THESIS

THE ECONOMIC BENEFITS OF OFF HIGHWAY VEHICLE RECREATION IN LARIMER COUNTY, COLORADO

Submitted by

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY DANIEL DEISENROTH ENTITLED THE ECONOMIC BENEFITS OF OFF HIGHWAY VEHICLE RECREATION IN LARIMER COUNTY, COLORADO BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

Committee on Graduate Work

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ABSTRACT OF THESIS

THE ECONOMIC BENEFITS OF OFF HIGHWAY VEHICLE RECREATION IN LARIMER COUNTY, COLORADO

This thesis estimates the non-market benefits associated with Off Highway Vehicle (OHV) recreation in Larimer County, Colorado. We use a Travel Cost Model (TCM) and a Contingent Valuation Model (CVM) to estimate benefits to three different types of users: Dirt Bike Riders, All Terrain Vehicle (ATV) Riders, and 4-Wheel Drive (4x4) users. Using CVM we find the consumer surplus estimates to be between $87 and $207 per person per day, depending on model specification. This equates to a per summer per trail consumer surplus between $282,908.50 and $674,997.80, and a Larimer County OHV surplus per summer to be between $1,026,542 and $2,449,249. These results are consistent with previous research on OHV recreation (e.g. Englin et. al, 2006, Loomis, 2006). We also find that for our sample, the travel cost model does not find significance in the travel cost variable. We believe that this may be due to our open-ended travel cost question, or due to the fact that most OHV recreationists are traveling from the same area.

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DEDICATION

I would like to dedicate this thesis to my wife Noriko, whose patience with me far outweighs any burden that I may have encountered throughout this project.

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CHAPTER ONE: PROBLEM STATEMENT

Introduction

Off highway vehicle (OHV) recreation is one of the most destructive outdoor activities enjoyed by recreationists today. It is also an expensive sport, which means users most likely have a high net willingness to pay for the activity, and possibly a high consumer surplus. The U.S.D.A. Forest Service has proposed to amend OHV regulations in an attempt to mitigate the environmental damage inflicted by these vehicles (USDA Forest Service, 2004). It has been demonstrated that OHV use reduces the abundance of bird species and increases the desertion rates of nests in Northeastern California (Barton and Holmes, 2007). In Algodones Dunes in California, a study showed that OHV usage reduces the density of a threatened plant by 4-5 times, and that plants struck by OHVs have survival rates reduced by 33% (Groom et. al., 2007). Furthermore, the noise and size of the vehicles detract from the pristine aspects of nature that other recreationists, such as hikers or birdwatchers, try to enjoy. OHV use is basically incompatible with other recreation activities (Englin et al,, 2006). These problems render OHV usage an offensive activity in the eyes of some other users of a particular area, and some non users who hold intrinsic value to the natural aspects of the area.

In largely populated states, public OHV recreation areas are being shut down every year. In California, where population is higher than in any other state, entire sections of the state are shut down to OHV usage. The reason is that OHV areas are

generally open access areas and with open access, overexploitation may occur. In Colorado, on the other hand, population is low enough, for now, so that there are enough areas to provide enjoyment for all who wish to pursue OHV adventures. In Colorado there is also an Adopt-a-Trail system in which volunteers maintain the trail system they are using. However, even in Colorado, population is growing at a rate which will not allow for sustained OHV usage in open areas. Management decisions will need to be made in order to ensure few conflicts between OHV users and other users of public land.

This purpose of this particular study will be to investigate the consumer surplus (CS) for OHV usage in Larimer County and to explore the variables which influence CS. The reason that this must be done is that in order to make proper and educated policy decisions regarding OHV recreation, all costs and benefits must be taken into account. In other words, closing trails due to environmental damage may not be the socially optimal choice if the benefits foregone are higher than the costs.

The problem with OHV recreation is that its benefits are non market. In other words, OHV recreationists in Larimer County do not pay any fees except for the registration fees on their vehicles which is a mere $15 for dirt bikes and ATVs, and whatever the state requires for a street-legal 4x4 vehicle, which varies depending on the year manufactured and the original cost In Colorado the minimum fee is $32.60 as of 2001 (USDOT, 2001). There may be a much higher level of benefits which are not captured in the price of the registration fees. Therefore, in order to value OHV recreation on public land, non-market valuation techniques must be utilized. These techniques will be discussed in the next chapter.

CHAPTER TWO: VALUING OFF-HIGHWAY VEHICLE RECREATION

Previous OHV Studies

To date, there have been 4 studies which have attempted to characterize the demand curve for off highway vehicle recreation (Loomis, 2006; Englin and Holmes, 2005; Englin, Holmes, and Niell, 2006; Bowker, 1997). Two of these studies were of a data set obtained from National Forest land in North Carolina which evaluated consumer surplus for three pay-per-use trail areas. The three off-highway vehicle areas surveyed in North Carolina were all multiple use areas, allowing for trail bikes, ATV, and 4x4 uses (Englin and Holmes, 2005). Both studies utilized Travel Cost Models in order to estimate per person per day consumer surplus. In the two studies, using a standard Poisson distribution and Negative Binary model, consumer surplus was estimated to be between $41-$714 for one area, $27-$1000 for another, $101-$588 for the third, and finally, between $25-$909 for each of the four areas studied. The large range in estimates of consumer surplus was due to the fact that several models and restrictions were used.

The third study also uses a travel cost model, but unlike the other studies, this study was conducted in Croom Recreation area in Florida, a fee-based recreation area (Bowker, 1997). Consumer surplus estimates were between $12 and $66 depending on model restrictions (Bowker, 1997; Loomis, 2003), which is somewhat consistent with the above studies, although the lower estimates may be attributed to the different location and OHV characteristics. The conclusion of this study is that since the demand for OHV

recreation is relatively inelastic, and since there is a considerable amount of consumer surplus, the fee could be raised.

The fourth study was conducted in Craig, Colorado, which is quite a distance from any major populated area. This study (Loomis, 2006) uses a Travel Cost Model to determine consumer surplus for OHV recreation of $29.

The major differences in consumer surplus between the four studies show that more information is needed in order to generally assess the benefits of OHV recreation. Each one of the previous studies evaluates areas which are completely different from one another in attributes and accessibility, and so it is to be expected that the benefits associated with the recreation at these sites would be different. As such, our study, which evaluates OHV recreation on the Front Range in Colorado, which is characterized by rocky terrain and evergreen trees, should yield policy relevant results for USDA Forest Service decisions on the Arapahoe-Roosevelt National Forest. Furthermore, this study may yield relevant results through benefit transfer for decisions regarding other National Forests along the Front Range, such as Pike-San Isabel National Forest.

Problems Surrounding OHV Recreation

The general problem with (OHV) recreation on public land is that the motorized vehicles used for this sort of recreation impose external costs to the other users of public areas. OHV usage causes many sorts of pollution, including, but not limited to, noise pollution, harmful emissions into the atmosphere, and erosion. Furthermore, OHV recreation may interfere with other activities, such as equestrianism, mountain bike riding, hiking, et cetera. Finally, property owners whose property is adjacent to public

lands which exhibit high OHV use have been exercising vigilantism in Larimer County in order to inhibit OHV usage near their land.

Each May, the Larimer County 4x4 club, "The Mountaineers," does their annual maintenance of the major trails in Larimer County. During their May 2007 meeting, they discussed the fact that the first thing they do, before they do any sort of erosion control or other trail maintenance, is to drag large magnets across the trails in order to retrieve any metals that have been left on the trail. Specifically, they are picking up roofing nails which have been left on the trails by neighbors who wish to deter OHV recreationists from using trails next to their property.

Other problems can be seen in other states. In California, a state with similar OHV trails but higher population density, the entire North Coast region, or King Range, was shut down in 1998 to OHV usage by the Bureau of Land Management due to conflict with other recreational activities. "BLM states the restriction for vehicles on the beach is needed to provide consistent management of the overall area for backcountry recreation and assure the quality of the backcountry experience." (California Coastal Comission, 1998) The Black Sands Beach was the final 3.5 mile stretch of coastline which was open to OHV recreation in the King Range and is currently, as of 2008, closed to OHV usage. Furthermore, the closure of this section of coastline resulted in only 10.8 miles of California coastline available to OHV users (Off-Road, 2005).

Of course, there was a good reason for this closure. OHV recreation has caused many problems for California's many other recreationists. According to a report done by the California Wilderness Coalition and Sierra Club California, among others (1999) "While off-road recreation has prospered under the state's jurisdiction, the state's OHV

program is causing severe damage to the state's primary watersheds, displacing wildlife in our forests and deserts and commandeering a disproportionate share of recreation lands" (p. i). It seems that this sort of sentiment is consistent among non-OHV users of public lands.

What all of these studies fail to acknowledge is the benefits behind this sort of recreation. Many environmental impact studies have evaluated the costs associated with OHV recreation, but none have evaluated the benefits associated with OHV recreation. As a result, trail closure is the only option apparent to lawmakers.

In Colorado, there are many organizations which have "adopted" trails. This implies maintaining the trail in terms of erosion control and litter in order to ensure that the trail stays open for public OHV usage. These organizations include, but are not limited to, Tread Lightly, the Colorado Off-Highway Vehicle Coalition, and the Colorado Association of Four Wheel Drive Clubs. However, as the population of Colorado grows, we can expect to see many of the same problems with multiple-use conflict as a more populated state such as California has exhibited. In this sense, it is important to evaluate the benefits of OHV recreation in Colorado so that they may be compared with the environmental impacts and externality costs associated with the activity.

CHAPTER THREE: NON MARKET VALUATION METHODS

The Contingent Valuation Method (CVM)

CVM was first proposed by Ciriacy-Wantrup in 1947 to identify the value of non-market goods by aggregating the individual net willingness-to-pay amounts to create a market demand schedule. In 1974, CVM gained widespread recognition due to an air pollution abatement study in the Four Corners Region conducted by Randall et al., (1974). The theory underlying CVM was solidified by Hanemann (1984), and after a large oil spill in Alaska (Exxon-Valdez) a blue ribbon panel was formed and determined that CVM can produce estimates reliable enough to be a starting point for administrative and judicial determinations (Arrow et al, 1993).

In the contingent valuation approach, there are no revealed preferences so all measures of consumer surplus or net willingness to pay will be calculated on a hypothetical basis. In essence, the survey respondent is asked a question regarding their hypothetical net willingness to pay. This question can be open ended, such as:

"How much extra would you be willing to pay for this trip? $_____"

Or the question can be closed-ended, and/or dichotomous such as:

"Would you be willing to pay $50 extra to go on this trip?"

We chose the second, closed-ended format in order to reduce exaggeration of net WTP and to keep the questions simple for the respondents. In this case, we have a simple response set: yes or no. In terms of the model, this response set becomes 1 and 0, where 1

represents a yes answer and 0 represents a "no" answer. The dollar amount individuals are asked to pay varies randomly across the sample.

