TWO ESSAYS ON THE ECONOMIC VALUE OF ELK VIEWING IN MICHIGAN

By

Paul Austin Hunt

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Agricultural, Food, and Resource Economics—Master of Science

2019

ABSTRACT

TWO ESSAYS ON THE ECONOMIC VALUE OF ELK VIEWING IN MICHIGAN

By

Paul Austin Hunt

This thesis examines the value of wilderness recreation in the context of Michigan's Elk Range. The Michigan Elk Range is a near-wilderness area located in the northern Lower Peninsula of Michigan, and it is home to one of the largest free-roaming elk herds east of the Mississippi River. The first essay takes a broad look at the value of wilderness recreation in the area by estimating a single-site travel cost model. After estimating the mean overall consumer surplus value ($86 per trip) for a population of Michigan Elk Range users, we segment the model by each respondent's interest in the elk herd and by their primary activity. These results show that the value for elk viewing is higher than the overall value, and this accords with economic theory about higher values for goods/services with few or no substitutes. The second essay takes a closer look at elk viewing itself by evaluating elk viewing preferences using a discrete choice experiment. The choice experiment asks respondents to choose between two recreation areas that are identical apart from their distance from the respondent and the chances of experiencing some elk-related attributes. The results show that there is significant variation in respondents' preferences. To explain this variation, visitors are segmented by their primary activity in the Michigan Elk Range as well as their elk viewing experience. Unsurprisingly, elk viewers place a higher value on the elk-related attributes than other activity groups, and all activity groups have a significant positive preference for at least one elk attribute suggesting the presence of elk may also incidentally affect activities besides elk viewing. Additionally, respondents with more elk viewing experience place a higher value on the elk-related attributes.

ACKNOWLEDGMENTS

Funding support for this research was provided by the Michigan Department of Natural Resources and the U.S. Fish and Wildlife Service through the Pittman-Robertson Wildlife restoration Act Grant MI-155-R. This research benefited from assistance provided by Clay Buchanan (Michigan Department of Natural Resources), Melissa Nichols (Michigan Department of Natural Resources), Scott Whitcomb (Michigan Department of Natural Resources), Brian Mastenbrook (Michigan Department of Natural Resources), Cody Stevens (Michigan Department of Natural Resources), Aren Calton, and Tara Buehler. I'm also grateful for the members of the fall survey team: Tom Giesemann, Joe and Judi Jarecki, Sarah Topp, and Lija Krievs.

I would thank my committee members, Drs. Joseph Herriges, Soren Anderson, and Frank Lupi, for their guidance in the preparation of this thesis. My adviser, Dr. Frank Lupi, has provided indispensable guidance, support, and assistance throughout this process, and I feel fortunate to have been able to learn from him. Lastly, I'm grateful to my father, Paul Hunt, my late mother, Lorraine Hunt, and my brother, Jason Hunt, for their love and support.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Animals have been a source of wealth and value throughout human history and across all cultures. While this notion is not disputed, history is replete with examples of extinction events caused by the mismanagement of animal capital stock. Environmental and natural resource economics emerged in the second half of the 20th century, in part, to identify and promote welfare-enhancing wildlife management practices. One key insight that informed this effort was the recognition that animals and other natural resources provide multiple values and benefits, and this came to be known as a Total Economic Value (TEV) framework. Under this framework, people can hold both *use* and *nonuse* values for different animal species. Use values typically involve some sort of direct interaction with an ecosystem resource, while nonuse values relate to people's intrinsic or existence value for an ecosystem resource. Use values can be further subdivided into *consumptive* and *non-consumptive* use values, where consumptive use typically involves extraction of the resource and non-consumptive use does not (Heal et al. 2005; Segerson 2017).

This thesis contributes to knowledge about the TEV of elk in Michigan. After going extinct in the 19th century, elk were reintroduced to Michigan in 1918 and can now be found in a 600 square-mile elk range in the northern Lower Peninsula. Given the uniqueness of this particular elk herd, there is likely some nonuse value for Michigan residents. As an example of this, the state of Michigan recently introduced specialty elk themed license plates as a way to commemorate the 100th anniversary of the elk reintroduction. Consumptive use values are derived from an annual Michigan elk hunt. Each year, thousands of Michigan residents enter a lottery to win one of 200 Michigan elk hunt licenses. Though the Michigan Department of Natural Resources (MDNR) actively seeks to minimize negative values created by the elk herd,

the herd has been known to cause crop damage to neighboring farms and to be involved in vehicular collisions on Michigan roads and highways.

This study directly pertains to the non-consumptive use value of the Michigan Elk Herd, which is elk viewing. Elk viewing can occur anywhere throughout the elk range, but it tends to take place around areas that the MDNR has cleared and planted for elk feeding and elk viewing areas. Elk viewing typically occurs at dawn or dusk, when the animals are most active, and fall is the peak elk viewing season, as this time of year corresponds to the elk rutting season. Additionally, elk viewing can occur simultaneously with the many other recreational activities that occur within the Michigan Elk Range.

The first essay presents a recreation demand model for visitors to the Michigan Elk Range. Because the Michigan Elk Range is large, dispersed, and has many entrance roads, it is difficult to identify and estimate the underlying population of Michigan Elk Range users. Generally, the population is composed of Michigan residents (with lesser numbers from neighboring states) who hunt, fish, or engage in some other type of remote outdoor recreational activity. The essay will identify consumer surplus values per trip to the Michigan Elk Range, and Appendix IV presents some strategies and insights that could be used in future research to identify the target population. The recreation demand model uses data from an intercept survey conducted in major recreation areas of the Michigan Elk Range during the summer and fall of 2018. Because the area is also used for a variety of other forms of recreation (e.g., hunting, fishing, hiking, camping, etc.), this essay also presents separate models based on respondents' primary activities in the Michigan Elk Range as well as their stated attitudes concerning the elk herd.

The second essay presents the results of a discrete choice experiment that was completed by a sample of Michigan Elk Range visitors in a follow-up survey conducted in the spring of 2019.[1] The choice experiment tasked respondents with choosing between two possible recreation areas that differed in their distance from the respondent's home and the likelihood of experiencing various elk-related attributes. There was significant variation in respondents' preferences for the various elk-related attributes, so the essay also reports strategies for segmenting respondents into different classes.

[1] The follow-up online survey was sent to visitors who completed the intercept survey and provided an email address.

REFERENCES

REFERENCES

Heal, G. M., Barbier, E. B., Boyle, K. J., Covich, A. P., Gloss, S. P., Hershner, C. H., ... Shrader-Frechette, K. (2005). *Valuing ecosystem services: toward better environmental decision-making*. National Academies Press.

Segerson, K. (2017). Valuing Environmental Goods and Services: An Economic Perspective. In P. A. Champ, K. J. Boyle, & T. C. Brown (Authors), *A primer on nonmarket valuation* (pp. 1-25). Springer.

CHAPTER 1: Segmented Recreation Demand Models for the Michigan Elk Range

I. Introduction

The idea of wilderness has long captivated the American imagination. When the possibility emerged that America's wilderness could disappear due to urbanization and over extraction of natural resources in the first half of the 20th century, Congress responded by setting aside public land to be preserved in perpetuity through the Wilderness Act of 1964. This act defines wilderness as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain", and part of the motivation behind wilderness preservation was to provide "opportunities for solitude or a primitive and unconfined type of recreation" (Wilderness Act of 1964). This definition of wilderness recreation inherently requires trade-offs. Most notably, managers of wilderness areas are tasked with striking a balance between visitor accessibility and comfort, on the one hand, with solitude and protection of plant and animal life, on the other (Lawson and Manning 2001). While wilderness recreation is diverse and continually changing, one significant subset is wildlife-based recreation. Over 35 million Americans fished and over 11 million Americans engaged in some form of hunting in 2016. Additionally, over 86 million Americans engaged in wildlife viewing, including 23 million Americans who travelled at least one mile away from their home with the primary purpose of wildlife viewing (Cordell et al. 2008; USFWS 2016).[2]

In this spirit, the aim of this study is to estimate the economic value, or consumer surplus, of recreational trips taken to the Michigan Elk Range. This specific application is a useful case

[2] "Wildlife watching is defined here as closely observing, feeding, and photographing wildlife, visiting parks and natural areas around the home because of wildlife, and maintaining plantings and natural areas around the home for the benefit of wildlife… secondary or incidental participation, such as observing wildlife while doing something else, was not included in the survey (USFWS 2016).

study in valuing wilderness recreation because the Pigeon River Country State Forest, the core of the Michigan Elk Range, is one of the largest undeveloped areas in Michigan's Lower Peninsula (MDNR 2007). Most distinctively, this area is home to Michigan's only free-roaming elk herd, and the herd provides visitors with both consumptive value (through the annual elk hunt) as well as non-consumptive value (through elk viewing).

To accomplish this valuation, we report the results of a survey of Michigan Elk Range visitors conducted in the summer and fall of 2018 and estimate several single-site travel cost models of recreation demand. Our first model is for overall Michigan Elk Range visitors, and we find that the mean consumer surplus value for a visit (per-household, per-trip) is $86.21, and this corresponds to a per-day average value of $20.28. This estimate is an unbiased estimate of the average consumer surplus value per trip, because we use methods to correct for the intercept sampling. However, in order to estimate an aggregate consumer surplus value for recreational visits to the Michigan Elk Range, we would need to quantify the total trips or the population of Michigan Elk Range users. This is challenging given the dispersed nature of recreation in the region, so Appendix IV includes some strategies and insights that could be used in future efforts to estimate the target population.

In order to approximate the value of the elk herd to visitors, our second set of demand models segment respondents by their reported interest in seeing elk on their visit. The third set of demand models segment respondents into groups based on the primary activity of their intercepted visit. Given the uniqueness of the elk herd, we would expect that elk viewers have a higher consumer surplus value for accessing the Michigan Elk Range than other visitors because there are no nearby substitutes. This is indeed what we find. Visitors reporting that the chance of seeing elk was their primary motivation for visiting the area exhibit higher consumer surplus

values than those who say that the elk either played some role or no role in their decision to visit. This finding is repeated when we run separate models by visitors' primary activities, and we find that visitors coming to the area primarily for wildlife viewing have the highest consumer surplus values of any activity group.

This study is situated in two areas of the recreation demand literature. Because of the unique presence of the elk herd, this study is linked to the literature on the demand for wildlife viewing. There have been many papers that have examined the economic value for various types of wildlife viewing, and one of the more popular subjects has been bird watching. For example, studies on the value of bird watching include Edwards et al. (2011), which estimated the value of migratory shorebird viewing in Delaware using a single-site travel cost model, and Kolstoe and Cameron (2017), which used data from an online bird watching social media platform to estimate the consumer surplus value or willingness to pay (WTP) for additional bird species using a multi-site travel cost model. They also explored how novelty and variety-seeking preferences influence visitor site choice when bird watching. Other studies have explored the value of viewing large charismatic mammals, and these include studies on bear viewing (Richardson et. al 2014; Richardson et. al 2017), whale watching (Loomis et. al (2000), and African safari animals (Mladenov et al. (2007).

