and Access Fees on
a Mountain Biker's Trail Selection and Consumer's Surplus

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Thirty million North Americans own mountain bikes

three million are avid trail riders.

in 1983 the Slickrock Trail in Moab, Utah was used by 1,000 mountain bikers; ten years later it was ridden by over 90,000

A consequence is trail degradation and conflicts with other users.

Typical response is closing trails and/or entire sites to mountain biking.

When mountain biking is allowed, it is often on four-wheel drive roads rather than the narrow single-track trails many bikers prefer.
The impact of such changes is evaluated by developing and estimating a random utility model that predicts the effects of trail characteristics, access fees, and characteristics of the individual on trail selection.

The model is used to estimate an individual’s per-trip compensating variation associated with a change in site characteristics and/or access fees.

These CV's vary as a function of the characteristics of the individual.

The model also estimates how site selection will change if site characteristics and/or access fees change.

The results indicate that bikers have significant willingness to pay for trail quality.
Estimation is with stated preference data.

Specifically, a set of hypothetical mountain bike trails were created and each surveyed biker was asked to make five pair-wise choices.

Focus groups were used to identify relevant site and user characteristics.

Three hundred individuals completed the final survey at the Portland Bike Show.
Have you been run down by a mountain biker?

Due to the differences in speed conflicts with hikers and equestrians:

bikers must slow down, and hikers and equestrians often need to get out of the way.

The sensitivity of mountain bikers to the introduction of access fees needs to be evaluated.

access fees are a likely reality

Revenues used to maintain trails

Access fees might also make private sites profitable.

Individual estimates of willingness to pay and/or willingness to accept are derived for

changes in the site characteristics, and the introduction of an access fee at a popular mountain bike site near Boulder, Colorado.
I. A Discrete Choice Random Utility Model of Mountain Bike Site Choice

Individual i chooses mountain bike site j that provides the greatest utility

The utility individual i receives from choosing to ride his mountain bike at site j is

\[ U_{ij} = V_{ij} + e_{ij} \]

where each \( e_{ij} \) is independently drawn from a univariate Extreme Value Distribution,
This multinomial logit model imposes the independence of irrelevant alternatives (I.I.A.) property;

that is, the ratio of any two probabilities is independent of any change in any third alternative

I.I.A. allows the parameters calculated from choices among pairs of sites to be generalized to choice sets with any number of alternatives.

this is important for the design of our hypothetical choice experiment
$V_{ij}$ is a function of

- a vector of the trail characteristics, $Z_j$, defining site $j$

- the amount of money the individual has left to spend on all other goods after choosing to ride at site $j$

- and other characteristics of individual $i$, $S_i$.

  $S_i$ consists of common socioeconomic variables such as age and gender in addition to variables which describe individual $i$’s interest in mountain biking and his or her cycling skill.

The estimated model assumes that budget affects site-choice and is therefore an "income effects" model.
II. The Benefit and Costs of a Stated Preference Approach

Modeling and estimating recreational site-choice behavior requires that

the researcher must be able to identify the sites in the individual’s choice set

identify the cost to the individual of a trip to each of these sites

and list and quantify the characteristics of each site that affect site-choice.
Site identification, travel costs, and site characteristics have been studied for years for such activities such as fishing and downhill skiing, the study of mountain bike site choice is new, and there are new difficulties.

These issues can be controlled and studied by asking respondents to choose the preferred alternative from a small set of hypothetical sites with each choice set depicting different cost and characteristic tradeoffs.
Consider a site to be a system of interconnected single-track and double-track trails open to mountain bikes, but not to cars.

Sites tend to be well defined.

Travel-cost is problematic.

Mountain bikers can always drive to the trail head, but in many cases they can also bike to the site.
Because of this, travel costs to the same site can vary extensively across individuals and, for a given individual, from ride to ride as a function of the individual's time constraints and preferences for riding on the road.

Such variations in costs are important but difficult for the researcher to observe.

The problem of estimating travel costs can be avoided if one restricts the analysis to hypothetical sites the researcher can specify road type and distance to each of the sites.
We make the simplifying assumption that the sites are all the same short distance from the individual's residence so travel is immaterial and individuals make their choices solely on the basis of site characteristics and access fees.

This allows us to investigate the impact of access fees on site-choice without the added complication of travel costs.
A stated-preference technique is advantageous for several additional reasons.

Mountain biking in the real world involves both participation and site-choice decisions.

A stated preference approach allows us to easily separate the site-choice decision from the participation decision.
Another advantage of a stated preference technique is that it allows the individual to “experience” greater variation in site-choice than exists in the real world.

Independent variation in trail characteristics across sites is necessary to estimate the influence of trail characteristics on site-choice. With hypothetical sites, sufficient variation can always be generated.

For example, the influence of access fees on site-choice cannot be estimated with data on actual sites because there is not sufficient variation in access fees across sites, most sites are free. But the impact of fees can be estimated by varying access fees across hypothetical sites.
Potential problems exist with the use of contingent behavior data.