What we try to estimate, then, is the probability of a yes response. The contingent valuation model can be based on either a logit function or a probit function which correspond with our expectations regarding peoples' preferences: At lower prices, we expect probabilities near 1, and at high prices we expect probabilities near 0. Furthermore, we cannot use a linear function because a linear function may estimate probabilities greater than one and less than zero for certain prices. For example:

Figure 3.1: Logistic versus Linear Models

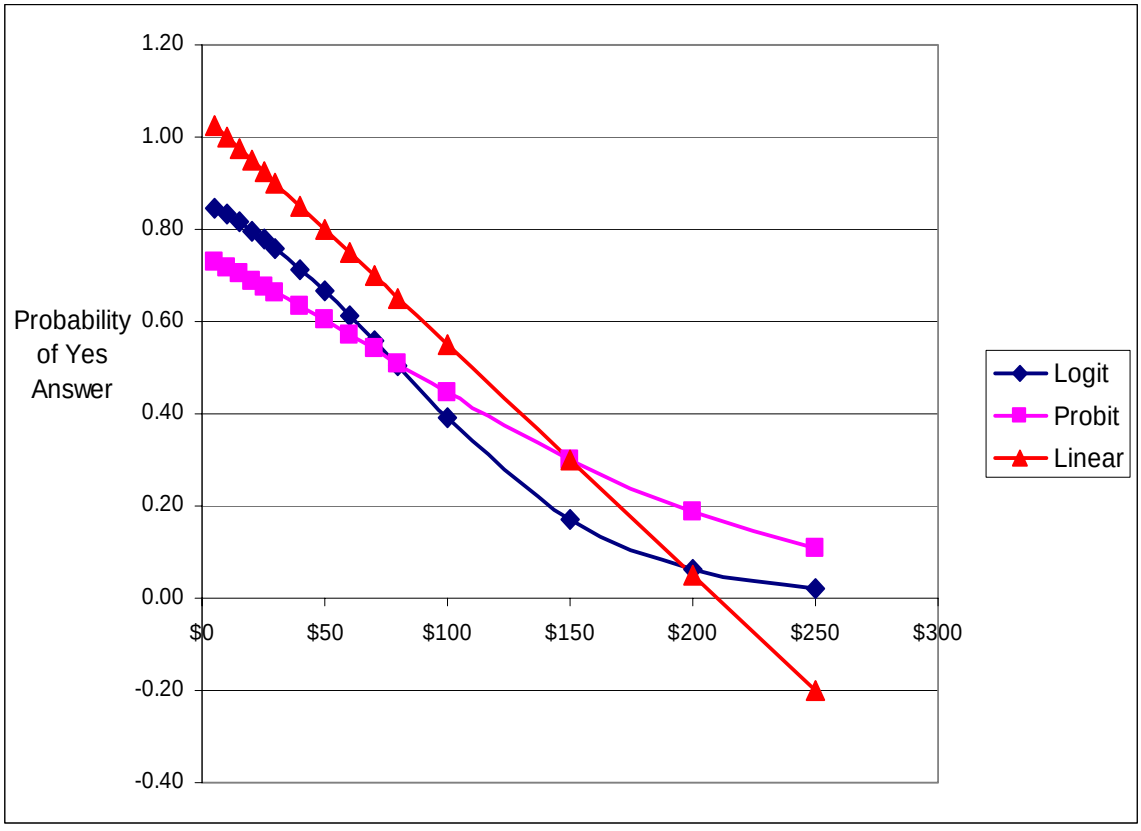


Figure 3.1 shows that while the logistic and probit functions only approach a probability of zero, the corresponding linear function reaches and goes below zero, which

we know is theoretically impossible based on the fact that probabilities cannot be less than zero.

The Travel Cost Method (TCM)

The Travel Cost Model is one of two revealed preference techniques that can quantify non-market goods. Unlike Hedonic models, the TCM is direct in that it deals with stated travel costs rather than property values, and it reflects the consumer's revealed net willingness to pay. The idea for the TCM is attributed to Harold Hotelling, who proposed the basic notion of the method to a national park service director in a 1947 letter.

The Travel Cost model was first used to value non-market recreation goods by Clawson and Knetsch (1966). The basic premise of the TCM is that the number of trips to a recreation site will decrease with increases in distance traveled (and thus increased cost) (Walsh, 1986). This model basically asks people how many times they visit a particular site in a year. This quantity variable becomes the dependent variable, logged, and regressed upon all other independent variables. The most important independent variable is the travel cost of the trip to the location discussed. What we expect is that more remote locations, all other things controlled, will be visited less due to the higher travel cost. Ultimately, the consumer surplus can be extracted from this model by integrating the area under the demand curve (Creel & Loomis, 1990; Englin & Shonkwiler, 1995).

In the travel cost model, the costs faced by the consumer are the costs associated with travel to the recreation site. This would include the gasoline cost and the time cost of the trip to the recreationist. The time cost, by convention, will be one-third of the typical

wage of the recreationist (Cesario, 1976). These costs become one of the exogenous variables in the model, and we expect that higher costs will result in a lower amount of visits to the area. In our survey, rather than bog down recreationists with long tables asking them to fill in individual costs, such as gasoline, lodging, vehicle maintenance, et cetera, we simply asked their travel cost and their travel time. As our results show, this may have proven to be a poor choice.

There are several weaknesses to the travel cost model itself. The first is that it assumes that the trip must be a single destination trip, not merely a stop on the way to another destination (Freeman, 1993). However, the trip may be one of many equally important trips. The second problem is that there must not be any utility in the travel time itself. There are also several mathematical problems with the standard Ordinary Least Squares (OLS) travel cost model. First, number of trips is a discrete dependent variable, whereas OLS assumes a continuous distribution. In order to control for censoring and the integer nature of trip demand, the use of count data models in travel cost analysis is attractive (Hellerstein, 1991).

Endogenous Stratification/Truncation

One thing that needs to be addressed is that fact that our sample may not be exactly representative of the population we are trying to estimate. Specifically, the goal of this study is to estimate the value of OHV recreation to recreationists in Larimer County, Colorado. However, since sampling was done on-site, we only sampled people who were recreating on the days we were surveying. This introduces a bias because we were not sampling those OHV users who were staying home or doing something else on

those days. In addition, with on-site sampling, the probability of being sampled is directly proportional to the number of trips made to the site. In other words, on-site surveying created an "avidity bias" which must be corrected. In the Poisson travel cost model, this bias can be corrected for by simply subtracting one from the dependent variable, or number of trips (Englin and Shonkwiler, 1995).

This same on-site bias may exist for the contingent valuation method. However, methods of estimating the existence and corrections for this are still being developed by other researchers. This issue will be explored in future research, but it is outside of the scope of this thesis.

CHAPTER FOUR: MODELS AND EXPECTATIONS

In order to value OHV recreation in Northern Colorado, we follow the methods of Englin and Holmes (2005) and Fix (1998). We incorporate a travel cost model and a contingent valuation model into our study in order to assess the net willingness to pay and consumer surplus for OHV Recreation.

There are several expectations that seem clear in our modeling of OHV recreation. This study is essentially a benefit analysis, or the benefit half of a cost benefit analysis. Therefore, we examine several aspects of consumer preferences in order to attempt to construct a demand curve and an aggregate figure describing consumer surplus, given no explicit market price or site fee to the consumer other than the travel costs associated with a trip.

Since OHV recreationists on public land do not pay any fees, the benefits of this recreation are in the form of consumer surplus. That is, the difference between the consumers' maximum willingness to pay and the actual travel cost associated with a trip will be the consumer surplus and thus the benefit to the recreationist. These benefits will vary from person to person, depending on a set of exogenous variables describing their preferences and describing the characteristics of the OHV location.

For example, if an OHV user spends $40 in gas and an hour of his time which he values at $10 to drive to a trailhead location, but he would have been willing to pay $100 for this trip, his marginal consumer surplus would be measured at $50. In our models, we

attempt to estimate the average consumer surplus among OHV recreationists in Larimer County. Many economists often prefer the TCM to the CVM due to the fact that the travel cost model deals with *revealed* willingness to pay (i.e. they spent the money on the trip so we know the minimum they would pay) versus *hypothetical* net willingness to pay (our CVM asks survey respondents how much they *would* pay if gas prices went up).

In both our travel cost models and our contingent valuation models, costs, trail attributes and demographic information are included. Costs that will not be included in this model are fixed costs associated with OHV recreation. These costs include the vehicle itself, previous modifications made to the vehicle, and any other tools or toys that are brought along with the recreationist on the trip. These will not be included because these are not marginal costs associated specifically with this trip to this site, but applicable to all trips to all sites.

Theoretically, the demand for OHV recreation will be siimilar to the demand in other markets. Namely, as the price associated with OHV recreation increases, we will expect that the usage, or quantity of days allocated to this sort of recreation, will decrease. There are, however, many other variables which will affect the demand, and ultimately the benefit, of OHV recreation to its users. These variables include trail quality variables, such as amount of rocks, mud, water, and playgrounds which will contribute to the challenge and fun to the recreationists. Finally, demographic variables such as age, level of education, sex, and income must be included in order to control from one user to the next. The travel cost model will be constructed as follows:

$$(1) \qquad \ln(\text{trips}) = \beta_0 + \beta_1*(TC) + \beta_2*(V_2) + \ldots + \beta_N*(V_N) + u$$

Where TC is the travel cost associated with the trip, $\mathbf{V} = (V_2,\ldots,V_N)$ is the vector of trail attributes and demographic attributes associated with the particular trail and individual surveyed, and u is the error term associated with the model. Poisson and Negative Binomial distributions are used and compared in terms of their effectiveness using the same variables. We expect that there will be a negative coefficient on the travel cost variable, and using the travel cost model, the consumer surplus per trip with this functional form is calculated simply by dividing $(-1/\beta_1)$ (Loomis, 2006).

The contingent valuation model is estimated very similarly in the variables, but slightly different in that the logit and probit models we use does not estimate the log of the number of trips taken. In the CVM, the models actually estimate the log of the odds ratio, as seen in the following equation:

$$(2) \qquad \ln[pYES/(1-pYES)] = \beta_0 + \beta_1*(PRICE) + \beta_2*(V_2) +\ldots + \beta_N*(V_N) + u$$

In this case, PRICE represents the hypothetical increase in travel cost asked of each respondent in the survey, and pYES represents the probability that the individual indicates that yes, they would be willing to pay this increased price for OHV recreation. We would expect, again, a negative coefficient on the price variable, and in this case, the consumer surplus will be calculated via the following equation (Hanemann, 1984):

$$(3) \qquad MWTP = - [\beta_0 + \beta_{2)}*(V_2) +\ldots + \beta_N*(V_N)]/ \beta_{1,}$$

where **V** represents the vector of the mean of the independent variables. This estimate of consumer surplus per trip is called the median net willingness to pay. It can be derived as follows. First, start with the model being estimated under probit and logit specifications:

$$(4) \qquad \ln[pYES/(1-pYES)] = \beta_0 + \beta 1*(PRICE) + \beta_{(2)}*(V_2) + \ldots + \beta_{(N)}*(V_N)$$

At the median, the probability of a yes answer will be the same as the probability as a no answer, .5. That means the dependent variable at the median will be the natural log of .5/.5, or ln(1) = 0.