A few studies have looked directly at elk viewing. Donovan and Champ (2009) used a single-site travel cost model to estimate the value of elk viewing in Oregon during winter supplemental feedings, and their study reported a mean per-day consumer surplus value of $138 ($170.45 in 2019 dollars).[3] This is likely to be higher than the Michigan elk range use value

[3] Donovan and Champ report a sample mean per day access value of $369. We are unsure how they reached this number. Consumer surplus for an individual is defined as $CS_n = \frac{1}{-\beta_{TC}}$. Donovan and Champ report that their travel cost coefficient was −0.00726, so this would result in a consumer surplus value per trip of $138.

because the authors of this study assumed a higher travel cost, but it could also differ because of different preferences, site quality, and other factors. Their paper defined direct vehicle costs as $0.485 per mile, which was the IRS standard mileage rate in 2007. This represents an average vehicle operation cost, which includes full coverage insurance and any vehicle taxes and registration fees. Alternatively, we will use a marginal travel cost instead of an average cost (see section III for details on how we determine travel cost), so our direct vehicle costs are much lower (Hang et al. 2016). Additionally, elk viewing was the only activity in the Donovan and Champ study area, whereas the present study in the Michigan Elk Range includes visitors participating in a whole range of activities. Other studies that estimate values for elk viewing include Loomis and Caughlan (2004), which estimated a mean consumer surplus of $52 per-day ($74 in 2019 dollars) for elk and bison viewing in the National Elk Refuge in Wyoming, and Shafer et al. (1993), which estimated consumer surplus for elk viewing in Pennsylvania to be just over $20 per-day for intercepted visitors ($43.30 in 2019 dollars). It should be noted that the Shafer study used a stated preference approach (i.e. visitors were asked open-ended questions about their WTP for elk viewing), while this study uses a revealed preference approach based on actual behavior.

Another strand of relevant literature includes studies that provide additional insights to the single-site travel cost model. Aside from simply determining site access values, these studies use the single-site travel cost model to answer additional research questions. Boxall et al. (2003) combined a single-site travel cost model (revealed preference) with contingent behavior questions (stated preference) in order to estimate the economic value of aboriginal pictographs on wilderness canoe trips in Manitoba. Respondents were asked to answer a question about their actual number of trips to the park as well as a hypothetical question about how many additional

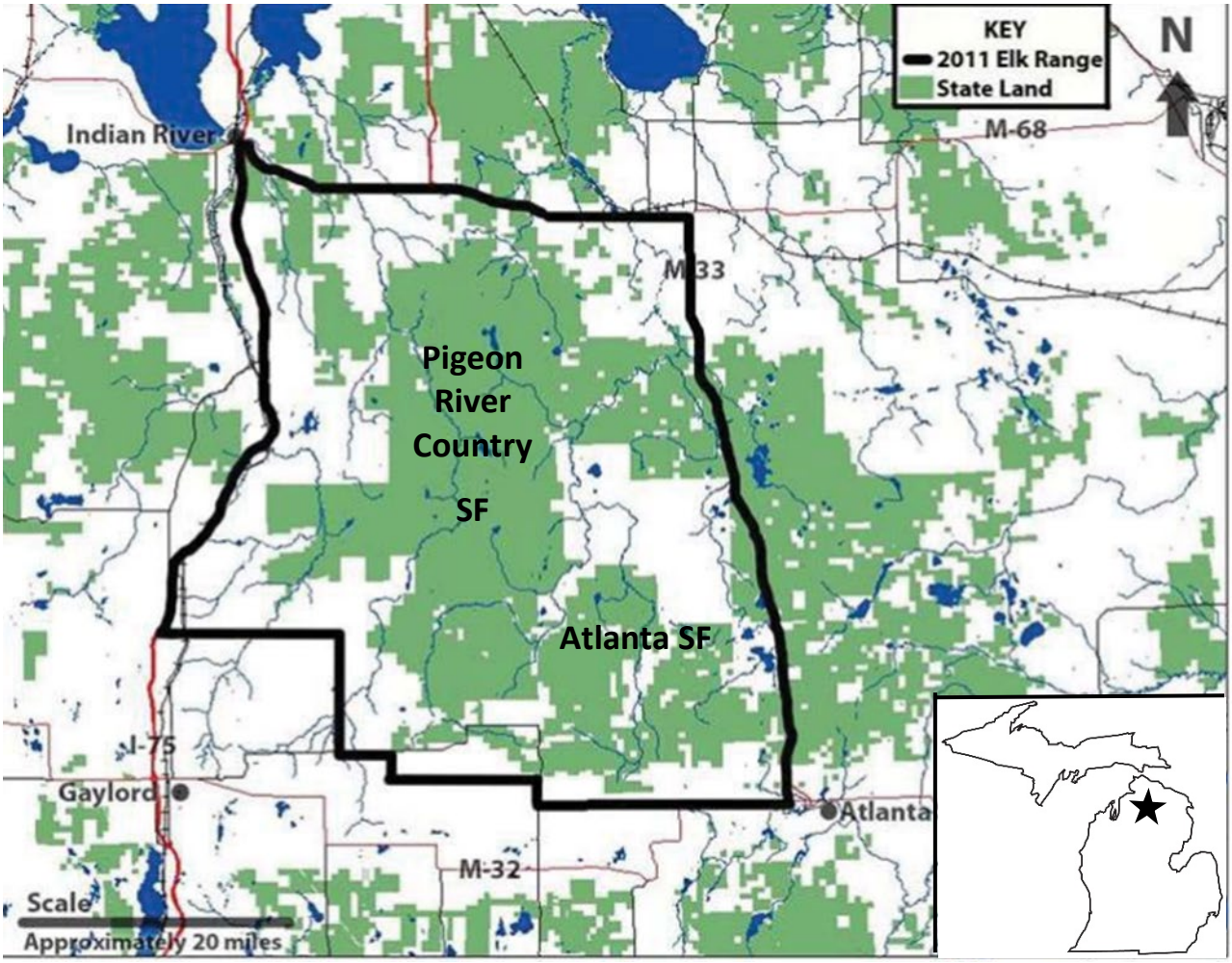
trips they would take provided that they would see a pictograph. This results in two dependent variables, and they were able to determine the added value of the pictographs by taking the difference between consumer surplus with the actual trips versus consumer surplus with the hypothetical trips. Of course, this method depends on the hypothetical pictograph question introducing new information to the respondent. If a respondent had already factored in the presence of pictographs, then being informed about them in the survey would not change his trip behavior.

Another approach that contributes insights beyond the simple single-site travel cost model involves running segmented models for different visitor groups, and this is an approach that we adopt in this study. Benson et al. (2013) did this in the context of visits to Yellowstone National Park. Apart from estimating consumer surplus values for the entire sample of respondents, they estimated values for distinct types of visitors to Yellowstone. Using activities reported in a survey, the authors used cluster analysis to group respondents into activity-based clusters, and their demand models showed that activity clusters had different consumer surplus values for their respective trips to Yellowstone, with backcountry enthusiasts having about twice the surplus values as picnickers.

The present study contributes to the small number of studies that estimate consumer surplus values for wilderness recreation. Additionally, this is one of the only studies to estimate the value of elk viewing in the Eastern United States. Originally native throughout the eastern half of North America, Eastern Elk went extinct by the end of the 19th century. Michigan and Pennsylvania were early states to reintroduce elk, which they did in the 1910s. Apart from Michigan and Pennsylvania, there are now elk herds in Arkansas, Kentucky, Missouri, Minnesota, North Carolina, Tennessee, Virginia, West Virginia, and Wisconsin (RMEF 2019).

Many of these herds have been established in the past 30 years through partnerships between the Rocky Mountain Elk Foundation (RMEF) and state wildlife agencies. Elk reintroduction results in the creation of consumptive use values (from hunting), non-consumptive use values (from elk viewing and ecosystem services), and existence values (Segerson 2017). Elk reintroduction can also result in negative values, and two salient examples of this would be vehicular collisions and crop damages (Hegel et al. 2009).

Figure 1.1: Michigan Elk Range



Though the Michigan Elk Range is made up of both public and private land, this study only surveyed visitors in portions of the Pigeon River Country State Forest (PRCSF) and Atlanta State Forest (ASF) where recreation is known to occur. In the summer, recreation centers on lakes, rivers, and seven state forest campgrounds. Boating, swimming, and fishing occur in area lakes, and the most popular lakes include Cornwall Flooding, Pickerel Lake, various sinkhole lakes, and Foch Lakes (in the ASF). Both the PRCSF and the ASF have numerous access points to highly rated fly-fishing sections of the Pigeon, Sturgeon, and Black rivers. There are several hiking, biking, and equestrian trails in the Michigan Elk Range. The most prominent is the High-

Country Pathway, an 80-mile trail that circumnavigates the Michigan Elk Range. The most popular form of recreation in the fall is hunting, which is highly dispersed throughout the forests. Elk Viewing is another popular activity in the fall, as well, and it peaks in popularity in late September— during the elk rutting (or mating) season. The MDNR maintains about 1,000 acres of grass openings and planted fields for elk feeding. Some of these openings are publicized as "elk viewing areas" on MDNR maps and brochures, along with other helpful information on elk viewing (MDNR 2012). There is a total of 13 elk viewing areas identified throughout the Michigan Elk Range (MDNR 2019). Some have dirt parking areas that allow visitors to view elk from their cars, while others require a short hike to reach. In general, PRCSF recreation guidelines require that recreation is low impact, is not noisy or something that lessens the enjoyment of others, does not lead to further development of facilities, and is consistent with the overall wild character of the forest (MDNR 2007).

The data used in this study comes from an intercept survey conducted in the summer (June, July, and August) and fall (September, October, and November) of 2018 along predetermined routes in the Michigan Elk Range. The routes were not all-encompassing (due to the dispersed nature of recreation in the area), but they were chosen to balance the need for interviews and the need for a representative sample. The summer intercept surveys were conducted between June 7th and September 1st, and the sampling was scheduled on a rotational basis- 4 days of sampling followed by 4 days without sampling. The fall intercept surveys were conducted between September 9th and November 24th, and the sampling was scheduled on random days adjusted for interviewer availability. We interviewed visitors seen along routes and left paper surveys on the windshields of parked cars when the vehicle owners were not present. These paper surveys were individually numbered so that returned surveys could be matched with

route vehicle count records to determine when and where the survey was distributed. The response rate for interviews was nearly 100% and the return rate for paper surveys left on windshields was 28% in both the fall and summer. All total, the intercept survey collected 756 usable observations. See Appendix I for disposition tables that detail the response rates for the survey.[4]

Whenever a group of visitors was encountered, we only interviewed one member. In order to minimize bias, the adult with the most recent birthday was asked to complete the interview. The survey included questions on home zip code, the recreational activities participated in over the course of the visit, sites visited within the Michigan Elk range, total hours of visit (if day trip), total nights of visit (if overnight trip), lodging type, whether recreation was the main reason for the overall trip, how many times the visitor left and reentered the forest, the importance of seeing elk for the visit, whether/where they saw elk, how many people travelled with them to the forest, how many trips they took to the Michigan Elk Range in the past year, and the respondent's age, gender, and highest level of education. 68% of the sample is male, and the mean age is 51.7. The most common primary activities were (in order of popularity): hunting, camping, fishing, and hiking. Close to 80% of visitors in our sample were intercepted on an overnight trip away from their primary home.