Most significant, it is stated preference data rather than revealed preference data.

There is no guarantee that individuals will actually do what they state they will do.

Observed behavior (revealed preferences data) involves commitment and opportunity cost, while stated preferences do not.
III. Survey Design: Pairs of Hypothetical Sites

Recently, hypothetical choice experiments have emerged as an analytical tool in the field of environmental economics. We identified six site characteristics, and used them to create 36 hypothetical mountain bike sites. Our experiment presents individuals with five pairs of hypothetical mountain bike sites, and asks each individual to choose the preferred site from each pair.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total length of trail</td>
<td>7 miles</td>
</tr>
<tr>
<td></td>
<td>14 miles</td>
</tr>
<tr>
<td></td>
<td>21 miles</td>
</tr>
<tr>
<td>2. Percentage of trail which is single-track</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>3. Total vertical feet of climbing</td>
<td>400 feet</td>
</tr>
<tr>
<td></td>
<td>1200 feet</td>
</tr>
<tr>
<td></td>
<td>2200 feet</td>
</tr>
<tr>
<td>4. Number of peaks along trail profile</td>
<td>1 peak</td>
</tr>
<tr>
<td></td>
<td>2 peaks</td>
</tr>
<tr>
<td></td>
<td>4 peaks</td>
</tr>
<tr>
<td>5. Entrance fee</td>
<td>$1</td>
</tr>
<tr>
<td></td>
<td>$5</td>
</tr>
<tr>
<td></td>
<td>$8</td>
</tr>
<tr>
<td>6. Used by hikers/ equestrians</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td>NO</td>
</tr>
</tbody>
</table>
Fifty pair-wise choice sets were constructed by randomly pairing sites from the 36 sites, rejecting and replacing any pairings which displayed dominance.

The 50 choice sets were blocked into ten sets, creating ten versions of the survey, each with five pairs.

Choice sets were limited to five to insure that an individual would give their full attention to each choice set and complete the survey.

The focus groups demonstrated that individuals would have no difficulty making five pair-wise choices and explaining in words each of those choices.
\[ V_{ij} = \beta_1(\text{dist}_j) + \beta_2(\text{dist}_j)^5 + \beta_3(\text{dist}_j)(\text{vfc}_j) + \beta_4(\text{vfc}_j) + \]
\[ \beta_5(\text{gender}_i)(\text{vfc}_j) + \beta_6(\text{vfc}_j)(\text{peaks}_j) + \beta_7(\text{peaks}_j) + \beta_8(\text{str}_j) + \]
\[ \beta_9(\text{str}_j)(\text{susp}_i) + \beta_{10}(\text{hiker}_j) + \beta_{11}(\text{budget}_i-\text{fee}_j) + \]
\[ \beta_{12}(\text{budget}_i-\text{fee}_j)(\text{train}_i) + \beta_{13}(\text{budget}_i-\text{fee}_j)(\text{mtb’er}_i) + \]
\[ \beta_{14}((\text{budget}_i-\text{fee}_j)^5) \]

where

\text{fee}_j = \text{Required entry fee for trail access at site } j. \\
\text{dist}_j = \text{Total mileage of the trail at site } j. \\
\text{str}_j = \text{The miles of single-track trail at site } j. \\
\text{vfc}_j = \text{total vertical feet of climbing at site } j. \\
\text{peaks}_j = \text{The total number of peaks along the trail profile at site } j. \\
\text{hiker}_j = 1 \text{ if site } j \text{ is used by hikers and equestrians; and 0 if not.} \\
\text{budget}_i = \text{Individual’s daily household budget.} \\
\text{gender}_i = 1 \text{ if individual } i \text{ is male, 0 if female.} \\
\text{mtb’er}_i = 1 \text{ if individual } i \text{ considers him/herself a mountain biker, 0 if some other type of cyclist.} \\
\text{train}_i = 1 \text{ if individual } i \text{ considers a mountain bike ride training, 0 if otherwise.} \\
\text{susp}_i = 1 \text{ if individual } i \text{ has a suspension system on his/her mountain bike, 0 if not.
explanatory variables highly significant
model correctly predicts 64% of actual choice behavior.

All parameter estimates have plausible signs. Likelihood ratio
tests indicate each variable adds significantly to the model’s
explanatory power.

The null hypothesis of no-income effects is rejected at a ten
percent level of significance.

The marginal utility of money is a function of the individual's
budget, whether a mountain bike ride is training, and whether
the individual considers himself a mountain biker.

Summarizing, single-track has a positive effect on site-choice
stronger if the individual owns a mountain bike with a
suspension system.

presence of hikers and equestrians has a highly significant
negative impact on site-choice.
The interpretation of the other parameters is less straightforward.

The effect of increasing distance depends on the amount of climbing at the site.

  Vertical feet of climbing combined with trail length largely determine the difficulty of a trail, and more difficulty is good but only up to a point.

The results indicate that bikers prefer short-steep trails and longer-flatter trails to those in between in terms of grade and length.