Therefore:

$$0 = \beta_0 + \beta_1*(PRICE) + \beta_2*(V_2) + \ldots + \beta_N*(V_N)$$

Some simple algebraic manipulation yields that the price at which half of the people say yes and half of the people say no, or the Median Willingness to Pay (MWTP), is:

$$(3) \qquad MWTP = - [\beta_0 + \beta_{(2)}*(V_2) + \ldots + \beta_N*(V_N)]/ \beta_1.$$

For the logged-model, where the price variable is logged, the formula is simply exponentiated in order to obtain the MWTP estimate:

$$(5) \qquad MWTP = \exp\{-[\beta_0 + \beta_2*(V_2) + \ldots + \beta_N*(V_N)]/ \beta_1\}.$$

Furthermore, the marginal effects on net WTP for each variable can be determined by dividing each coefficient besides the price coefficient individually by the price coefficient. This can be seen in Cameron (1988) and Loomis (1987):

$$(6) \qquad dWTP/d(Vn) = - \beta_N / \beta_1$$

And for the logged model, where our price variable is logged and the other variables are linear:

$$(7) \qquad \%dWTP/d(Vn) = - \beta_N / \beta_1$$

In this case, the marginal values are interpreted as percentage changes in net WTP given unit changes in the variables. Finally, for the income variable, which is logged, the following formula arises:

$$(8) \qquad \%dWTP/\%d(Income) = - \beta_{(Income)} / \beta_1.$$

The interpretation here, since this is a log-log specification, is that the marginal value gives the percentage change in net WTP given a percentage change in income.

Finally, while median and mean estimates are sometimes very similar, they are also sometimes very different, for example when there are many people who say yes to high bid amounts (Hanemann, 1984). Therefore, we will also report mean net willingness to pay estimates for our models. Furthermore, we do not expect any negative net

willingness to pay since recreationists had the option to take the trip or not and chose to take their trip. Therefore, our mean net WTP estimate will be restricted to the positive quadrant of our demand curve. The mean net willingness to pay can be estimated for the logit model with a linear price variable via the following formula, as in Loomis (1999):

$$(9) \qquad \text{Mean WTP} = \ln[1+\exp(\beta_0 + \beta_{(2)}*(V_2) +\ldots + \beta_{(N)}*(V_N))]*(1/\beta_{(1)})$$

For the Probit model, mean net willingness to pay will be the same as median (Cameron and James, 1997) but this does not exclude the negative net WTP values. We are currently unaware of any formula which computes the mean net WTP for the probit model for the non negative quadrant. For the logged probit model, as in Hanemann and Kaninnen (1999):

$$(10) \qquad \text{Mean WTP} = [\exp(1/\beta_1)]*[(\exp\{-[\beta_0 + \beta_2*(V_2) +\ldots + \beta_N*(V_N))/ \beta_1\}]$$

and finally, for the logged logit model, as in Hanemann (1984):

$$(12) \qquad \text{Mean WTP} = [(\exp\{-[\beta_0 + \beta_2*(V_2) +\ldots + \beta_N*(V_N))/ \beta_1\}]*[(\pi/\beta_1)/(\sin(\pi/\beta_1))]$$

Where $\beta_1 > 1$

One thing that will be different between the TCM and the CVM is that in the linear in bid price CVM, income should not be included because it drops out of the utility

difference model (Hanemann, 1984). However, if both income and bid price are logged, they are able to stay in the model due to the non-linear form of the two variables in the model. We estimate models with and without income in order to see if there is any difference between the two models.

CHAPTER FIVE: DATA GATHERING

Data Needs: Sampling Location

For our sample the difficult part was determining the sites to be sampled. Ideally, a cluster sampling methodology would be employed, sampling a representative group from each and every site in Larimer County, Colorado. Unfortunately, there are too many sites in Larimer County for this given the project budget and many sites are used so infrequently that it is unlikely that any sample of adequate size will be generated from these sites. We selected three trailhead locations, ranging in difficulty from easy to difficult. We selected these three sites because we knew two factors about them. First, these trails were used by all three types of Off Highway Vehicles: All Terrain Vehicles, Dirt Bikes, and 4x4s. Second, these three trails were the only three trails in Larimer County that are maintained by an active OHV organization, "The Mountaineers." This led us to believe that we would obtain a higher survey rate responses and accurate results from these locations since we knew that these trails are heavily used by all types of Off Highway Vehicles.

This dictates that our study will only represent these areas, but since these areas have such high usage, it would not be out of line to infer similar results to other high use areas in neighboring counties. Plus, since the environmental problems associated with OHV recreation is associated with high-use areas, these areas are the most policy relevant to study.

These three locations are numbered 1, 2, and 3 on the map in Appendix 1. The first map indicates the trailhead locations in Larimer County and the second map indicates the location of Larimer County in Colorado. The first location, Sevenmile Creek, is of low difficulty and is characterized by long stretches of trail which cross streams and meanders through trees. The second location was of medium difficulty, named Kelly Flats. This trail is characterized by relatively flat, moderately difficult trails with several difficult obstacles which can be avoided by the recreationist if he or she wishes. The final survey site, Moody Hill, is characterized by difficult rock climbing and long stretches of hill climbing, which involves a well equipped OHV and a skilled user.

Sampling Methodology

The second selection process was choosing specific visitors to survey. We would ideally have obtained a random sample of all OHV recreationists in Larimer County. However, we only actually surveyed those who choose to recreate during the summer of 2007. This will eliminate from the sample those who recreate during the winter, such as snowmobilers.

As described earlier, our surveys were given out and completed on-site. This addresses three issues: First, our costs were cut by not needing to follow the Dillman Tailored Design Method (Dillman, 2000) with multiple mailings and such. There was a huge time investment on the part of the interviewer, but this was still the cheapest option. Second, respondents were not put off by our asking for their address, thus giving them the perception that we are jeopardizing their confidentiality with the study. Third, this

addresses item non response bias because the interviewer will be able to provide guidance and assistance in understanding the questions.

In spite of these benefits, there are three main problems with this data collection method. The first is interviewer bias. While the interviewer may provide assistance in understanding the questions, the interviewer needed to provide *consistent*, non biased help to all respondents who are having problems with a particular question. Fortunately, there was only a negligible amount of difficulty with the survey across respondents. The second problem is that this data collection method requires a huge time investment. The third and final problem is that by intercepting visitors on-site, there is an "avidity" bias, which means that we were much more likely to survey someone who lived nearby and takes a dozen trips per year than someone who lives 500 miles away and takes one trip per year. This problem was addressed in the "Endogenous Stratification" section.

Survey Creation and Focus Group

Our survey was patterned after other surveys of recreational users, such as Loomis, 2006, Loomis and Keske, and Keske and Loomis (both working papers). However, our survey was of course tailored to the needs of this particular study. For example, we were <u>not</u> interested in the economic contribution of OHV recreation to the local economy, so the survey did not become bogged down with pages and pages of difficult expenditure questions.

Once we had an instrument which we felt would be effective and concise, we conducted a focus group. The focus group was administered in May 16, 2007 at the Larimer County 4x4 club ("The Mountaineers") monthly meeting. The club was nice

enough to allow 30 minutes for filling out the survey and then discussing any problems they had with it. Notes were left on the surveys themselves as well, and following the meeting, adjustments were made to the survey as necessary.

One question in the survey was probably more important than any other for this focus group. The question was designed to elicit a distribution of net willingnesses to pay without asking the closed ended question which ultimately appeared on the survey. The question was worded as follows:

> *As you know, the cost of gasoline, oil, vehicle maintenance, alternative fuels, etc. has been rising over time. How much would you have been willing to pay additionally in order to go on your most recent trip?* _____

What we found is that the average person put down something on the order of $20. This told us that our closed ended question which would ultimately be in the survey should have values that averaged about $20. We found out later in our pretest that this assumption was incorrect.

Pretest

In order to ensure that our survey actually worked on-site, we administered a pre-test. This pre-test was administered to 17 users in May of 2007. The pretest response rate was 100%, meaning that everyone who was asked to fill out a survey, did a survey. The survey was almost exactly in its final form, and we were able to also this time ask the net WTP question in a closed-form manner:

As you know, the cost of gasoline, oil, vehicle maintenance, alternative fuels, etc. has been rising over time. If the cost of your most recent trip were to increase by $_____, would you still have taken this trip?

YES *NO*

This time, however, we realized that the average net WTP was closer to $60-$100. As we surveyed, in the spirit of Hanemann and Kanninen (1999), we also adjusted the distribution of our bid amounts as we conducted the survey. This was a random process which involved weighting higher hypothetical price values more heavily until we found that roughly 50% of respondents were saying "yes" to our dichotomous choice question. We used this information to create our final survey version, which resulted in a 52.5% "yes" rate, indicating a reasonably balanced bid price design.

Data Collection

The actual survey distribution took place over the summer of 2007. The specific dates can be seen in table 1. A typical survey day proceeded as follows:

First, early in the morning, I would go to the grocery store and purchase supplies. This generally consisted of cubed ice, as sodas and bottled water had been purchased ahead of time. These items acted not necessarily as direct incentives to fill out the survey, but as "tokens of gratitude" for filling out the survey.

From the grocery store, I would drive to the trailhead location, which was between 45 minutes and 1 hour 15 minutes away. There was no reason to arrive at the trailhead too early because people were surveyed *after* they had finished their day of OHV recreation. Generally, the "early birds" started early enough to finish around 11am,

while late comers were finishing around 6pm. I was usually at the trailhead at 10 and left after 6pm.

The surveying itself was pretty straightforward, but a bit unconventional in nature. Essentially, I would stand in the middle of the trail or parking lot and flag people down. I would then explain to them that I am doing a survey in order to quantify the value of OHV recreation. I also explained that the study I am doing may result in more trails being left open. Most people agreed to do the survey immediately, at which point I offered them something to drink.

There were some other things I did which probably increased the response rate. I helped a couple of men fix their dirt bikes, aired up the tires on one man's trailer, and tried to start a dirt bike by strapping it to my Jeep and driving it down the road. I helped people with directions, gave advice on local trails, and tried to fit in with the OHV crowd. I was also at the site in my OHV Jeep which suggested I was a user. However, I was wearing a Colorado State University, Department of Agricultural and Resource Economics Hat, a collared Colorado State University shirt, and a name tag with my name and the Colorado State University logo. This clearly identified me as being part of a research project at Colorado State University.