One of the overall objectives of this study is to understand values for elk viewing, so it was important to interview visitors whose primary recreational activity was elk viewing. This was done by including elk viewing areas at the end of evening shifts. One challenge in intercepting elk viewers is that some of them drive around the elk range looking for elk, as

[4] Appendix IV reports 367 completed interviews and 393 returned paper surveys for a total of 760 completed surveys. The *completed* survey count (760) differs slightly from the *usable* (756) survey count because four respondents returned a paper survey in which they indicated that they had already completed a survey.

opposed to parking in one location for the duration of the activity (like fishing, hiking, biking, etc.). Additionally, elk viewing typically occurs at dusk, when the elk are most active. This relatively short window made it difficult to cover all the elk viewing areas in one shift. In total, 35% of sampled visitors reported elk viewing as one of the activities they participated in on the visit when they were surveyed, and 10% reported that elk viewing was the primary activity (alone or in combination with another activity) on the surveyed visit. One reason to believe that elk viewing may be more common than what is indicated in the survey data is that a follow-up survey of elk range visitors indicated that about 80% of them had gone elk viewing at least once sometime in the past.[5]

III. Theory of Recreation Demand

For goods and services traded on a market, prices can reveal information about the value that people place on that good or service. Because most environmental amenities in wilderness recreation are not traded in markets, there are no corresponding prices to reveal value. Forests, beaches, rivers, and mountains facilitate outdoor recreation and are welfare enhancing, but for a variety of reasons, access tends to be free or only requires a small fee that does not reflect users' values. The PRCSF does not have any access fee, although it does require a Michigan Recreation Passport to access some trailheads and boat ramps. The job, then, for researchers is to estimate consumer surplus values in the absence of market prices. Typically, this is done in one of two ways. Researchers can directly elicit information using survey questions on hypothetical scenarios relating to recreation— referred to as stated preference. Another approach infers values using data on actual recreational behavior—referred to as revealed preference. This study will

[5] The follow-up survey was an online survey conducted in the spring of 2019. It was made up of about 300 respondents from the intercept survey who provided us with email addresses.

use respondents' reported trips and travel costs to estimate a demand curve for recreation in the Michigan Elk Range.

One form of revealed preference valuation uses travel cost as a proxy for the price of recreational site access. The idea, first proposed by Harold Hotelling in a letter from 1947, is that visitors to any given recreational site pay an explicit price (for fuel costs, tolls, entrance fees, and vehicle depreciation or maintenance) and face an opportunity cost for the time spent travelling to the site (Freeman et al. 2014). This means that a sample of visitors to a recreational site cover a whole range of latent site-access prices, and researchers can use this information along with various demographic characteristics and a dependent variable (the number of actual trips each visitor took to the site over a given period) to estimate a demand curve for recreational site access. All else equal, we would expect that someone living 20 miles away from a given recreational site would take more trips to that site than an identical person living 40 miles from that same site.

When analyzing a cross-section of data from a single recreational site, this idea can be expressed formally as a single-site travel cost model. This model says that the number of trips an individual takes to a given recreational site over the course of a season (x_n) is a function of the individual's cost in reaching that site (TC_n), trip costs to substitute sites, various demographic characteristics of the individual (Z_n), and the individual's income (y_n) (Parsons 2017). We were not able to get data on substitute sites as there are a large number of alternatives sites for most activities, but we do explore the issue of heterogeneity in the consumer surplus values by segmenting the recreation model. Therefore, our model can be expressed as:

$$x_n = f(TC_n, Z_n, y_n) \quad (1)$$

Consumer surplus for that same individual is simply the integral of equation 1 with TC_n^0 being the current access price and TC_n^* being the choke price (i.e. the travel cost at which the individual would not take any trips to the site).

$$cs_n = \int_{TC_n^0}^{TC_n^*} f(TC_n, Z_n, y_n)\, dTC_n \qquad (2)$$

Travel cost is made up of two components: direct, out-of-pocket costs as well as an opportunity cost of time. In order to estimate the opportunity cost of time, we follow a common approach in the literature and define it as 1/3 of the respondent's hourly wage rate (Freeman et al. 2014; Parsons 2017). To get an hourly wage, we divide each respondent's annual household income (which we define as the mean household income in the respondent's home zip-code) by 2,080. The direct, out-of-pocket costs are calculated as \$0.285 per mile multiplied by the round-trip distance divided by the number of adults in the vehicle group.[6] This out-of-pocket travel cost is lower than driving costs sometimes seen in the literature because we only include expenses that were solely incurred for the recreational trip (i.e. the *marginal* driving costs), so this would not include money paid for vehicle purchase, insurance, or registration. Distances are measured from the respondents starting zip-code to the location in the Michigan Elk Range where they were interviewed or received a paper survey. Distances and travel times are calculated using the Stata georoute module (Weber and Péclat, 2017). Travel cost is formally defined as follows (where y_n is annual household income in dollars, t_n is round-trip travel time

[6] The \$0.285 per mile figure assumes fuel efficiency of 22 mpg (U.S. BTS 2019), average fuel price of \$2.80 per gallon (U.S. EIA 2019), \$0.0756 per-mile vehicle marginal depreciation costs, and \$0.0821 per-mile vehicle marginal maintenance costs (AAA 2018).

in hours, d_n is round-trip distance in miles, and a_n is the number of adults travelling in the vehicle):

$$TC_n = \left(\left(\frac{y_n}{2{,}080}\right) * \left(\frac{1}{3}\right) * t_n\right) + \left(\frac{0.285 * d_n}{a_n}\right) \quad (3)$$

A common empirical challenge that researchers face when estimating travel cost models is how to use multiple purpose and/or multiple destination trips, as it is not clear how to delineate travel costs among separate components of an overall trip (Parsons 2017; Freeman et al. 2014). This problem is more common in cases where the respondent is on an overnight trip, as is the case with 80% of Michigan Elk Range visitors in our sample. Our solution, then, was to ask respondents to report whether recreation in the Michigan Elk Range was their primary purpose for making the overall trip away from home. If a respondent answered "yes", then we used the respondent's home zip-code as their starting zip-code. If a respondent answered "no", then we used the distance from their primary destination to the Michigan Elk Range.[7] Out of the 756 total responses, 4 respondents did not include a zip-code and 54 (7.1%) respondents indicated that recreation was not their main reason for visiting. Of these respondents, 26 provided the location of their primary destination (allowing us to give them a new starting zip-code), 28 respondents were given an imputed distance and 9 were removed because they reported not having a main destination.[8] In total, 743 (96.3%) of the 756 respondents were included in the travel cost analysis. Fourteen respondents did not provide their age, and 14 respondents did not provide their education level. We replaced these missing values with the respective mean values.

[7] The primary destination location is determined from one of two ways. In the fall intercept survey, we asked respondents staying in lodging outside of the forest to report the city that they stayed in. We also asked respondents to report the city where their primary destination was located in a follow-up online survey we did in early 2019.
[8] The imputed distance was the mean distance of visitors who had a starting zip-code other than their home zip-code.

IV. Poisson Count Model

In order to estimate our model, we use a truncated Poisson count model that is adjusted for endogenous stratification (i.e. the over-sampling of high use visitors). This structural solution corrects for potential bias in the parameter estimates (provided that the data generating process for trips does indeed follow a Poisson distribution), but it does not correct for potential bias in visitor characteristics (e.g., age, income, seasonal trips, etc.). Because of that, the results provide an unbiased estimate of the per-trip consumer surplus values (Haab and McConnell 2003), but by themselves do not provide an unbiased aggregate value. To estimate demand curves for the average visitor and aggregate the values, we would need to weight the intercepted data by the probability of being intercepted.

We assume that a Poisson specification is appropriate for estimating trips for our underlying target population (Michigan Elk Range visitors). However, it is highly likely that this specification does not represent the trip data generating process for a population defined as all Michigan adults since the vast majority of Michigan adults would never visit this area; rather it applies to some population of potential visitors. Appendix IV provides a discussion about how future research might estimate the target population of Michigan Elk Range visitors and/or the total number of trips.

A Poisson specification is commonly used in recreation demand modelling because it handles non-negative discrete count data well. The disadvantage of a Poisson specification is that it assumes that the mean and variance (both defined by the parameter λ_n) are the same, which is not always the case (Haab and McConnell 2003).[9] A standard Poisson model defines the probability of a household taking x_n trips over the course of a season as:

[9] To check for overdispersion, we ran a negative-binomial model with a correction for endogenous stratification. The resulting dispersion coefficient (α) was not significant, so we were justified using a Poisson specification.

$$\text{pr}(x_n) = \frac{\exp(-\lambda_n) \times \lambda_n^{x_n}}{x_n!} \quad (4)$$

Running this Poisson regression results in coefficients for each of the explanatory variables (travel costs, demographic variables, and income). The expected number of overall trips in a year (semi-log demand function) is given as follows:

$$E(x)_n = \lambda_n = \exp\left(\beta_{TC} TC_n + \beta_z Z_n + \beta_y y_n\right) \quad (5)$$

The consumer surplus per season can be calculated as $CS_n = \frac{\lambda_n}{-\beta_{TC}}$ and, likewise, consumer surplus per trip can be estimated as $CS_n = \frac{1}{-\beta_{TC}}$.[10]

Two common approaches to sampling include random population sampling (i.e. sending survey invites to random members of the general public) and on-site sampling (Haab and McConnell 2003). We chose to use an on-site sampling approach because the Michigan Elk Range is a sparsely visited recreation area, and if we had used a random sample of Michigan residents, the vast majority of respondents would have likely told us that they have never visited the Michigan Elk Range. That being said, the biggest disadvantage to on-site sampling comes from endogenous stratification.

Endogenous stratification, as mentioned above, simply means that when employing an on-site survey, interviewers are more likely to encounter visitors with high use levels than visitors with low use levels. Our sample is more likely to include the person who visits the Michigan Elk Range everyday than the person who only ever visited a single time. Failing to adjust for endogenous stratification would mean that the sample average of trips and the

[10] Consumer surplus is the area under the demand curve (see equation 2). Since the Poisson specification uses an exponential demand function, the choke price is infinite. Thus, $CS_n = \int_{TC_n^0}^{\infty} \exp(\beta_0 + \beta_{TC} TC_n)\, dTC_n = \left[\frac{\exp(\beta_0 + \beta_{TC} TC_n)}{\beta_{TC}}\right]_{TC_n = TC_n^0}^{TC_n \to \infty} = \frac{\lambda_n}{-\beta_{TC}}$ (Haab and McConnell 2003).

estimated demand parameters would be biased. To account for endogenous stratification, one needs to account for the intercept probabilities based on the stochastic process that generates the trip taking data for the population (Haab and McConnell 2003). It has been shown that when the data generating process for trip taking is itself a Poisson process, then the unbiased population parameters can be estimated from a standard Poisson regression of the number of trips minus one $(x_n - 1)$ on the independent variables (Haab and McConnell 2003), as in equation (6). This correction does not change the upward bias in the sample average of trips, but it does yield unbiased parameter estimates of the demand function.

$$\text{pr}(x_n) = \frac{\exp(-\lambda_n) \times \lambda_n^{x_n - 1}}{x_n - 1!} \qquad (6)$$

Table 1.1: One-Way Distances from the Michigan Elk Range *(unweighted)*

Distance (*miles*)	Frequency	Percent
0-20	99	13.32%
20-40	134	18.03%
40-60	39	5.25%
60-120	48	6.46%
120-180	82	11.04%
180-240	219	29.48%
240+	122	16.42%
Total	743	

Table 1.1 shows the breakdown of visitor one-way travel distances to the Michigan Elk Range. One thing to note is that 30% of visitors live between 180 and 240 miles from the

Michigan Elk Range. This range contains much of the Michigan population centers— Detroit and its surrounding suburbs, Lansing, and Grand Rapids. A similar proportion of visitors live in nearby communities in Northern Lower Michigan (i.e. those between 0 and 40 miles away). Out of state visitors are a small, but not insignificant, subset of the overall sample.