Increasing the number of peaks on a trail makes the site more attractive if the site has more than 238 vertical feet of climbing and less attractive if the site has less climbing.

  Rolling hills are an attractive feature, one gets to climb and then recover on the downhill before the next climb

but "rollers" need to be of a sufficient height before they become a positive feature.
Increased access fee has a negative impact on site choice

but the magnitude of that impact varies across individuals as a function of

the individual's budget

whether the individual considers himself a mountain biker

whether the ride is a training ride
A Representative Individual’s Per-ride Compensating Variations, PRCV, for Changes in Site Quality and/or Access Fee

For the example, assume that there are only two mountain bike sites available to the residents of Boulder, Colorado:

White Ranch (W) and the Sourdough Trail (S), both popular sites.

For simplicity further assume each site is the same distance from each individual’s residence.

Given these assumptions, if given the choice between White Ranch and the Sourdough trail, 62% of trips will be to White Ranch.

Now consider the per-ride compensating variation individual i associates with proposed change in the trail characteristics and/or access fee at one or both of these sites.
The per-ride compensating variation associated with this change, $\text{PRCV}_i$, is

the amount of money that when subtracted from the daily budget in the proposed state makes maximum utility in the proposed state with this compensation equal to maximum utility in the original state.

For example, for a fee increase at White Ranch,

$\text{PRCV}$ is zero for those individuals who choose the Sourdough trail with or without the fee

the negative of the fee for those individuals who choose White Ranch both with and without the fee

and between zero and the negative of the fee for those individuals who would choose White Ranch before the fee is introduced but not afterwards.
Denote the per-ride compensating variation for a representative individual of type i, \( PRCV_i^r \)

\( PRCV_i^r \) are estimated for each of four possible changes in quality/access fees at White Ranch. The four proposals are:

1. The introduction of a four dollar access fee at White Ranch.

2. Prohibiting the use of White Ranch by hikers and equestrians.

3. Banning mountain bikers from all single-track trails at White Ranch.

   This will also reduce the total mileage by seven miles, total vertical feet of climbing by 1,365 feet, and number of peaks by one.

4. The conversion of the 5.1 miles of double-track trails at White Ranch into single-track trails, funded by a five dollar access fee.
### Table III
PRCV for the four White Ranch scenarios

<table>
<thead>
<tr>
<th>Change in Quality and/or Fee</th>
<th>Statistic</th>
<th>PRCV&lt;sub&gt;i&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction of $4 access fee at WR.</td>
<td>mean</td>
<td>$-2.40</td>
</tr>
<tr>
<td></td>
<td>median</td>
<td>$-2.45</td>
</tr>
<tr>
<td>2. Prohibiting hikers and equestrians at WR.</td>
<td>mean</td>
<td>$7.49</td>
</tr>
<tr>
<td></td>
<td>median</td>
<td>$5.70</td>
</tr>
<tr>
<td>3. Closing all single track trails at WR.</td>
<td>mean</td>
<td>$-9.24</td>
</tr>
<tr>
<td></td>
<td>median</td>
<td>$-5.64</td>
</tr>
<tr>
<td>4. All single-track trails and $5 fee at WR.</td>
<td>mean</td>
<td>$-0.25</td>
</tr>
<tr>
<td></td>
<td>median</td>
<td>$-1.49</td>
</tr>
</tbody>
</table>
PRCV_i^r's vary across individuals as a function of gender and interest in mountain biking.

**Table IV**

PRCV_i^r's for the four White Ranch scenarios for four proposed representative individuals

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Individual</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Casual Cyclist</td>
<td></td>
<td>$-1.79</td>
<td>$3.41</td>
<td>$-0.87</td>
<td>$-1.67</td>
</tr>
<tr>
<td>3. Road Rider</td>
<td></td>
<td>$-2.56</td>
<td>$9.97</td>
<td>$-9.68</td>
<td>$-1.11</td>
</tr>
<tr>
<td>4. Weekend Mountain Biker</td>
<td></td>
<td>$-1.82</td>
<td>$4.85</td>
<td>$-3.01</td>
<td>$-0.45</td>
</tr>
</tbody>
</table>
Figure I indicates that $PRCV^r_i$ for a deterioration in site quality (proposal 3) is a decreasing function of daily budget; that is, individual with larger budgets need to be paid more to accept a quality decrease in the physical characteristics of a site.

**Figure I.**

$PRCV^r$ for proposal 3 for a casual cyclist as a function of the individual’s daily budget.
In contrast consider proposal 4, it involves both a fee increase and a conversion of double track into single track. Proposal 4 makes casual cyclists worse off.

Figure II indicates that the amount that the causal cyclist must be paid to accept this deterioration is a decreasing function of his or her daily budget; that is, causal cyclists that are affluent need to be paid less to accept the change than do casual cyclists that are poor.

Figure II.
PRCV* for scenario four for a casual cyclist as a function of the individual's daily budget.*

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*PRCV*: Per-Ride Cost of Valuing.