Some people, however, felt stressed for time. In this case, I offered them something to drink and explained the importance of this study. I always drove my jeep to the trailhead so that people could see that I was not there to "shut the gate" on their trails or charge them anything. This, I believe, helped more than anything to increase the response rate to nearly 90%.

Still some people did not want to do the survey because they wanted to get home. At this point, I offered them a survey which they could take home with them and mail back in a pre-paid envelope. The problem was that only 4 people all summer replied to this mail survey. However, only 3 people all summer still refused all survey options, and they were all in the same off highway vehicle.

Finally, we surveyed all users of the trail, including passengers. This meant that as long as one person wanted to fill out a survey, all people ended up filling out a survey because they would need to wait for the first to fill out the survey anyways. Since almost all people who were approached filled out a survey, this was not a major issue.

What is shown in table 6.1 is that only on one day were there a lot of "NOs." There were so many people on the trail that day that it was tough for me to spend enough time talking with everyone about the importance of the survey. On all other days, I was able to spend adequate time with each and every user of the trail on that day, as long as they did not simply speed out of the trail and past the parking lot. In other words, there were some people who left the trailhead immediately, whereas most people stopped at the bottom of the trail in the parking lot which is where I intercepted them.

CHAPTER SIX: TESTS AND RESULTS

Demographic and General Survey Results

The first thing to consider in any study such as this is whether the sample accurately represents the population of interest. The best way to proxy this is to sample in an unbiased manner and use an unbiased survey instrument. This implies surveying at a broad enough spectrum of locations, and not "targeting" any particular type of individual. For this study, our sampling locations included trails maintained by the Larimer County 4x4 club which are also used by ATVs and Dirt Bikes. Furthermore, all individuals who recreated on a survey day were approached.

After approaching an individual, if they refused to do a survey on site, they were offered a take-home version of the survey, which included a pre-paid envelope for returning the survey to us. Of the 28 people who were handed this envelope, 4 envelopes were returned. These four surveys were included in the overall response rate. Finally, of all 233 people who were approached, only 3 refused both the on-site and mail back survey.

Our average response rate was 88.31%. Furthermore, the majority of people who did not fill out a survey did so on the same day when the researcher was overwhelmed by too many people at the trailhead. The aggregated, as well as day by day response rates are summarized below in table 6.1.

Table 6.1: Response Rates by Date and Location

Day	Date	Location	Total Completed	Total Approached	Response Rate
Pretest	**28-May**	**Kelly Flats**	**17**	**17**	**100%**
1	30-Jun	Kelly Flats	19	19	100%
2	1-Jul	Kelly Flats	19	19	100%
3	8-Jul	Sevenmile	35	54	65%
3	8-Jul	Kelly Flats	0	2	0%
4	21-Jul	Sevenmile	13	13	100%
4	21-Jul	Kelly Flats	16	16	100%
5	5-Aug	Moody Hill	28	31	90%
5	5-Aug	Kelly Flats	1	1	100%
6	12-Aug	Moody Hill	26	28	93%
7	27-Aug	Moody Hill	24	25	96%
8	3-Sep	Moody Hill	23	23	100%
		TOTALS	**204**	**231**	**88.31%**

Before we analyze the data and try to calculate mean and median net willingness to pay estimates for OHV recreation in Larimer County, it is important to acknowledge the characteristics of the sample. One of the most important variables for the TCM in this case is the trip purpose. There are three sorts of trip purposes which are asked of the survey respondents in the following question:

> Was your trip to this trail: (check only one):
>
> _____the main reason you took the trip from home?
>
> _____one of many equally important reasons you took the trip from home?
>
> _____just a "spur of the moment" stop on a trip taken for some other reason?

The first, second and third responses represent "Primary, Secondary and Tertiary" trip purposes, respectively. The percentage of people who answered each category (including those who did not fill in any category) is summarized below in table 6.2.

Table 6.2: Purpose of Trip		
Type of Trip	Number of Visitors	Percentage of Visitors
Primary Purpose	166	81%
Secondary Purpose	17	8%
Tertiary Purpose	13	6%
Blank	8	4%
Total	204	100%

Both primary and secondary trip purposes are used in our analysis since these groups represent the population which meets the assumption needed in TCM (namely, that we are observing individuals who executed their trip in order to reach the destination in question). The tertiary group is not included in our analysis since we cannot assess whether they are primarily OHV recreationists, or if OHV recreation is just an incidental activity to their main recreation activity such as camping. Obviously individuals who left this question blank cannot be used in any model.

As stated earlier in this paper, the study was aimed at three distinct populations of OHV user: 4x4, ATV, and Dirt Bike users. Table 6.3 summarizes two things: first, it summarizes the percentages of each type of vehicle on the trail, and second it summarizes the method of transportation to the trailhead.

There seems to be an abundance of 4x4 vehicles on the trail, but this may be misleading. 4x4 vehicles generally lower the air pressure in their tires before a trail run, and inflate their tires after a trail run. This requires stopping at a trailhead location for some time, which was perfect for surveying. Furthermore, 4x4 vehicles may carry passengers, who were also surveyed. In the case of dirt bikes, on the other hand, there is one person per bike, and often times these people do not stop at the trailhead. As for

ATVs, while they do stop at the trailhead to load their OHVs onto a trailer, on-site observation suggested that there were simply fewer ATVs on the trail than dirt bikes.

Table 6.3: Travel Characteristics	
Type of Vehicle Used on the Trail?	
4x4	45%
ATV	20%
Dirt Bike	35%
Method of Transportation to the Trailhead?	
4x4	42%
Truck with Trailer*	31%
Truck Without Trailer	26%

*One user was driving a minivan with a trailer

The middle section of the survey asked respondents about the trail characteristics and their preferences in a two part fashion. Users were also asked about the level of crowding on the trail in order to get an idea of the perceived crowdedness on the trails in Larimer County. The questions regarding preferences were formatted as follows:

1. Were there *Rock / Dirt Obstacles* on this trail?

   Yes *No (skip to question 2)*

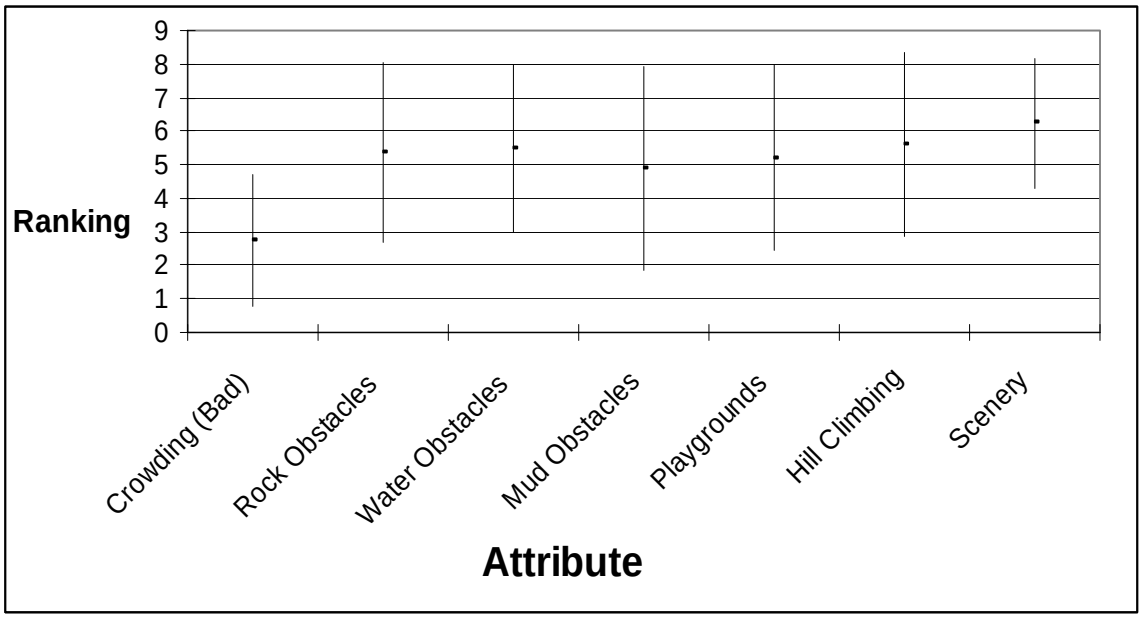
1a. If *Yes*, how would you rate this feature (circle the number)?

   1 2 3 4 5 6 7

   (Dislike) (Neutral) (Like very much)

If someone circled no on the first question they were not supposed to answer the second part of the question. Figure 6.1 summarizes the results of this section.

Figure 6.1: User Preferences*



*Point estimates with a range of 2 standard errors

What we see is that scenery was ranked highest among users, along with hill climbing, water obstacles, and rock obstacles. However, most people did not fill out questions regarding water obstacles and hill climbing. Furthermore, most people did not feel that there was much crowding on the trail.

Finally, demographic information was collected in the end of the survey. What we found is that 81% of OHV users are Male, and the average age of these users is 33 years. Nearly all are employed, and most work full time. Only one OHV user was retired. The average individual has the equivalent of a 2 year degree, and the average household income is nearly $85,000 annually, compared with a median income in Larimer County of $68,200 annually (Compass of Larimer County, 2007). These results are summarized in table 6.4.

Table 6.4: Demographic Information

Demographic Variable	Percentage or number
Male	81.32%
Female	18.68%
Age	33 Years
Employed	94.51%
Employed Fulltime	85.19%
Retired	0.56%
Education	14 Years
Income	$84,411*

*2007 Larimer County median income is 68,200

CVM Results

The contingent valuation question was structured as follows:

8. As you know, the cost of gasoline, oil, vehicle maintenance, alternative fuels, etc. has been rising over time. If the cost of your most recent trip were to increase by $_____, would you still have taken this trip?