V. Results

Table 1.2: Descriptive Statistics for Respondents *(Unweighted)*

Variables	*Description*	*Mean*	*SD*
Annual Trips	Trips to Michigan Elk Range in last year	8.47	23.31
Male	Male=1 Female=0	0.69	0.46
Income	Mean household income by zip-code (*in thousands of dollars*)	71.46	22.43
Trip Length	Length of visit to Michigan Elk Range (*in days*)	4.25	3.15
Vehicle Group size	Total vehicle group size (net children under 18)	1.90	1.01
Travel Cost	See equation 3	120.38	156.66
Distance	One-way distance from Michigan Elk Range	152.81	177.61

Table 1.3: Overall Travel Cost Model (Poisson Maximum Likelihood Model)

Variables	(1)	(2)
Travel Cost	-0.0116***	-0.0116***
	(0.000276)	(0.000276)
Income	-0.00800***	-0.00807***
	(0.000964)	(0.000956)
Age	0.00360***	0.00361***
	(0.000914)	(0.000909)
Education Level	-0.00506	
	(0.00562)	
Male	0.0230	
	(0.0288)	
Constant	3.274***	3.220***
	(0.105)	(0.0741)
Log-Likelihood	-7759.3718	-7760.1481
Observations	743	743
Consumer Surplus	86.21***	86.21***
Income Elasticity	-0.57***	-0.58***
Own-Price Elasticity	-1.4***	-1.4***

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 1.2: Demand Curve for Overall Recreation Demand Model (unweighted, using average trip characteristics)

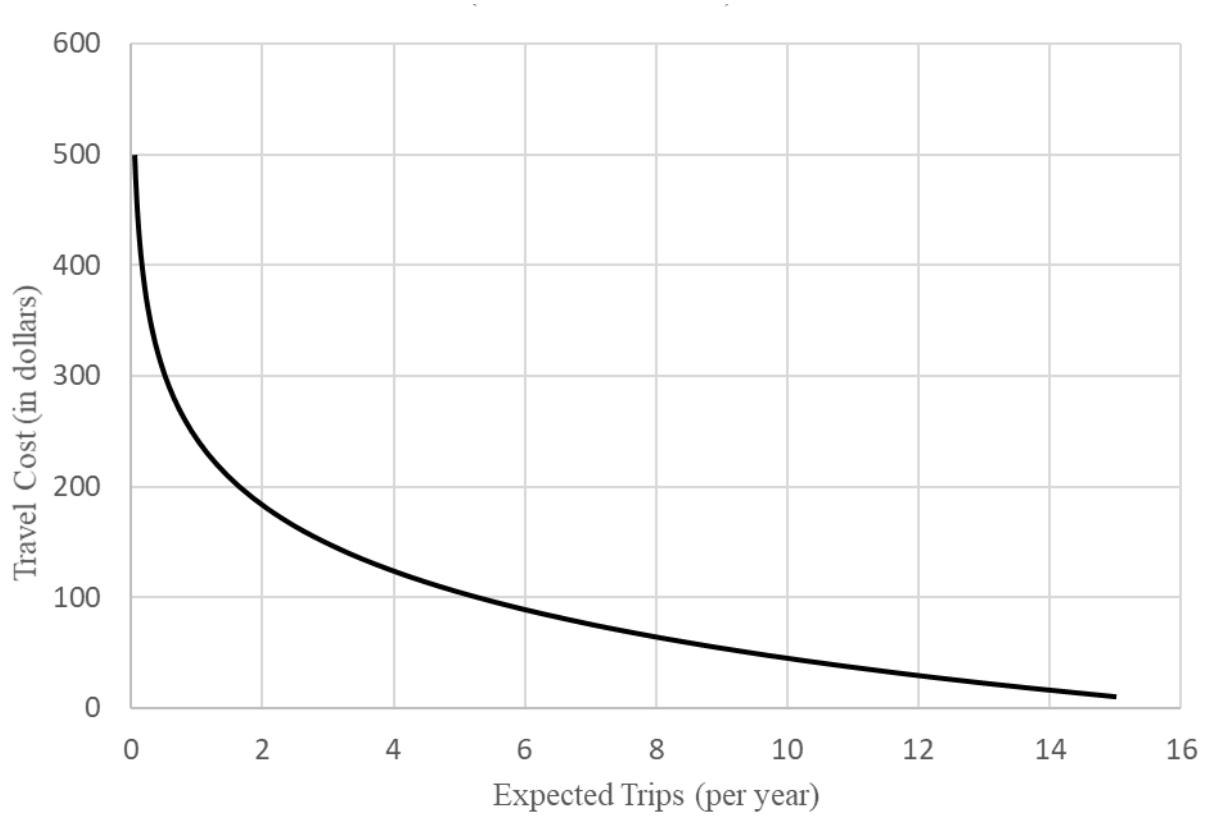


Table 1.3 includes results of the single-site travel cost model we used to estimate per-trip consumer surplus values for all recreation in the Michigan Elk Range. As we would expect, the coefficient on travel cost is negative and significant, and the mean consumer surplus per-trip to the Michigan Elk Range is $86.21. Given that the mean trip length from our intercept survey was 4.25 days, the mean consumer surplus per-day is $20.28. The coefficients on age and income are significant, and they indicate that older visitors are expected to take more trips in a year and that wealthier visitors are likely to take less trips in a year. The education level and gender variables were not significant, and it made no practical difference to the results when these variables were dropped in model 2. Figure 1.2 maps out a demand curve for the overall model using mean values for all demographic values. Income and own-price elasticity measures are calculated by multiplying the respective parameter estimates with the sample means for income and travel cost.

The income elasticity (-0.57) is negative, and this indicates that recreational trips to the Michigan Elk Range is an inferior good. The own-price elasticity (-1.4) is elastic, indicating the presence of many substitutes. This idea will be explored later in the segmented model approach.

The travel cost model summarized in Table 1.3 tells us the expected per-trip values for the Michigan Elk Range population, but it does not easily lend itself to comparison or tell us anything about how visitor segments value the area differently. One way to segment visitors is to run separate travel cost models based on survey respondents' attitude toward the elk herd. This first segmented model uses the following question from the intercept survey: "What role did the chance of seeing elk play in your decision to visit?" Respondents were given three possible options as answers. The first was "the chance of seeing elk was my primary reason for visiting". The second option was "the chance of seeing elk played a role in my decision to visit, but it was not my primary reason". The third option was, "The chance of seeing elk played no role in my decision to visit". Some summary statistics about the three groups are shown in Table 1.4. It is important to remember that this question was asked specifically in reference to the visit when the visitor was surveyed. Therefore, it does not necessarily represent any given individual respondent's attitude toward elk for *all of their visits* to the Michigan Elk Range over a given year. Still, by assuming that our sample is representative of all recreation trips to the Michigan Elk Range in summer and fall, this question provides a useful metric for estimating the value of elk viewing.

Table 1.4: Summary Statistics by Respondents' Answers to the Question "What role did the chance of seeing elk play in your decision to visit?"

	Mean Trip Length (*days*)	Mean Trips in Past year (*trips*)	Mean Travel Cost (*dollars*)	Mean Distance (*miles*)	Mean Income (*thousands of dollars*)
Primary reason for visiting (*n=113*)	4.71	6.99	$104.70	145.7	69.91
Played a role, but not primary (*n=294*)	4.45	6.07	$137.00	173.7	73.83
Played no role (*n=333*)	3.94	11.14	$111.60	137.5	69.98

Table 1.5: Travel Cost Model Segmented by Answer to Elk Importance Question

Variables	Elk-Very Important	Elk-Somewhat Important	Elk-Not Important
Travel Cost	-0.00813***	-0.00859***	-0.0150***
	(0.000665)	(0.000425)	(0.000464)
Income	-0.0218***	0.000920	-0.00904***
	(0.00302)	(0.00153)	(0.00145)
Age	-0.0551***	0.0104***	0.0125***
	(0.00274)	(0.00182)	(0.00116)
Education Level	-0.155***	-0.00757	0.0240***
	(0.0201)	(0.0107)	(0.00722)
Male	0.0163	-0.329***	0.0580
	(0.0827)	(0.0529)	(0.0394)
Constant	8.970***	2.181***	2.728***
	(0.345)	(0.199)	(0.140)
Log-Likelihood	-822.54542	-2050.877	-4296.3416
Observations	113	294	333
Consumer Surplus	123.00***	116.41***	66.67***
Income Elasticity	-1.52***	0.07	-0.63***
Own-Price Elasticity	-0.85***	-1.18***	-1.67***

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.5 displays separate travel cost models for each of the three responses to the question on elk importance in the intercept survey. The highest per-trip consumer surplus comes from visitors who indicated that the presence of elk was their primary motivation for visiting the Michigan Elk Range, and their consumer surplus per-trip is $123.00. The second group (*elk played some role*) has a mean per-trip consumer surplus of $116.41, and the third group (*elk played no role*) has a mean per-trip consumer surplus of $66.67. When adjusted for mean trip lengths, the per-day consumer surplus values are $26.11 (*elk were primary reason for visiting*), $26.16 (*elk played some role*), and $16.92 (*elk played no role*).

When only looking at those respondents who answered that elk viewing was their primary motivation for visiting, those who take the most trips to the Michigan Elk Range are, on average, younger and have less education and income. When only looking at those respondents who answered that elk viewing played some role in their decision to visit, those who take the most trips to the Michigan Elk Range are, on average, older and more likely to be female. When only looking at those respondents who answered that elk viewing played no role in their decision to visit, those who take the most trips to the Michigan Elk Range are, on average, older and have higher education levels but less income. Although there is little difference in the consumer surplus estimates between the "elk were primary" group and "elk played some role" group, the large difference in consumer surplus estimates between the "elk played some role" group and the "elk played no role" group indicate that elk viewing is a non-trivial component of the overall value of Michigan Elk Range recreation.

Segmenting Michigan Elk Range visitors by their answers to a question on elk importance was helpful, but this approach is limited insomuch that it is based on respondents' answers to a subjective multiple-choice question and tells us nothing about visitor motivation apart from elk viewing. Another way to segment respondents is to use their self-reported primary activity on the intercepted visit. Respondents were asked to report all of the activities they participated in as well as the primary activity or activities from the intercepted visit.