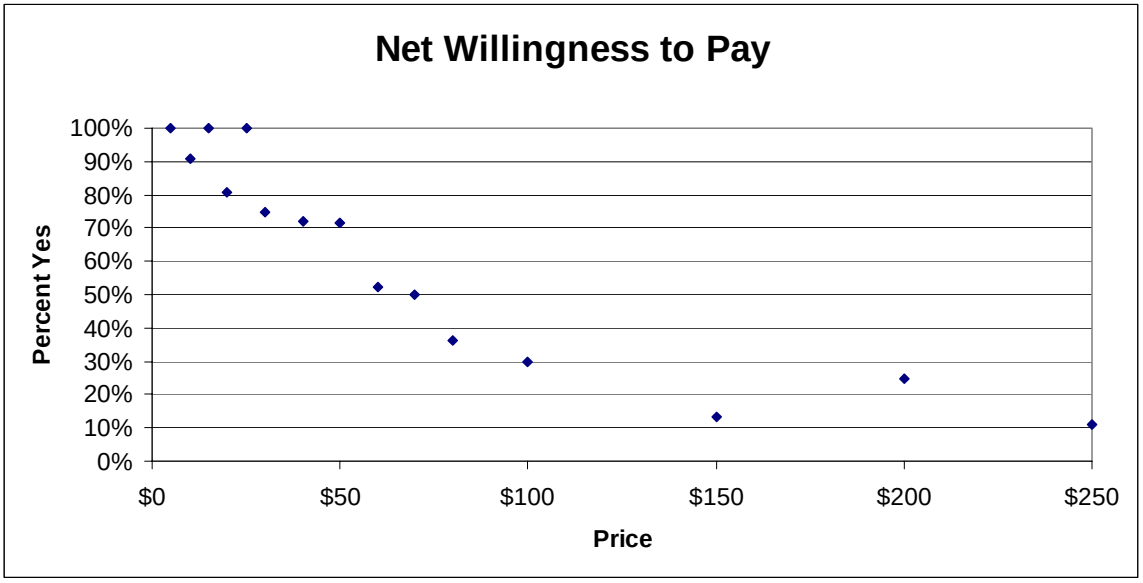
YES NO

The cost of trip increase ranged from $5 to $250 dollars in increments summarized in Table 5. As would be expected, as the price went up, the percentage of people saying yes to a particular price went down. In order to properly represent the probability distribution at the various price levels, it is necessary to construct clusters of prices and analyze the percentage of people who answered yes at that price level. This construction is summarized in table 6.5 and in figure 6.2.

Table 6.5: % Yes at Different Price Levels

Price	Percent Yes
$5	100%
$10	91%
$15	100%
$20	81%
$25	100%
$30	75%
$40	72%
$50	71%
$60	52%
$70	50%
$80	36%
$100	30%
$150	13%
$200	25%
$250	11%

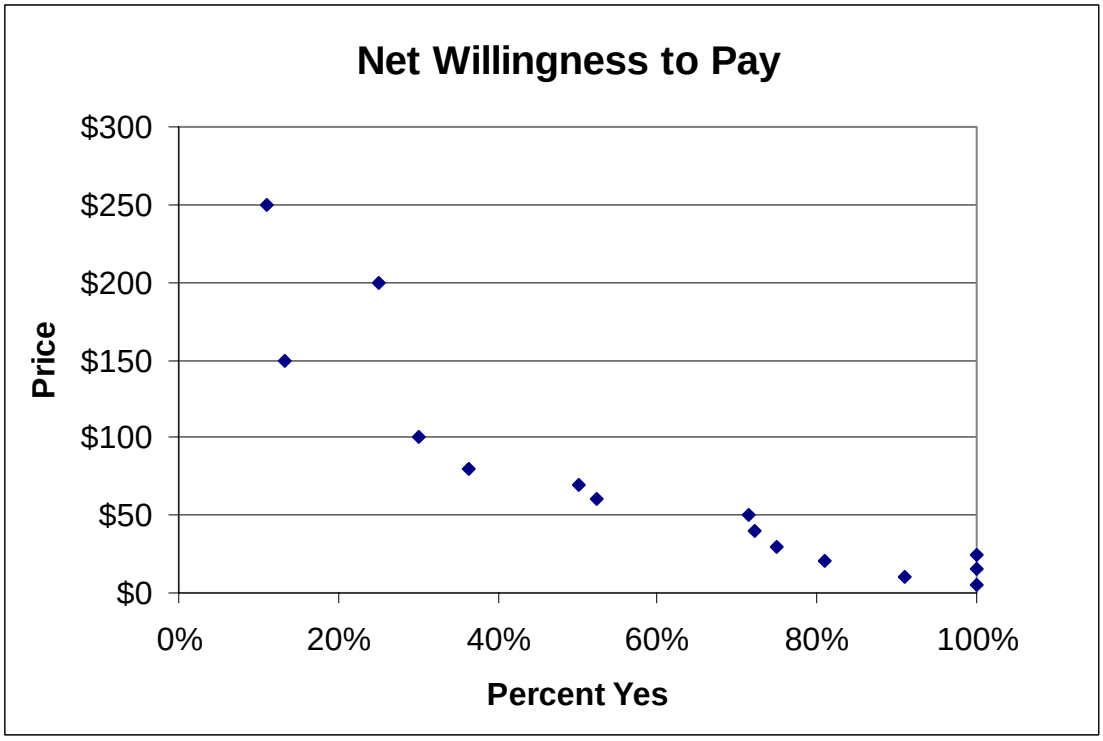
Figure 6.2: Net Willingness to Pay



Traditionally, price is graphed on the vertical axis and quantity is on the horizontal axis. In this case, we don't necessarily have a *quantity*, but we do have a

quantity of people who said yes which can be translated into a percentage figure as done above. Once this is graphed, it is easy to see that our data exhibits a nice downward sloping demand curve with approximate logistic properties (Figure 6.3).

Figure 6.3: Net Willingness to Pay



What seems to be an outlier at $200 is actually a result of the fact that only 4 individuals were asked if they would pay $200, and one of them said yes.

Model Results

In our models, we used logit and probit specifications as described above. The only real difference between the two models is that the probit model is based on a normal distribution whereas the logit model is based on a logistic distribution.

In our case, PRICE represents the hypothetical increase in travel cost asked of each respondent in the survey, and pYES represents the probability that the individual indicates that yes, they would be willing to pay this increased price for OHV recreation. V is the vector of trail attributes and demographic attributes associated with the particular trail and individual surveyed.

We included several intuitive variables in our model. DRIVER is a binary variable indicating whether or not the individual was a driver. Passengers would be coded as a 0, for example. This variable was included because the driver may be the decision maker in the group and he/she may have a different preference for this site where they drove. 4x4 is another binary variable indicating whether the individual was driving a 4x4 vehicle or not. A second binary variable for either ATV or Dirt Bike (not for both since with 3 variables, only 2 dummies are needed in order to avoid a singular matrix) is not included since the two forms of recreation are similar in cost and quality, whereas a 4x4 can cost over $50,000. Furthermore, when we tested a smaller model, there was no significance of the ATV variable, for example.

“Like Rocks” is the only preference variable used in the model. The variable represents a scale of 1 to 7 representing how much a particular individual enjoys this particular trail feature (rocks). There are two reasons why other preference variables were not included. First, Larimer County OHV recreation can be characterized by rocky

terrain. Second, not many people answered the other questions since many people did not find other obstacles (such as mud, water crossings, hill climbing, etc.) on the trails we selected, so there was no rating to be given.

Two dummy variables were included for Kelly Flats and Sevenmile Creek trailhead locations (if both variables are 0, then Moody Hill is the location surveyed).

Demographic information is also included in the model. Income is included only in some models due to the fact that income nets out in the linear in bid in the logit and probit models, as discussed earlier. However, when we did use income, we used the natural log of income as well as the natural log of the price variable.

Finally, while it rains almost every afternoon during the summer in the Larimer County high country, there was one particular day where it was raining all day long. Therefore, weather became a binary variable in our model as well, with a 1 representing an extremely rainy day.

Several variables in the survey were excluded from our model. Preference variables, such as "How much did you enjoy the water crossings on this trail?" were excluded because there were only a few people who answered this question. This is not item non response: the question was not applicable to them. They answered "no" to the previous question which asked "Were there any water crossings on this trail?" Other variables were tested and were very insignificant, so in order to reduce the variance in our overall model, and raise our degrees of freedom, these variables were excluded.

The results of our four models (Logit, Probit, Logit with logged income and price and Probit with logged income and price) are summarized below in table 6.6. Standard errors are italicized.

Table 6.6: Logit and Probit Specifications (CVM)

Variable	LOGIT	PROBIT	LNLOGIT	LNPROBIT
Constant	1.57	0.94	-1.06	-0.11
	1.63	*0.96*	*4.67*	*2.72*
Price	-0.02	-0.01		
	*0.004***	*0.002***		
Ln(Price)			-1.70	-0.95
			*0.29***	*0.15***
Driver	-0.21	-0.18	-0.34	-0.17
	0.54	*0.31*	*0.58*	*0.33*
4x4	-0.57	-0.34	-0.45	-0.31
	0.45	*0.27*	*0.50*	*0.29*
Like Rocks	0.26	0.15	0.34	0.19
	*0.15**	*0.09**	*0.17***	*0.09**
Sevenmile	0.70	0.43	0.74	0.38
	0.56	*0.33*	*0.59*	*0.35*
Kelly Flats	0.20	0.09	0.24	0.14
	0.52	*0.31*	*0.58*	*0.33*
Education	-0.04	-0.03	-0.07	-0.04
	0.09	*0.05*	*0.10*	*0.06*
Sex	-0.25	-0.10	-0.30	-0.17
	0.52	*0.31*	*0.56*	*0.32*
Weather	-1.14	-0.70	-1.63	-0.96
	*0.59**	*0.35***	*0.68***	*0.38***
Ln(income)			0.71	0.36
			*0.40**	*0.23*
McFadden R-Squared	.25	.25	.31	.30
N	170	170	159	159
LR-Statistic	59.76	58.58	67.78	66.49

*indicates significance at the 10% level
**indicates significance at the 5% level
***indicates significance at the 1% level

Correlations between independent variables are shown below in table 6.7. We can see that there is no correlation between variables which is large enough to warrant removal of a variable.

Table 6.7: Correlations Between Independent Variables

	Price	Driver	Jeep	Like Rocks	Sevenmile	Kelly Flats	Education	Sex	Weather	Income
Price	1.00	-0.09	0.13	-0.02	0.28	-0.01	0.04	-0.04	-0.06	-0.08
Driver	-0.09	1.00	-0.40	0.10	-0.21	-0.05	-0.11	0.42	0.17	0.13
Jeep	0.13	-0.40	1.00	0.03	0.04	0.34	0.13	-0.16	-0.19	-0.18
Like Rocks	-0.02	0.10	0.03	1.00	-0.24	0.12	-0.05	0.17	0.17	0.11
Sevenmile	0.28	-0.21	0.04	-0.24	1.00	-0.33	-0.08	0.00	-0.21	-0.07
Kelly Flats	-0.01	-0.05	0.34	0.12	-0.33	1.00	-0.05	0.09	-0.22	0.08
Education	0.04	-0.11	0.13	-0.05	-0.08	-0.05	1.00	-0.15	-0.10	0.04
Sex	-0.04	0.42	-0.16	0.17	0.00	0.09	-0.15	1.00	0.00	0.11
Weather	-0.06	0.17	-0.19	0.17	-0.21	-0.22	-0.10	0.00	1.00	0.03
Income	-0.08	0.13	-0.18	0.11	-0.07	0.08	0.04	0.11	0.03	1.00

From a benefit transfer standpoint that there is no difference in the location of the logit function with regard to these sites we surveyed at (i.e. coefficients on Kelly Flats and Seven Mile Creek not significantly different zero). As derived in Chapter 3, the mean and median net willingness to pay is calculated via the following table (table 6.8):

Table 6.8: Median and Mean Net WTP Estimates

	Median Net WTP	Mean Net WTP
LOGIT	$80.46	$87.09
PROBIT	$83.31	$83.31*
LNLOGIT	$68.16	$131.57
LNPROBIT	$67.36	$207.79

*This is not restricted to the positive quadrant.

Using the fact that almost everyone on the trails was surveyed for 8 weekend days out of the roughly 40 weekend days open to OHV recreation in Larimer County, we can assume that we surveyed at *least* 1/5 of the total users of a trail during the summer of

2007. Granted, there were probably many other users during the week, and perhaps other users during those surveyed weekend days, we know that with 206 people surveyed, and each person spending, on average, 3.15 days on the trail per year, we can aggregate up to at least 3248 user days per trail per summer. Furthermore, each user averaged 11.44 OHV trips in Larimer County, which means that there are at *least* 11,787 user days per summer in Larimer County.

With this logic in mind, we can use the minimum and maximum mean net WTP figures to estimate that the aggregate per trail consumer surplus level in Larimer County is at *least* between $282,908.50 and $674,997.80. We can also use these figures to estimate the aggregate Larimer County OHV surplus per summer to be at *least* between $1,026,542 and $2,449,249. Again, these are very conservative estimates of surplus since this does not include weekdays and people who were not surveyed.

The confidence intervals around the median estimates are shown in table 6.9 below.

Table 6.9: 95% Confidence Intervals Around Median Net WTP Estimates

	Lower Bound	**Median**	Upper Bound
Logit	$70.56	**$80.46**	$95.58
Probit	$55.54	**$83.29**	$116.89
Logged Logit	$24.79	**$68.16**	$184.94
Logged Probit	$37.04	**$67.36**	$128.16

As expected, the price variable is highly significant and negative, corresponding with a downward sloping demand curve. Furthermore, Like Rocks is marginally significant, indicating that the more an individual enjoys rocks, the more they are willing to pay for OHV recreation in Larimer County.

Oddly enough, however, the only other variable which was consistently significant across models was the Weather variable, where rainy weather decreases the probability of a yes answer to the price variable. Income was only significant at the 10% level in one out of two models.

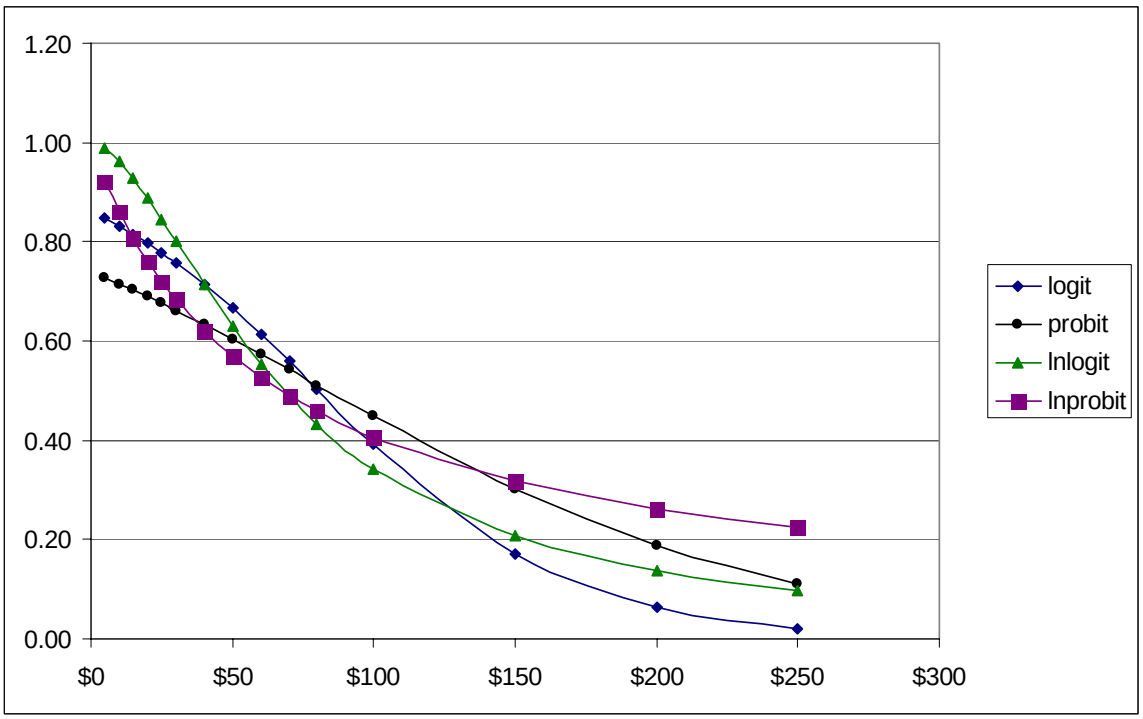
All four models are used to predict hypothetical probabilities of a yes vote, given average values for all variables except for the price variable, which is distributed as it was in the survey. The results of this modeling are summarized below in table 6.10.

Table 6.10: Logit and Probit Predicted Probabilities

Price	LOGIT	PROBIT	LNLOGIT	LNPROBIT
$5	0.85	0.73	1.00	0.97
$10	0.83	0.72	0.99	0.93
$15	0.81	0.70	0.98	0.89
$20	0.80	0.69	0.97	0.84
$25	0.78	0.68	0.95	0.80
$30	0.76	0.66	0.92	0.75
$40	0.71	0.63	0.85	0.67
$50	0.67	0.60	0.76	0.60
$60	0.61	0.57	0.67	0.54
$70	0.56	0.54	0.58	0.49
$80	0.50	0.51	0.50	0.44
$100	0.39	0.45	0.37	0.37
$150	0.17	0.30	0.18	0.25
$200	0.06	0.19	0.10	0.18
$250	0.02	0.11	0.06	0.14

Furthermore, these results are graphed below in Figure 6.4. It is easy to see that these results look very similar to the actual data shown above in Table 6.5.

Figure 6.4: Logit and Probit Models



As defined in Chapter 3 of this thesis, the marginal effects of the significant variables are defined in table 6.11. The first two columns represent linear relationships, where a one-unit change in the independent variable will change net WTP by the given amount. In the next two columns, a one unit change in the dependent variable will change net WTP by the given percentage. Finally, for income, since it is logged, a 1% change in income will change net WTP by the given amount.

Table 6.11: Marginal Effects

	LOGIT	PROBIT	LNLOGIT	LNPROBIT
LikeRocks	$11.58	$11.89	20.08%	19.66%
Weather	-$50.50	-$56.02	-95.76%	-100.89%
Income			0.42%	

Finally, the prediction success is the most important indicator of whether or not the model is good at predicting a yes or no vote. We determine the predictive success of each model by applying each individual's preferences to the model, with the price given to them on their survey. The model will give a probability between 0 and 1 of a yes vote. If this probability is greater than .5, we assume that the model has predicted a yes vote. If the probability is below .5, we assume the model has predicted a no vote. We then compare our model results to our actual results. The models accurately predict a yes or no vote more than 75% of the time. These results are summarized in table 6.12.

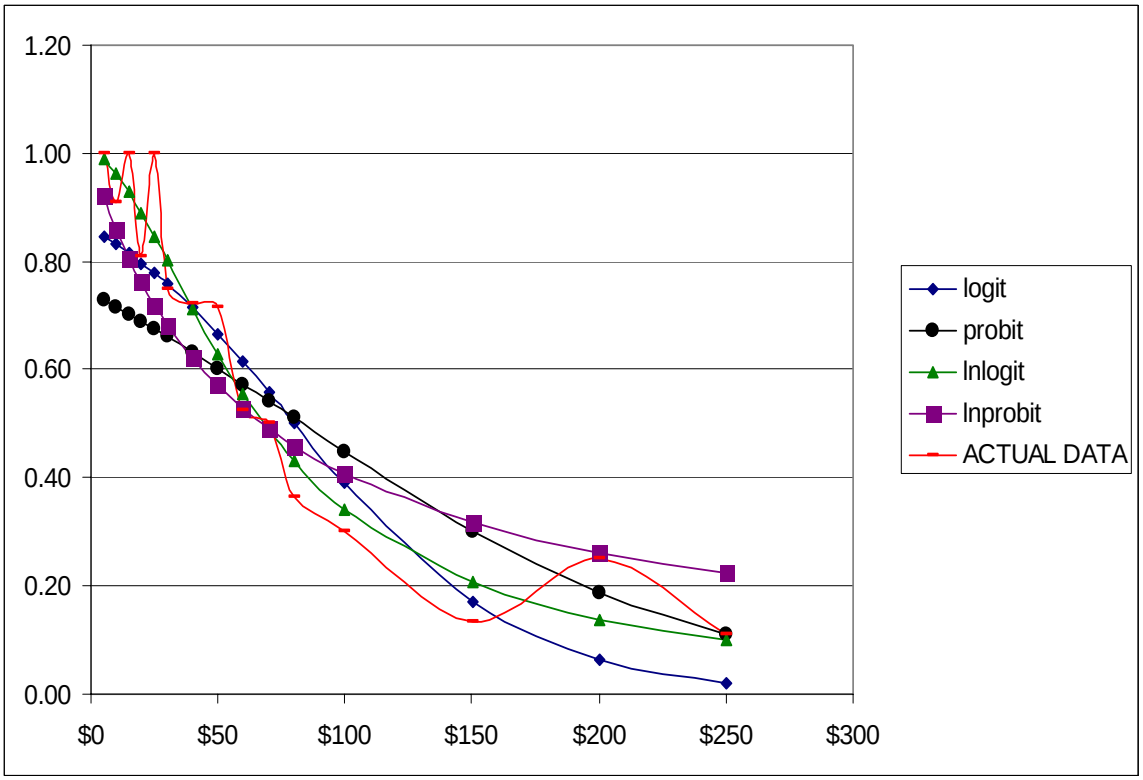
Table 6.12: Prediction Success

Model	Percentage Correct
Logit	75.29%
Probit	74.70%
Logged Logit	77.98%
Logged Probit	76.73%

In spite of this predictive success, we can see from the actual data that the Logged Logit model most closely follows the true distribution of the sample data given the high

probability of a "yes" answer below $30 (Figure 6.5). This model also had the highest likelihood ratio statistic at 67.78.

Figure 6.5: Logit and Probit predictions versus Actual Data



TCM Results

As in our Logit and probit models, price was our independent variable of interest. However, in this case, our price was not hypothetical, it was the reported travel cost from home to the trailhead and back again. Level of education, sex, and income must be included in order to control from one user to the next. The reported travel cost was simply divided by the stated total number of people in the vehicle traveling to the trailhead in order to accurately identify the true travel cost seen by the user. The

dependent variable is the log of the number of trips that an individual takes to a particular location in a given year.