Table 1.6: Summary Statistics by Primary Activity Groups

	Mean Trip Length (*days*)	Mean Trips in Past year (*trips*)	Mean Travel Cost (d*ollars*)	Mean Distance (*miles*)	Mean Income (*thousands of dollars*)
Path Activities (*n=140*)	3.34	9.36	$120.30	153.7	74.23
Wildlife Viewing (*n=88*)	4.30	5.500	$106.20	153.0	68.55
Hunting (*n=133*)	5.62	13.38	$146.10	167.1	70.47
Water Activities (*n=174*)	3.67	6.55	$128.00	158.2	73.78
Camping (*n=176*)	4.86	5.06	$111.20	151.7	69.34

Table 1.7: Travel Cost Model Segmented by Primary Activity

Variables	Path Activities	Wildlife Viewing	Hunting	Water Activities	Camping
Travel Cost	-0.0122***	-0.00215***	-0.00991***	-0.0116***	-0.0148***
	(0.000632)	(0.000751)	(0.000456)	(0.000644)	(0.000808)
Income	-0.0326***	-0.00588*	-0.00173	-0.00408*	0.00812***
	(0.00242)	(0.00312)	(0.00167)	(0.00235)	(0.00303)
Age	0.00761***	-0.00377	-0.0134***	0.00832***	-0.000683
	(0.00207)	(0.00389)	(0.00188)	(0.00232)	(0.00263)
Education Level	-0.267***	-0.0945***	0.123***	0.109***	-0.0784***
	(0.0136)	(0.0235)	(0.0106)	(0.0124)	(0.0175)
Male	-0.900***	-0.475***	0.248**	0.764***	0.701***
	(0.0618)	(0.105)	(0.108)	(0.103)	(0.0862)
Constant	9.090***	3.883***	2.116***	0.231	2.703***
	(0.280)	(0.428)	(0.220)	(0.253)	(0.314)
Log-Likelihood	-1681.6223	-555.5855	-1394.1801	-1228.7362	-816.9303
Observations	140	88	133	174	176
Consumer Surplus	81.88***	465.95***	100.86***	85.97***	67.63***
Income Elasticity	-2.42***	-0.40*	-0.12	-0.30*	0.56***
Own-Price Elasticity	-1.47***	-0.23***	-1.45***	-1.49***	-1.65***

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.6 displays some summary statistics by primary activity group and Table 1.7 displays the results of the separate models. To better facilitate analysis, primary activities were grouped into similar activities. “Path Activities” include hiking/backpacking, bicycling, and horseback riding, and driving for pleasure. “Wildlife Activities” include elk viewing, bird watching, and a more generic category for viewing wildlife and/or scenery. 81 of the 88 respondents in the “Wildlife Activities” category reported elk viewing as their primary activity. “Camping Activities” include camping, relaxing, and picnicking. “Hunting Activities” include hunting and mushroom picking. Lastly, “Water Activities” include stream fishing, lake fishing, swimming, and boating/kayaking/canoeing. Some respondents did not include a primary activity, and because of that, 58 (7.8%) of the respondents in the overall model are not included in this model. Some respondents (7.5%) indicated multiple primary activities.[11] Respondents that reported primary activities from two different activity groups (as defined above) show up twice in this model (one for each of their reported activities).

The order of the mean consumer surplus values per trip by activity group are as follows: Wildlife Viewing ($465.12), Hunting ($100.91), Water Activities ($86.21), Path Activities ($81.97), and Camping ($67.57). Intuitively, the high value for wildlife viewing make sense. The wildlife viewing category is primarily composed of elk viewers, and since there are no substitute sites for elk viewing in the state, it would follow that mean consumer surplus are correspondingly higher than the activities with more substitute sites. This same type of insight similarly follows with regards to the other activity categories. In a rural area, such as Michigan’s

[11] 9 respondents are in both the path and wildlife viewing groups. 5 are in both the path and camping groups. 2 are in both the path and water activity groups. 6 are in both the wildlife viewing and camping groups. 3 are in both the wildlife viewing and water activity groups. 1 is in both the wildlife viewing and hunting groups. 14 are in both the camping and water activity groups. 1 is in the camping and hunting groups. 2 are in both the water activity and hunting groups.

northern Lower Peninsula, there are many available options for camping. Similarly, there are many nearby trails where one could go hiking, biking, or horseback riding. Hunting or participating in a water activity (fishing, boating, and swimming) in the Michigan Elk Range arguably has fewer apparent substitutes in the region. One possibility is that tradition, nostalgia, or past experience plays a role. In a follow-up survey we asked about the importance of tradition when choosing to visit the Michigan Elk Range. 53% of overall respondents said that tradition was very important. For those that reported hunting in the Michigan Elk Range during the previous year, 64% said that tradition was very important for visiting. Similarly, 63% of respondents who reported fishing in a stream in the Michigan Elk Rang during previous year and 62% of respondents who reported fishing in a lake reported that tradition was very important in their decision to visit.

The high consumer surplus value for wildlife viewing is less clear, however, when approaching it from the perspective of the summary statistics found in Table 1.6. Wildlife viewers are, on average, the closest activity group to the Michigan Elk Range. Correspondingly, they have lower average travel costs as well. Additionally, wildlife viewers, on average, have the second fewest (after camping) number of yearly trips to the Michigan Elk Range. Given this information alone, it does not follow that wildlife viewing would have the highest consumer surplus value. The answer, then, as to why this group has such a high consumer surplus estimate is found when looking at the overall shape of the demand curve.

Figure 1.3: Demand Models for Wildlife Viewing and Hunting (Using the average trip to the Michigan Elk Range)

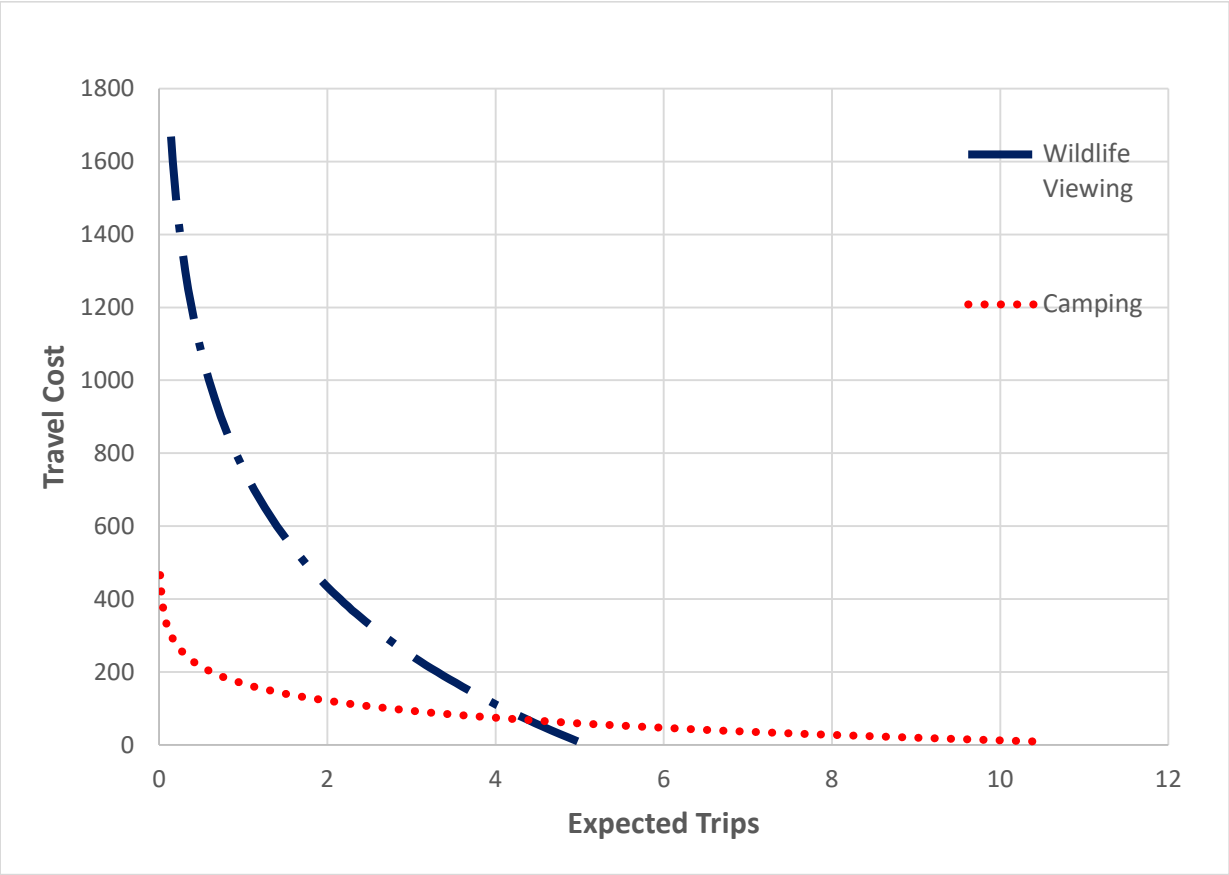


Figure 1.3 displays both the average trip demand curves for wildlife viewing (the highest value activity group) and camping (the lowest value activity group), and the differences are striking.[12] The wildlife viewing trips exhibit a steep demand curve, indicating that changes to travel costs have less of an effect on the total number of trips demanded than does that same change for camping. Even though the average wildlife viewing trip has a closer starting point, the wildlife viewing trips that start from farther away have a (relatively) similar overall demand, and this is consistent with the intuitive understanding from above. The camping group, on the

[12] The graph uses values from the average *trip*. This is different from the average visitor.

other hand, exhibits a flat demand curve. This means that camping trips are more sensitive to travel cost, and this likewise confirms the intuitive understanding that the relatively lower value for camping is driven primarily by an abundance of substitute sites in the area. In order to drive this point home, it is worth noting that the own-price elasticity for wildlife viewing trips is -0.23 and the own-price elasticity for camping trips is -1.64, over 7 times larger.

VI. Discussion

The goal of this essay was to estimate the value of recreational access to the Michigan Elk Range, a near-wilderness area in the northern Lower Peninsula of Michigan. We found that the average per-trip consumer surplus value for a visit to the Michigan Elk Range is $86.21 (or $20.28 per recreation-day). In a follow-up survey (composed of 316 respondents to the intercept survey) we learned a little more about why visitors value the Michigan Elk Range. 80% of respondents reported that the quiet/solitude that characterizes the area was a very important reason in their decisions to visit. Similarly, 76% of respondents indicated that the non-developed nature of the area was a very important reason for visiting, and 70% reported that that the opportunity for remote recreation was very important. This suggests that our consumer surplus estimates capture some benefits of wilderness that could be lost with the possible development of roads, buildings, or other man-made facilities.

We also ran segmented travel cost models for visitor classes. The first segmented model split up the visitor sample by their reported interest in seeing elk on their intercepted visit. We found that there was a fairly large increase in consumer surplus estimates for visitors answering that the elk presence played some role in their decision to visit as opposed to no role in their decision to visit. The consumer surplus estimate was nearly identical for respondents indicating that the elk presence played some role in their decision to visit as opposed to the primary role.

When segmenting visitors by their primary activity on the intercepted visit, we found that wildlife viewers had substantially higher consumer surplus estimates, and this was due to their inelastic demand for visits to the Michigan Elk Range. Visitors primarily visiting to camp, on the other hand, have a very elastic demand for visits to the Michigan Elk Range. These results make economic sense given that there are no comparable substitute sites for the wildlife viewing (as this is the only elk herd in Michigan) yet there are many nearby camping sites.

The results of this chapter rely on using an econometric technique to correct for our intercept sampling. While this approach yields and unbiased estimate of demand parameters and per-trip consumer surplus values, additional research is needed to allow the values to be aggregated. Further work in this area should define the target population and sub-populations (based on primary activities) and compute aggregate consumer surplus values (see Appendix IV). Doing this would allow for better decision-making when managers find themselves dealing with a user conflict. Additionally, further work in this area should develop a scheme to weight the intercept survey by the likelihood of being intercepted. The intercept survey routes were roving, and certain areas received more coverage than others. Weighting each survey by the probability of interception would allow us to estimate demand curves using the average visitor to the Michigan Elk Range. It also would provide another way to address endogenous stratification in our sampling process.

REFERENCES

REFERENCES

AAA (American Automobile Association). (2018). Your driving costs. Retrieved from https://newsroom.aaa.com/auto/your-driving-costs/, accessed June 29, 2019.

Benson, C., Watson, P., Taylor, G., Cook, P., & Hollenhorst, S. (2013). Who Visits a National Park and What do They Get Out of It?: A Joint Visitor Cluster Analysis and Travel Cost Model for Yellowstone National Park. *Environmental Management, 52*(4), 917-928. doi:10.1007/s00267-013-0143-4

Boxall, P., Englin, J., & Adamowicz, W. (2002). The contribution of aboriginal rock paintings to wilderness recreation values in North America. In S. Navrud & R. C. Ready (Authors), *Valuing cultural heritage: Applying environmental valuation techniques to historic buildings, monuments, and artifacts* (pp. 105-117). Cheltenham (UK): E. Elgar.

Cordell, H. K., Betz, C., & Green, G. T. (2008). Nature-based outdoor recreation trends and wilderness. *International Journal of Wilderness, August 2008, Volume 14, Number 2, Page 7-13*. Retrieved from https://www.fs.usda.gov/treesearch/pubs/all/30615, accessed on 6/30/2019

Donovan, G., & Champ, P. (2009). The Economic Benefits of Elk Viewing at the Jewell Meadows Wildlife Area in Oregon. *Human Dimensions of Wildlife, 14*(1), 51-60. doi:10.1080/10871200802545773

Edwards, P. E., Parsons, G. R., & Myers, K. H. (2011). The Economic Value of Viewing Migratory Shorebirds on the Delaware Bay: An Application of the Single Site Travel Cost Model Using On-Site Data. *Human Dimensions of Wildlife, 16*(6), 435-444. doi:10.1080/10871209.2011.608180

Freeman, A. M., Herriges, J. A., & Kling, C. L. (2014). *The measurement of environmental and resource values: Theory and methods*. Abingdon, Oxon: RFF Press.

Greenberg, S., Godin, T. (2015). A Tool Supporting the Extraction of Angling Effort Data from Remote Camera Images, *Fisheries*, *40(6)*, 276-287, doi: 10.1080/03632415.2015.1038380

Haab, T. C., & McConnell, K. E. (2003). *Valuing environmental and natural resources: The econometrics of non-market valuation*. Cheltenham: Edward Elgar Pub.

Hang, D., McFadden, D., Train, K., & Wise, K. (2016). Is vehicle depreciation a component of marginal travel cost?: A literature review and empirical analysis. *Journal of Transport Economics and Policy (JTEP)*, *50*(2), 132–150.

Hegel, T. M., Gates, C. C., & Eslinger, D. (2009). The geography of conflict between elk and agricultural values in the Cypress Hills, Canada. *Journal of Environmental Management, 90*(1), 222-235. doi:10.1016/j.jenvman.2007.09.005

Kolstoe, S., & Cameron, T. A. (2017). The Non-market Value of Birding Sites and the Marginal Value of Additional Species: Biodiversity in a Random Utility Model of Site Choice by eBird Members. *Ecological Economics, 137*, 1-12. doi:10.1016/j.ecolecon.2017.02.013

Lawson, S. R., & Manning, R. E. (2001). Solitude Versus Access: A Study of Tradeoffs in Outdoor Recreation Using Indifference Curve Analysis. *Leisure Sciences, 23*(3), 179-191. doi:10.1080/014904001316896864

Loomis, J. B., & Caughlan, L. (2004). *Economic analysis of alternative bison and elk management practices on the National Elk Refuge and Grand Teton National Park: A comparison of visitor and household responses* (Report No. 2004–1305). doi.org/10.3133/ofr20041305

Loomis, J., Yorizane, S., & Larson, D. (2000). Testing Significance of Multi-Destination and Multi-Purpose Trip Effects in a Travel Cost Method Demand Model for Whale Watching Trips. *Agricultural and Resource Economics Review, 29*(2), 183-191. doi:10.1017/s1068280500005311

MDNR (Michigan Department of Natural Resources). (2007). A Concept of Management for the Pigeon River Country. Retrieved from https://www.michigan.gov/documents/dnr/PRC_Concept_of_Management_481226_7.pdf, accessed on 6/30/2019.

MDNR (Michigan Department of Natural Resources). (2012). Michigan Elk Management Plan. Retrieved from https://www.michigan.gov/documents/dnr/ElkPlanFinal_382059_7.pdf, accessed on 6/30/2019.

MDNR (Michigan Department of Natural Resources). (2019). Michigan's Elk Viewing Guide, Retrieved from https://www.michigan.gov/documents/dnr/DNR_Elk_Brochure_401828_7.pdf, accessed on 7/8/2019.

Mladenov, N., Gardner, R. J., Flores, E. N., Mbaiwa, E. J., Mmopelwa, G., & Strzepek, M. K. (2007). The value of wildlife-viewing tourism as an incentive for conservation of biodiversity in the Okavango Delta, Botswana. *Development Southern Africa, 24*(3), 409-423. doi:10.1080/03768350701445525

Parsons, G. R. (2017). Travel Cost Models. In P. A. Champ, K. J. Boyle, & T. C. Brown (Authors), *A primer on nonmarket valuation* (pp. 187-233). Dordrecht: Springer.

Richardson, L., Huber, C., & Loomis, J. (2017). Challenges and Solutions for Applying the Travel Cost Demand Model to Geographically Remote Visitor Destinations: A Case Study of Bear Viewing at Katmai National Park and Preserve. *Human Dimensions of Wildlife, 22*(6), 550-563. doi:10.1080/10871209.2017.1369196

Richardson, L., Rosen, T., Gunther, K., & Schwartz, C. (2014). The economics of roadside bear viewing. *Journal of Environmental Management, 140*, 102-11doi:10.1016/j.jenvman.2014.01.051

RMEF (Rocky Mountain Elk Foundation). (2019). Eastern Elk Initiative. Retrieved from http://www.rmef.org/Conservation/Initiatives/EasternelkInitiative.aspx, accessed June 29, 2019.

Segerson, K. (2017). Valuing Environmental Goods and Services: An Economic Perspective. In P. A. Champ, K. J. Boyle, & T. C. Brown (Authors), *A primer on nonmarket valuation* (pp. 1-25). Dordrecht: Springer.

Shafer, E. L., Carline, R., Guldin, R. W., & Cordell, H. K. (1993). Economic amenity values of wildlife: Six case studies in Pennsylvania. *Environmental Management, 17*(5), 669-682. doi:10.1007/bf02393728

U.S. BTS (Bureau of Transportation Statistics). (2019). National Transportation Statistics, 2019, Table 4- 23.

U.S. EIA (Energy Information Administration), (2019). Weekly retail gasoline and diesel prices. Retrieved from https://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm, accessed June 29, 2019.

U.S.Cong. (1975). *The Wilderness act of 1964* (M. Clark, A. Giles, & D. Perry, Authors) [Cong. Bill]. Austin, TX: LBJ School of Public Affairs.

U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

Weber, S., & Péclat, M. (2017). A Simple Command to Calculate Travel Distance and Travel Time. *The Stata Journal: Promoting Communications on Statistics and Stata, 17*(4), 962-971. doi:10.1177/1536867x170170041

CHAPTER 2: Preferences and Values for Elk-Related Attributes among Visitors to the Michigan Elk Range

I. Introduction

While hunting and fishing participation rates have been stagnant or falling, more Americans than ever are engaging in wildlife viewing. In 2016 "86.0 million U.S. residents, 34 percent of the U.S. population 16 years or older, participated in wildlife-watching activities", and this includes 23.7 million people who took trips away from their home to go wildlife viewing (USFWS 2016). Despite the apparent value of wildlife viewing, the economics of wildlife viewing are generally not well-understood. Some of this is due to the ubiquitous nature of wildlife viewing around the home and in daily routines. Another complication is that wildlife viewing can be enjoyed in conjunction with other recreational activities (e.g., hunting, fishing, hiking, etc.). Additionally, the nature of wildlife viewing varies considerably depending on the animal in question. Whale watching is quite different from bird watching on one's back porch, which is quite different from viewing elephants on an African safari. Accordingly, the best way to foster a better understanding of wildlife viewing is to build up a set of studies diverse in both geographic region and in the particular animal being viewed. In this spirit, this essay will examine elk viewing in Michigan.

Michigan is one of the few eastern states with an elk herd, and this herd currently occupies over 100,000 acres in the northern Lower Peninsula, hereafter referred to as the Michigan Elk Range. The Michigan Elk Range is primarily located on state forest land, meaning that the area has a variety of other recreational and extractive uses. Given what we know about wildlife viewing and the unique characteristics of the Michigan Elk Range, our research questions are as follows. Does the chance of seeing Michigan's elk herd affect visitors'

recreational decisions? What do preferences look like when we break up elk viewing into some component attributes? Is there variation in visitors' preferences for elk viewing? If there is, can we use any known characteristics to explain the variation? To answer these questions, we will use a discrete choice experiment (DCE) that was conducted with known visitors to the Michigan Elk Range. A choice experiment presents respondents with a survey choice scenario where they are tasked with choosing between two or more alternatives. Each alternative is described by a set of attributes, and these attributes vary between alternatives. By analyzing the respondents' choices and their respective attributes, researchers can estimate preferences for the attributes and marginal rate of substitution values between pairs of attributes (Freeman et al. 2014).

There have been many papers that have studied the economic value for various types of wildlife viewing, and one of the more popular subjects has been bird watching. Two studies on the value of bird watching include Edwards et. al (2011), which estimated the value of migratory shorebird viewing at a few Delaware beaches using a single-site travel cost model, and Kolstoe and Cameron (2017), which used data from an online bird watching social media platform to estimate willingness to pay (WTP) for additional bird species using a multiple-site travel cost model. Kolstoe and Cameron also explored how novelty and variety-seeking affects bird watching site choice. Other studies have explored the value of viewing large charismatic mammals, and these include studies on bear viewing (Richardson et. al 2014; Richardson et. al 2017), whale watching (Loomis et. al 2000), and African safari animals (Mladenov et al. 2007). Within this group, a few studies have estimated the value of elk viewing. Donovan and Champ (2009) used a single-site travel cost model to estimate the value of elk viewing in Oregon, and they estimated a sample mean per-day consumer surplus value of $138 ($170.45 in 2019

dollars).[13] Other studies that estimate values for elk viewing include Loomis and Caughlan (2004), who estimated a mean WTP of $52 per-day ($74 in 2019 dollars) for elk and bison viewing in the National Elk Refuge in Wyoming, and Shafer et al. (1993), who used an open-ended contingent valuation question to estimate a consumer surplus for elk viewing in Pennsylvania to be just over $20 per-day ($43.30 in 2019 dollars). Apart from the Shafer study, there have been no other studies on the economic value of elk viewing in the Eastern United States.

Another strand of relevant literature is made up of studies that have used choice experiments to estimate the values of recreational site attributes. Horne et al. (2005) used a spatially explicit choice experiment to examine visitors' preferences for forest management. Christie et al. (2007) similarly used a choice experiment approach to value potential improvements in British forests, and they were able to segment their results by specific user types. A few studies have used choice experiments to estimate values for wildlife viewing attributes. Boxall and Macnab (2000) used a choice experiment to estimate forest management preferences of moose hunters and wildlife viewers in Saskatchewan, where wildlife viewing conditions was one of the attributes. In particular, they found that wildlife viewing had had an average welfare value of up to 75 dollars a trip ($129 in 2019 dollars).[14] Boxall and Adamowicz (2002) utilized a choice experiment to value Canadian wilderness recreation, and they were able to segment respondents using a latent class approach. Brock et al. (2017) utilized a DCE to estimate values for backyard bird feeding and found that respondents were principally motivated

[13] Donovan and Champ report a sample mean per day access value of $369. We are unsure how they reached this number. Consumer surplus for an individual is defined as $CS_n = 1/-\beta_{TC}$. Donovan and Champ report that their travel cost coefficient was −0.00726, so this would result in a consumer surplus value per trip of $138.