Our vector of independent variables is the same as in our contingent valuation models found earlier in this paper. However, we added travel time into the travel cost model in order to account for the fact that the recreationist may not derive utility from their travel time. In other words, we expect a negative coefficient on the travel time variable (Cesario, 1976).

There are three specifications for our travel cost model. A poisson distribution was utilized twice: once without correcting for endogenous stratification (discussed earlier in this paper) and one with the correction (the correction involves simply subtracting 1 from the number of trips taken in a year). We also used a negative binomial distribution once without correcting for endogenous stratification. What we found was that all three models failed to find a relationship between travel cost and number of trips taken in a year. In fact, the only variable that displayed any significance at all was our preference variable Like Rocks. The results are summarized in table 6.13.

Table 6.13: Travel Cost Models

	Negative Binomial	Poisson	Poisson -1
Constant	0.48	0.42	-0.43
	0.75	*0.98*	*1.50*
TravelCost	-0.003	-0.002	-0.003
	0.003	*0.003*	*0.004*
Income	1.67E-06	1.22E-06	1.73E-06
	1.75E-06	*2.51E-06*	*3.72E-06*
Driver	0.29	0.35	0.53
	0.22	*0.33*	*0.51*
Jeep	-0.17	-0.07	-0.12
	0.18	*0.26*	*0.36*
LikeRocks	0.19	0.20	0.31
	*0.06****	*0.08***	*0.13***
Sevenmile	-0.32	-0.38	-0.58
	0.24	*0.25*	*0.43*
KellyFlats	-0.23	-0.31	-0.41
	0.23	*0.26*	*0.39*
Education	-0.01	-0.01	-0.01
	0.04	*0.04*	*0.06*
Sex	-0.23	-0.28	-0.42
	0.22	*0.31*	*0.44*
Weather	-0.33	-0.37	-0.51
	0.25	*0.41*	*0.58*
TravelTime	-0.13	-0.09	-0.16
	0.12	*0.19*	*0.31*
N	157	157	157
Adj. R-Squared	.01	.03	.03
P-value of Mixture Parameter	.0002		

*indicates significance at the 10% level
**indicates significance at the 5% level
***indicates significance at the 1% level

The results in our first models did not seem intuitive at all, so examination of the data seemed necessary. What we found is that on average, users took about 3 trips to a particular trailhead location in a year. Furthermore, the standard deviation was 4 trips.

However, there were 8 individuals who said that they took 15 or more trips to the trailhead where they were surveyed. Table 6.14 summarizes the results of the same model as previously discussed, only with these 8 outliers removed.

Table 6.14: Travel Cost Models Minus Outliers

Variable	Negative Binomial	Poisson	Poisson –1
Constant	1.21	1.22	0.84
	0.62	*0.59*	*1.04*
Travel Cost	-0.003	-0.003	-0.005
	0.003	*0.002*	*0.004*
Income	8.90E-08	1.31E-08	-1.25E-07
	1.59E-06	*1.39E-06*	*2.52E-06*
Driver	0.16	0.14	0.25
	0.20	*0.18*	*0.34*
Jeep	-0.30	-0.31	-0.57
	*0.16**	*0.16**	*0.29**
Like Rocks	0.12	0.13	0.22
	*0.05***	*0.05***	*0.09***
Sevenmile	-0.39	-0.42	-0.69
	0.20	*0.18***	*0.34***
Kelly Flats	-0.23	-0.24	-0.29
	0.19	*0.18*	*0.31*
Education	-0.04	-0.04	-0.07
	0.03	*0.03*	*0.05*
Sex	-0.02	-0.03	-0.06
	0.20	*0.17*	*0.31*
Weather	-0.92	-0.94	-1.69
	*0.23****	*0.24****	*0.56****
Travel Time	-0.10	-0.10	-0.21
	0.10	*0.09*	*0.19*
N	147	147	147
Adj. R-Squared	.01	.03	.03
P-value of Mixture Parameter	0.13	.13	.14

*indicates significance at the 10% level
**indicates significance at the 5% level
***indicates significance at the 1% level

Similarly to our first models, this specification finds no relationship between travel cost and number of trips taken in a particular year. What this specification does reinforce is the fact that the preference variable, Like Rocks, and the Weather influence trips. What is interesting is that in the CVM, it is understandable that the weather on a particular day would affect the net willingness to pay on that particular day. However, there is absolutely no explanation as to why the weather on a particular survey day would affect the number of trips an individual takes in a particular year. This result seems to further weaken what little information this model may have given.

New Travel Costs

Finally, in an effort to capture the relationship between travel cost and annual trips taken, two new travel cost variables were created. The first method was to simply use the stated zip code and stated travel distance to determine travel cost. This was done by comparing stated zip code with stated travel time, which seemed to vary wildly even within a particular zip code (in one case, 2 people from the same zip code indicated travel costs of $30 and $800, with corresponding travel times. They drove from North Dakota, stayed in Fort Collins, and then drove another 30 miles to the trailhead. The $30 dollar travel time was ultimately used to reflect the marginal cost of the OHV trip in Larimer County). We used stated travel time unless the zip code indicated an error. If there were more people who came from the same zip code, their travel time was used. Ultimately, the travel distance was multiplied by $.52 per mile, the average stated travel cost per mile.

The second method of calculating travel cost was a bit more complex. The creation of the new travel cost variable began by checking for odd distance-cost combinations, such as 1 mile and 70 dollars. If there was ever a missing stated travel cost, we simply used travel distance. For the odd combinations, we used stated zip code to determine which variable was most likely incorrect, travel time or travel cost. The variable which corresponded with the stated zip code was used to proxy travel cost. Furthermore, if both travel time and travel cost were left blank, zip code was used as described before.

Both travel cost variables were used in Poisson and Negative Binomial models. Table 6.15 shows that all of these models using calculated travel cost perform worse than the travel cost models described earlier in this section. As before, the travel cost variable is insignificant, suggesting that this may be a robust result.

This may also suggest a failure in our survey instrument in that our travel costs were not direct and did not specify costs of specific things, such as gas. It may even suggest that there is not enough variation in our data since most visitors were from nearby Fort Collins, CO or Loveland, CO.

Table 6.15: New Travel Cost Models

Variable	Zip Cost Negative Binomial	Zip Cost Poisson	New Cost Negative Binomial	New Cost Poisson
Constant	-0.52	-0.63	-0.70	-0.65
	1.42	*1.42*	*1.39*	*1.44*
Travel Cost	-0.007	0.003	0.011	0.008
	0.006	*0.008*	*0.007*	*0.004**
Income	4.06E-06	1.47E-06	1.32E-06	3.85E-07
	3.49E-06	*3.50E-06*	*3.63E-06*	*2.94E-06*
Driver	0.48	0.48	0.46	0.41
	0.41	*0.47*	*0.39*	*0.46*
Jeep	-0.39	-0.14	-0.51	-0.19
	0.34	*0.35*	*0.33*	*0.32*
Like Rocks	0.31	0.32	0.33	0.31
	*0.11****	*0.12***	*0.11****	*0.12***
Sevenmile	-0.44	-0.63	-0.49	-0.74
	0.47	*0.37**	*0.45*	*0.38**
Kelly Flats	-0.14	-0.44	-0.19	-0.47
	0.43	*0.37*	*0.42*	*0.37*
Education	0.00	-0.01	-0.01	0.01
	0.08	*0.06*	*0.08*	*0.05*
Sex	-0.34	-0.37	-0.29	-0.37
	0.43	*0.42*	*0.41*	*0.41*
Weather	-0.44	-0.48	-0.35	-0.43
	0.47	*0.58*	*0.45*	*0.57*
Travel Time	-0.32	-0.20	-0.35	-0.25
	0.22	*0.32*	*0.21*	*0.33*
N	157	162	162	162
Adj. R-Squared	-.05	.04	-.03	.07
P-value of Mixture Parameter	0		0	

*indicates significance at the 10% level
**indicates significance at the 5% level
***indicates significance at the 1% level

CHAPTER SEVEN: CONCLUSIONS AND EXTENSIONS

The purpose of this paper was to identify the consumer surplus, or net willingness to pay, for Off Highway Recreation in Larimer County, Colorado. This goal was attained, as we estimate a consumer surplus level of $87-$207 per person per day for this sort of recreation using the contingent valuation method. This equates to a per summer per trail consumer surplus between $282,908.50 and $674,997.80, and a Larimer County OHV surplus per summer to be between $1,026,542 and $2,449,249. The wording of our dichotomous choice question yields that the price of the trail surveyed, as well as all other trails have gone up in price. This means that while we may not be able to make statements about the value of OHV recreation at any particular trail, we can make statements about the value of OHV recreation in Larimer County as a whole.

Using these estimates, we can now make educated policy decisions regarding OHV recreation. Specifically, if a government organization is considering trail closure due to costs associated with OHV recreation, they will now be able to consider whether or not the costs of restoration and externalities imposed upon other recreationists exceed the benefits of OHV recreation.

We also attempted to use two different models, the contingent valuation model and the travel cost model, in order to come to the most accurate estimate of consumer surplus. However, what we found is that the travel cost model failed to have a negative price coefficient in this case, regardless of specification.

There are several possibilities regarding the insignificance of the travel cost model. One likely possibility is that there was not enough variability in the travel distance between individuals to indicate the downward-sloping demand curve we expect. Specifically, the average reported travel cost was about $54 dollars, but the standard deviation of this variable was $77 dollars. Furthermore, most people taking single or primary purpose trips were only traveling from the nearby towns of Fort Collins and Loveland, but there was a wide variety of travel costs even within the same zip code.

In other travel cost studies, such as Fix (1998), the location of interest was a famous location with few substitutes. As a result, there were some users who were local and some who were from very far away.

Furthermore, Fix (1998) used a survey instrument which articulated each and every travel cost separately, rather than simply asking recreationists what their travel cost was. It is possible that in this survey in Larimer County, it was simply too difficult for users to recall what costs they incurred in order to reach the trailhead. Recall that the question regarding travel cost was worded as follows:

9. What was your total Travel Cost (gas, oil, lodging, etc.) from your home to this trailhead and back again?

$_____

While we were attempting to gain information regarding the users' *perceived* travel cost, it is possible that survey respondents were not able to accurately assess their travel costs during the short time they were taking the survey without being aided by a detailed category of each expense.

What is certain is that the cost of having a small table breaking out the individual costs that users incurred during their travels would have been small in terms of response rate (especially considering the high response rate exhibited with this on site survey distribution method). However, the benefits might have been great. Not only would a more accurate travel cost variable have been procured, but other valuable information in terms of the economic contribution of OHV recreation to Larimer County would have been obtained.

It may be the case, however, that even with detailed travel cost information, the model would have failed to find any significance in the travel cost variable due to the lack of variation in our data. It may therefore be possible to assert that in cases where visitors are traveling from local towns, the CVM is a more efficient tool in assessing net WTP.