[14] This value was associated with places with the following attribute: "See common species of wildlife, one or two species never seen before, and a chance to see a rare or endangered species."

by non-consumptive use values (i.e. seeing the birds and engaging with them) as opposed to existence or intrinsic values.[15] They also found that respondents tended to value aesthetics over rarity and that people with more bird-feeding experience had higher engagement values than people with less bird-feeding experience.

Besides implementing one of the few discrete choice experiments principally about wildlife viewing, this study is unique because it segments the wildlife viewing experience into various attributes related to elk. These attributes include seeing at least one elk, hearing an elk bugle, seeing a bull elk, and seeing 10 or more elk. One reason for doing this is that the elk-related attributes identified in this study have different levels of rarity. Elk bugling, for example, is mainly associated with the fall rutting (i.e. mating) season, a period in late September when the elk are most active. Similarly, seeing a bull (male) elk is rarer than seeing a female elk due to the natural sex ratio of the species. Ultimately, we found that there is high variation in the values that Michigan Elk Range visitors place on experiencing the elk-related attributes, and we found that we could characterize Michigan Elk Range visitors into two types of visitors. The first type of visitor valued seeing at least one elk, hearing an elk bugle, and seeing 10 or more elk. The second type of visitor did not value the elk-related attributes as much as the first type and were more likely to either choose a recreational site outside of the elk range or choose to not recreate at all. Of all the attributes, seeing a bull elk was consistently insignificant for most visitors. This result is surprising because it goes against prior expectations, though we note in the discussion

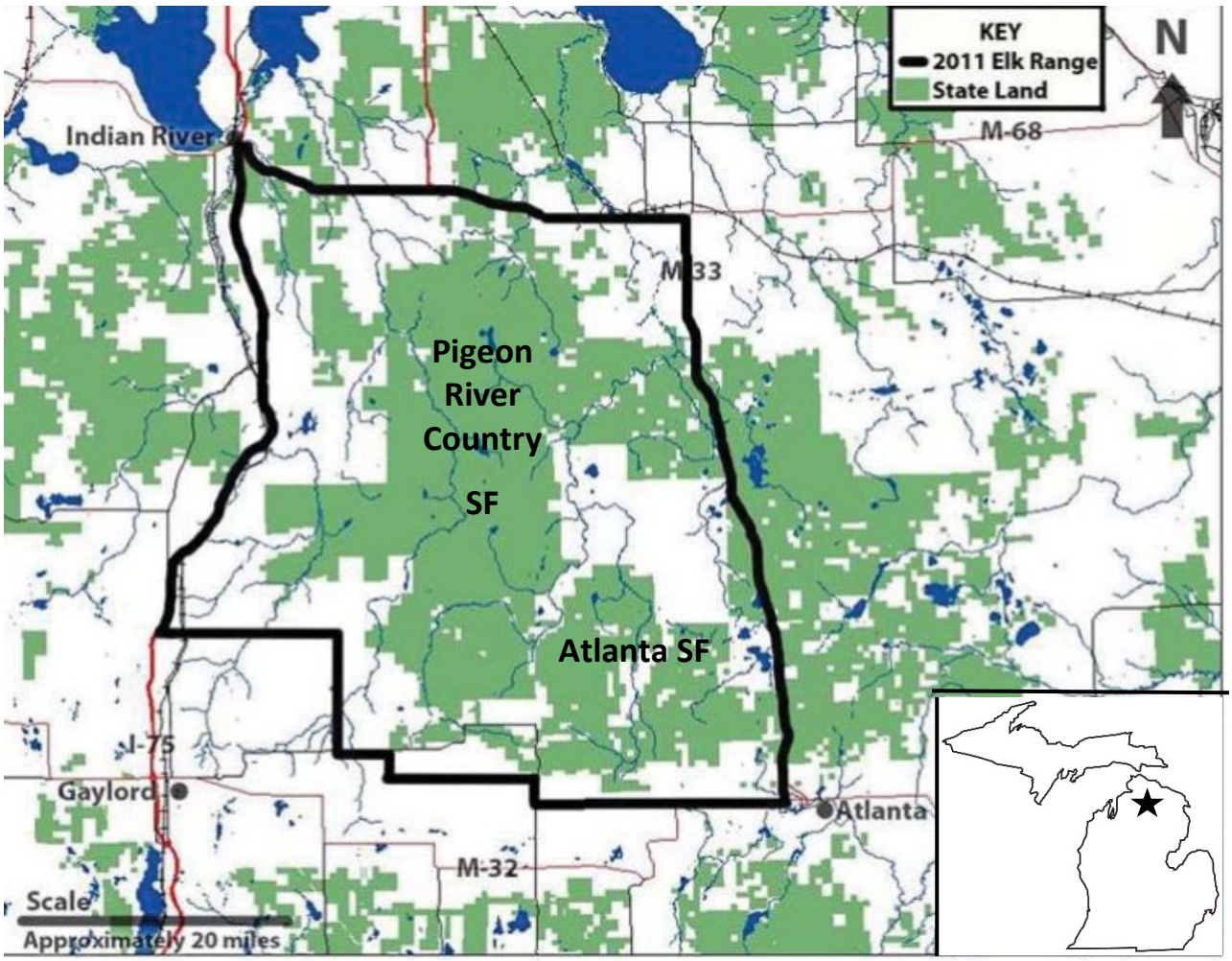
[15] The study describes the value of interacting with outdoor wildlife as a type "consumption value". This is non-standard terminology. Typically, consumptive use values imply that one's use of the good precludes use by another (e.g., hunting, fishing, and harvesting). Non-consumptive use values, on the other hand, does not diminish resource use by others. Bird watching, as is discussed in this study, fits the non-consumptive use value benefit (Segerson 2017).

some reasons why the study design may not provide us with the power to confidently identify this effect.

The structure of this paper is as follows. Section II provides and overview of the study area and details the data collection processes. Section III of the paper details the choice experiment, including motivation, experimental design, and pre-testing. Section IV covers the theoretical underpinnings of this study, that is random utility maximization (RUM) theory, and Section V covers the econometric theory used to estimate parameter values and variants that account for preference heterogeneity. Sections VI and VII analyze the overall results and identifies significant variation in elk-related coefficient estimates, and Section VIII reflects on and tempers the findings using auxiliary data.

Our empirical strategy for doing this will employ several different techniques for modeling preferences. The first model employs the simplest approach without heterogeneity, i.e. a conditional logit model. In order to check for variation in preferences for the elk-related attributes, the next step will be to estimate the model using a mixed logit approach. This approach provides standard deviation estimates for the elk-related attribute coefficients. After proving that there is significant variation in our estimates, the rest of the essay will look for visitor types that explain the variation. The first approach for doing this will be to return to a conditional logit model approach. However, this time it will be run using separate models that segment respondents by their primary activity from a previous visit to the Michigan Elk Range. The last approach will employ a latent class logit model that will use respondents' elk viewing experience in order to explain class membership.

Figure 2.1: Michigan Elk Range



II. Study Area and Survey

Following extinction in the 19th century, elk were reintroduced into Michigan a little over 100 years ago. Today almost 1,200 elk live in a 600 square mile elk range in Michigan's northern Lower Peninsula, and this makes it one of the largest elk herds east of the Mississippi River. Much of the Michigan Elk Range is accessible for public recreational access at the Pigeon River Country State Forest (PRCSF) and portions of the Atlanta State Forest (see Figure 2.1). The PRCSF is known for maintaining a near-wilderness state (MDNR 2007). Compared with other state forests, the PRCSF is more continuous, has a lower road density, and

maintains more stringent restrictions on the kinds of recreation they allow (e.g., ORV and equestrian restrictions). The MDNR maintains about 1,000 acres of grass openings and planted fields for elk feeding. Some of these openings are publicized as "elk viewing areas" on MDNR maps and brochures, along with other helpful information on elk viewing (MDNR 2012). There is a total of 13 elk viewing areas identified throughout the Michigan Elk Range (MDNR 2019). Some have dirt parking areas that allow visitors to view elk from their cars, while others require a short hike to reach. In addition to elk viewing, other popular recreational activities in the Michigan Elk Range include hunting, fishing in lakes and rivers, kayaking and boating, camping, horseback riding, hiking and backpacking, as well as morel mushroom hunting. Aside from recreation, portions of the Michigan Elk Range are used for logging and oil drilling.

This essay uses data collected in a two-stage survey of Michigan Elk Range visitors. The first phase of our survey consisted of an intercept survey conducted in the summer (June, July, and August) and fall (September, October, and November) of 2018. Respondents were intercepted along predetermined routes in the Michigan elk range. The routes were not all-encompassing due to the dispersed nature of recreation in the area, but they were chosen to balance the need for interviews as well as a representative sample of visitors. The summer intercept surveys were conducted between June 7th and September 1st, and sampling was scheduled on a rotational basis— 4 days of surveying followed by 4 days without surveying. The fall intercept surveys were conducted between September 9th and November 24th, and sampling was scheduled on random days adjusted for interviewer availability. We interviewed visitors seen along routes and left paper surveys on the windshields of parked cars when visitors were not present. Paper surveys were individually numbered so that returned surveys could be matched with our records to determine when and where the survey was distributed. The response rate for

interviews was nearly 100%, and the return rate for paper surveys left on windshields was 28% in both the fall and summer. Ultimately, the intercept survey resulted in 756 usable observations.[16] A disposition table detailing survey response rates can be found in Appendix I.

A key finding from the intercept survey was that 35% of visitors reported elk viewing as one of the activities they participated in on the visit when they were surveyed, and only about 10% reported that elk viewing was the primary activity (alone or in combination with another activity) on the surveyed visit. When asked what role the chance of seeing elk played in their decision to visit the Michigan Elk Range on the trip when they completed the intercept survey, 15% of respondents replied that the chance of seeing elk was their *primary reason* for visiting, 40% of respondents replied that the chance of seeing elk *played some role* (though not primary) in their decision to visit, and 45% of respondents replied that the chance of seeing elk played *no role* in their decision to visit. These results suggest that visitors to the Michigan Elk Range exhibit heterogeneity in their preferences for elk attributes when making site choices.

Through the intercept survey, we were able to collect 580 email addresses for an online follow-up survey, and this was the second phase of the survey. These 580 contacts were emailed with up to 6 survey invites in March and April of 2019. Of the 580 survey invites sent out, 24 were undeliverable, 39 resulted in surveys that were started but not completed, and 316 surveys were successfully completed (see Appendix I). The first section in this online follow-up survey asked respondents several questions about the visit when they received the intercept survey. The second section asked about respondents' forest related experience and attitudes. The third section

[16] Appendix I reports 367 completed interviews and 393 returned paper surveys for a total of 760 completed surveys. The *completed* survey count (760) differs slightly from the *usable* (756) survey count because four respondents returned a paper survey in which they indicated that they had already completed a survey.

included questions about the respondent's elk viewing history and experiences, and asked questions about the importance of the elk attributes which also introduced the attributes. The fourth section included the choice experiment, and the final section included a few demographic questions.

III. Choice Experiment

Figure 2.2: Example Choice Experiment (*with hunting as the primary activity*)

Suppose you are planning a trip to public land within Michigan. Your main activity will be **Hunting**. The table below shows two possible areas you could go for Hunting.