Nonetheless, the valuation information produced should be of use to the USDA Forest Service and OHV groups in better understanding the benefit of keeping open OHV trails in Larimer County. In addition, with an estimate of benefit per trip, this can be compared to the environmental damage cost from OHV recreation to determine whether it is cheaper to close trails or to undertake continual environmental damage mitigation and restoration of OHV trails to keep them open.

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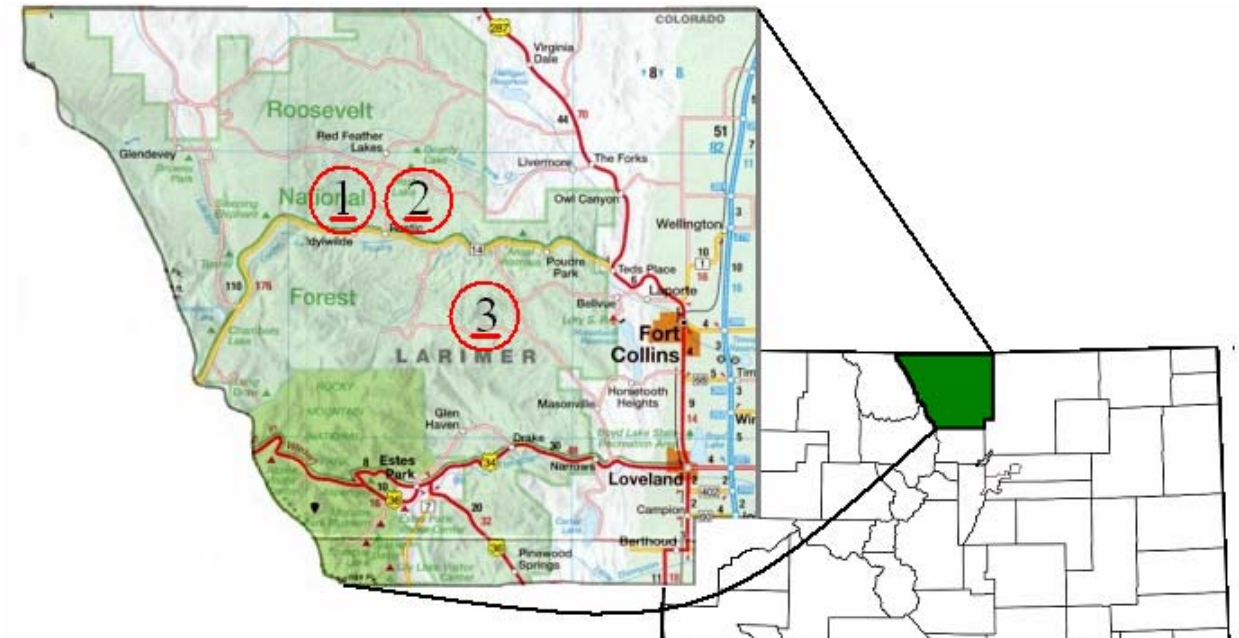
APPENDICES

APPENDIX 1: LARIMER COUNTY AND TRAILHEAD LOCATION MAP



1: Sevenmile Creek
2: Kelly Flats
3: Moody Hill/
Crystal Mountain

APPENDIX 2: SURVEY COVER LETTER

Dear OHV User:

This short survey is about your current visit to one of the many Larimer County OHV trails. We really appreciate you taking the time to fill this out.

Your responses to this survey will also help improve the quality of your recreation experience. So let us know what you think (besides responding to the survey questions, the back of the survey can be used to write any suggestions or concerns you would like to see addressed).

You are one of a small number of visitors being asked to give their opinion on OHV recreation. In order that the results of the study truly represent the thoughts of people visiting the area, it is important that each questionnaire be completed and returned.

The survey will only take a few minutes, but your answers mean a great deal to us.

The survey booklet contains all the information you will need to complete the survey. There are no right or wrong answers. It is important to hear from everyone, whether this is your first visit to the area or you are a regular visitor.

Your responses are completely confidential. Your name will never be placed on the questionnaire and your name will never be associated in any way with your answers.

If you have any questions, please or email Daniel Deisenroth at deisen@lamar.colostate.edu or John Loomis at jloomis@lamar.colostate.edu. Either one of us will be happy to answer any questions you have.

We look forward to receiving your survey in the days ahead.

Sincerely,

Daniel Deisenroth
Dept. of Agricultural and Resource Economics

Dr. John Loomis
Professor

APPENDIX 3: THE SURVEY

Your OHV Trip in Larimer County

What Did You Think?

Thank you for agreeing to complete this survey. Your answers will be quite helpful in maintaining and creating new recreation areas for you. The purpose of this survey is to understand features of trails that are important to you and the value that OHV users place on different trails in Larimer County. In this survey, when we refer to a **trip** we mean a trip from home to a recreation area and back again. For the purpose of this survey, a **trail** is an OHV route you traveled to in order to do 4x4, Dirt Bike, or ATV recreation. All questions on this survey refer to the trail at which you are being surveyed.

Section A.

1. Please circle the primary type of equipment you used on the trail today (circle one):

   4x4 ATV Dirt Bike

   1a. Were you a passenger or a driver?

   Passenger Driver

   1b. If you circled ATV or Dirt Bike, how many *other* ATVs or Dirt Bikes were transported with the same vehicle as your ATV/Dirt Bike?

   _____

2. What was the primary method of travel to the trailhead?

   4x4 Truck with Trailer Truck without Trailer RV

   Other_____

3. Was your trip to this trail: (check only one):
   _____the main reason you took the trip from home?
   _____one of many equally important reasons you took the trip from home?
   _____just a "spur of the moment" stop on a trip taken for some other reason?

4. How many people traveled with you to the trailhead today *in the same vehicle as you, **including yourself**?* _____

5. What will be your length of stay at or near the trailhead where you received this survey?

   #hours_____ or _____# days

6. What will be your total length of time away from home, on the entire trip?

   #hours_____ or _____# days

7. What was the **one way** travel time from your home to the trailhead where you received this survey?

_____# hours _____# minutes

8. What was your **one way** travel distance from your home to this trailhead?

_____# one-way miles

9. What was your total Travel Cost (gas, oil, lodging, etc.) from your home to this trailhead and back again?

$_____

10. Including this trip, how many OHV trips did you take to *this trail* in the last 12 months.

_____# of trips

11. How crowded would you say the trail was today ?

1 2 3 4 5 6 7

(Nobody on the trail) (Jam Packed)

Section B. Trail Characteristics

The following terms are used in the next several questions.

Rock / Dirt Obstacles refer to fairly large rocks or dirt mounds and slow driving.

Water crossings involve a river or stream.

Mud refers to a challenging area or hole which is muddy, deep or otherwise, not associated with a stream or river.

Hill Climbing involves steep, challenging inclines that are longer than 100 feet.

Playgrounds refer to **off-the-trail** areas which offer any of the above listed challenges.

Using these terms, please answer the following questions to the best of your abilities.

1. Were there *Rock / Dirt Obstacles* on this trail?

   Yes *No (skip to question 2)*

   1a. If *Yes*, how would you rate this feature (circle the number)?

   1 2 3 4 5 6 7

   (Dislike) (Neutral) (Like very much)

2. Were there *Water Crossings* on this trail?

   Yes *No (skip to question 3)*

   2a. If *Yes*, how would you rate this feature (circle the number)?

   1 2 3 4 5 6 7

   (Dislike) (Neutral) (Like very much)

3. Was there *Mud* on this trail?

   Yes *No (skip to question 4)*

   3a. If *Yes*, how would you rate this feature?

   1 2 3 4 5 6 7

   (Dislike) (Neutral) (Like very much)

4. Were there *Playgrounds* on this trail?

   Yes *No (skip to question 5)*

   4a. If yes, how would you rate this feature?

   1 2 3 4 5 6 7

   (Dislike) (Neutral) (Like very much)

5. Was there ***Hill Climbing*** on this trail?

Yes *No (skip to question 6)*

5a. If yes, how would you rate this feature?

1 2 3 4 5 6 7

(Dislike) (Neutral) (Like very much)

6. Now, please rate the scenery of the trail. Please circle only the number:

1 2 3 4 5 6 7

(Dislike) (Neutral) (Like Very Much)

7. Approximately how much money do you spend each year, on average, on *modifications/repairs* to your vehicle? Please circle one.

$0 $0-$99 $100-$199 $200-$499 $500-$999 $1000-$1999

$2000-$4999 $5000-$9999

Other_____

7a. How much did you spend on modifications/repairs that were *solely intended for this trip*? $_____

8. As you know, the cost of gasoline, oil, vehicle maintenance, alternative fuels, etc. has been rising over time. If the cost of your most recent trip were to increase by $_____, would you still have taken this trip?

YES NO

Section C. Please tell us something about yourself.

Remember, all of your answers are confidential. Only averages will be reported.

1. Are you? Male Female

2. What year were you born in? _____

3. Are you employed?

   YES----→Do you (circle one): Work full time Work Part-time

   NO-----→Are you retired (circle one)? Yes No

4. What is your zip code? _____

5. On this trip are you riding/driving as part of an organized club or event?

   YES NO

6. About how many OHV trips do you take each year to all areas in Larimer County.

   _____# of trips

7. Including this trip how many outdoor recreation trips of all types do you take during a typical summer?

_____ # of all trips

8. Please indicate your highest level of formal education (circle one)?

Elementary Middle High School AA/Technical School BA/BS MA/MS Ph.D

9. How many members are in your household? _____ persons

10. How many household members contribute to paying the household expenses?

_____ persons

11. Including these people, what was your approximate household income from all sources (before taxes) last year?

$0-29,999 $30,000-59,999 $60,000-99,999

$100,000-149,999 $150,000-249,999 $250,000+

Thank you for completing the survey!

If you have any additional comments on OHV recreation in general, OHV recreation in Larimer County, or this survey, please write them on the back page. When you are finished, please hand the survey back to the person who handed you the survey.

COMMENTS?

Please feel free to write any comments you have about OHV Recreation in Larimer County.

APPENDIX 4: SCRIPT FOR OHV SURVEYS

The following is a general idea of the sort of conversation I had at the trailhead with the OHV users:

Hi there. My name is Daniel Deisenroth and I am a researcher at Colorado State University.

I am conducting short interviews about your trip today in order to determine the preferences of OHV users.

Public management agencies may be able to use this information in order to keep trails open which are preferred or liked by OHV users. Furthermore, this study will demonstrate the value of OHV recreation

This survey is four pages long and shouldn't take more than five minutes. I really appreciate your time and energy. If you have any questions, feel free to ask.

Also, if you're thirsty, I have some cold drinks in an ice chest right over there by my jeep. Help yourself

If you have any questions at a later date, feel free to give me a call. Or send me an email. You can find the information on the cover letter right there on the clipboard.