Both areas:

- are good places for Hunting and have identical features except for elk

The areas differ in:

- their distance from your home
- the chances you'll experience various elk viewing characteristics

Area A is a **200 minute** drive from your home, and Area B requires an **additional 30 minutes** of driving beyond Area A. You may experience the elk viewing characteristics while Hunting in the area, or while entering or leaving the area.

Please review the characteristics of the two areas and answer the questions below.

Two Areas For Hunting

	Area A	Area B
Recreation Features	campgrounds, hiking/biking trails, equestrian trails, and places for hunting, fishing, and morel hunting	campgrounds, hiking/biking trails, equestrian trails, and places for hunting, fishing, and morel hunting
Elk Range	**Inside Elk Range** **15%** chance of seeing at least one elk **20%** chance of hearing an elk bugle **10%** chance of seeing a bull (male) elk **5%** chance of seeing 10 or more elk	**Inside Elk Range** **60%** chance of seeing at least one elk **20%** chance of hearing an elk bugle **50%** chance of seeing a bull (male) elk **20%** chance of seeing 10 or more elk
Additional Driving Time Beyond Area A	**0** additional minutes	**30** additional minutes

In the choice experiment, respondents were asked to think about future recreational trips in Michigan. These recreational trips were presented in the context of a designated activity, and

this activity was assigned to match each respondent's reported primary activity from the intercept survey.[17] Each respondent was shown three choice sets. In each choice set, respondents chose between two possible recreational areas (hereafter referred to as the left-side area and right-side area) along with the choice to visit neither area, an opt-out option. All the possible recreational areas were given identical non-elk related attributes: campgrounds, hiking/biking trails, equestrian trails, and places for hunting, fishing, and morel hunting. Thus, the left-side and right-side areas only differ in their distance from the respondent and in their levels of elk-related attributes.

The elk-related attributes included: seeing at least one elk, seeing 10 or more elk, seeing a bull elk, and hearing an elk bugle. In order to make the choice scenarios realistic, we employed several feasibility constraints. They are as follows:

1. The chance of seeing a bull elk and seeing 10 or more elk is always lower than the chance of seeing at least one elk.
2. The chance of hearing an elk bugle is independent of seeing at least one elk. That is, it is free to occupy its entire range.
3. If any of the elk-related attributes are zero, all the other elk-related attributes must also be zero, and "Outside the Elk Range" is listed above the elk-related attributes.
4. Similarly, if any elk-related attribute is greater than zero, all the other elk-related attributes must also be greater than zero, and "Inside Elk Range" is listed above the elk-related attributes.
5. Each of the elk-related attributes for the right-side area must be equal to or greater than the same elk-related attribute for the left-side area.

[17] Some respondent's primary activities were changed to better suit the choice experiment. For example, "Driving for Pleasure" was changed to "Viewing/Photographing Wildlife or Scenery".

6. The distance to the left-side area is the approximate driving time to the Michigan Elk Range from the respondent's home. The right-side area requires some additional driving time beyond the left-side area. For example, a respondent from Gaylord, Michigan is approximately 30 minutes from the left-side area. If the right-side area requires an additional 60 minutes of driving time beyond the left-side area, this means the left-side area is 30 minutes away from the respondent's home and the right-side area is 90 minutes away from the respondent's home.

Table 2.1: Elk-related Attribute Levels

Attribute	*Level*
Seeing at least one elk	{0, 15, 20, 25, 40, 60} % chance
Seeing 10 or more elk	{0, 5, 10, 15, 20, 50} % chance
Seeing a bull (male) elk	{0, 5, 10, 15, 20, 50} % chance
Hearing an elk bugle	{0, 5, 10, 20, 35, 50} % chance
Distance (Additional Driving Time Beyond Area A)	{15, 30, 60, 90, 120} minutes

The rules above ensure that the design exhibits a trade-off between the likelihood of experiencing elk related attributes and longer driving times (i.e. travel costs). The attribute levels are displayed in Table 2.1. The range of the elk-related attributes was chosen to be realistic and credible to respondents. The chance of seeing at least one elk goes up to 60%, and the chances for the other elk-related attributes can go up to 50%. We chose these values as the high end of the range because elk sightings are not guaranteed on every visit. The range on the distance (additional driving time) attribute goes up to 120 minutes, because two hours is close to the maximum time it takes to travel between any two given sites in the area. Travel in the area can be slow due to poor road quality, but the area is not large enough for journeys over two hours.

In order to increase the credibility of the choice scenarios, we assigned respondents into one of three groups for the experimental design process. For each group, we created 15 choice sets divided into five blocks of three, and each respondent was randomly assigned to one of the 5 blocks. The choice sets were created using the Ngene software to minimize D-error and make our parameter estimates as efficient as possible, given the feasibility constraints. The first group was made up of those respondents who indicated in the intercept survey that their primary activity was elk viewing. Since these respondents were being asked about possible elk viewing trips, it didn't make sense to have any of their choice sets include areas outside of the elk range (i.e. 0% chance of experiencing any of the elk-related attributes), so all of their alternatives (both left-side and right-side) were included in the elk range and featured only positive elk-related attributes.

The second group was based off an auxiliary question that immediately preceded the choice experiment. This auxiliary question asked respondents how important the various elk-related attributes are to them when choosing where to recreate in the Michigan Elk Range. Respondents who selected "not important" for all four elk-related attributes were assigned choice sets where all of the left-side areas were "outside the elk range" (i.e. 0% chance of experiencing any of the elk related attributes). Even for this group, however, the right-side area was always in the elk range.[18] The last group, a base group, was made up of those respondents that did not fall into either of the two groups from above. Members of this base group were sometimes given left-side areas inside the elk range and sometimes they were given left-side areas outside of the elk range. Just like the other two groups, all of their right-side areas were in the elk range. Given that

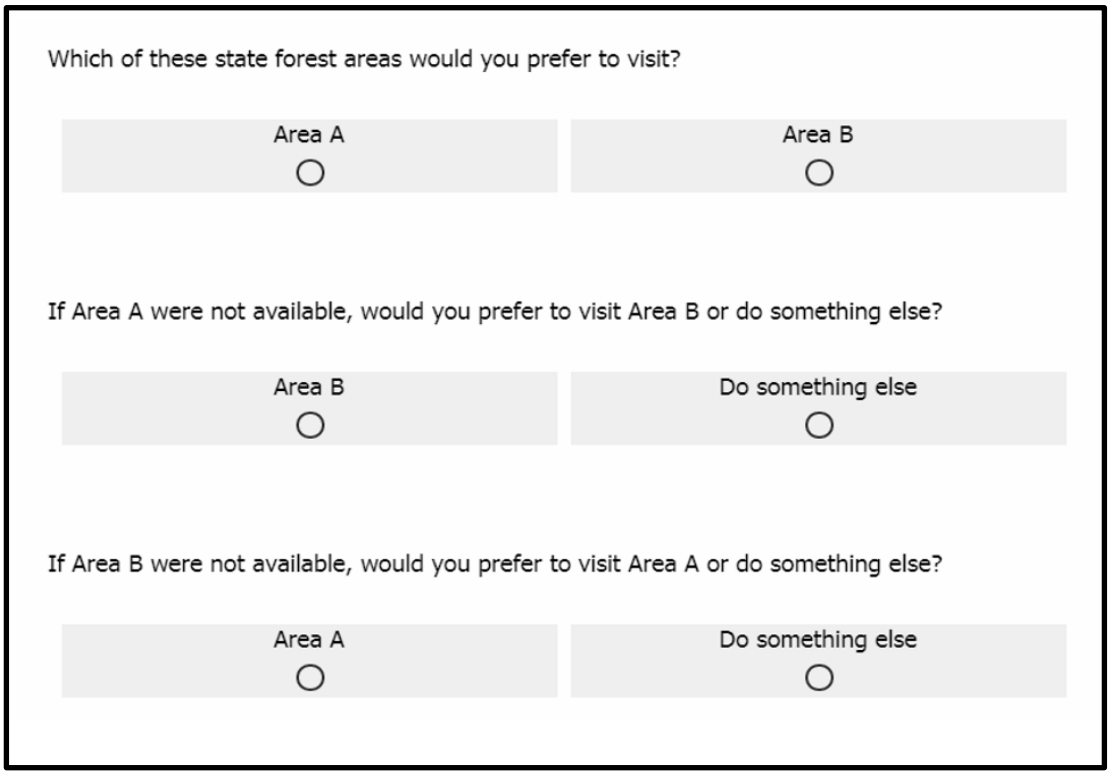
[18] Another purpose of the auxiliary question was to acquaint all respondents to the various elk-related attributes before they viewed the three choice scenarios.

these differences were minor, we were able to pool together all responses, regardless of group, in the analysis stage.

As part of the survey design process, we conducted cognitive interviews to pretest the online follow-up survey, and we paid particular attention to the choice experiment portion of the survey. In May 2018 we conducted pre-tests for the intercept survey with visitors to the Michigan Elk Range, and we acquired approximately 25 email addresses. In December 2018 we sent out invitations to these email addresses, and 9 individuals responded and completed individual cognitive interviews to pre-test the follow-up survey. The pre-test respondents completed the survey while on a video-phone call with us. This was advantageous because it allowed us to watch respondents as they answered survey questions and to probe respondents about their decision-making process and understanding using cognitive interviewing techniques.

The pre-tests resulted in several changes to the choice experiment. Importantly, complexity was reduced by putting all the choice questions in a common format (originally two of the questions had different seasons and the other used a different format to address trips in/out of the elk range). To further reduce complexity, the number of attributes was reduced (e.g. eliminating rare items like "seeing elk sparring"). The final survey version presents respondents with three choice scenarios of the exact same setting and format. This allows us to pool responses together and thus increase overall efficiency of the elk-related attribute parameter estimates (three observations for every respondent). Another advantage is that this format is easier for respondents because it can "provide respondents an opportunity to develop a better understanding of the task at hand" (Johnston et al. 2017).

Figure 2.3: Choice Experiment Response Questions



It is worth noting the format for how we elicited responses to the choice experiment due to formatting constraints within the online survey program. Figure 2.3 displays the three questions respondents were asked to answer following the presentation of each choice scenario. The first question elicits a binary choice between the two areas. The second and third questions asks respondents to choose between each of the respective areas in comparison to "do something else", an opt-out option. If a respondent answers "do something else" to both the second and third question, their recorded choice is "none", the opt-out option. If respondents do not select "do something else" to the second and third questions, their recorded choice is whichever area was selected in the first question. This type of choice experiment elicitation set-up is advantageous in that it records a binary choice (the first question) from all respondents while also allowing respondents the option to opt-out. The disadvantage of this elicitation set-up is that it can be a cognitive burden for some respondents, and it allows the respondents the option

of selecting intransitive responses to the three questions. Of the 913 total choice sets, 24 were intransitive. Appendix V displays robustness checks for the models presented in this study. One robustness check runs all of the models used in this study without intransitive responses, and another robustness check runs all of the models used in this study with only binary responses.

IV. Random Utility Maximization Theory

We expect that, when faced with a choice, people make decisions that maximize their expected utility. This is the key insight behind random utility maximization (RUM) theory which was first proposed by Daniel McFadden (1974). Individual decision makers make utility maximizing choices with certainty, whereas analysts have an incomplete view of any given choice occasion. From the analyst's perspective, an individual's utility derived from a given choice is made up of both observed and unobserved portions. Holmes et al. (2017) states this relationship formally as:

$$V_{ik} = v_{ik}(Z_i, y_k - p_i) + \varepsilon_{ik} \quad (1)$$

where total indirect utility (V) for individual k when he selects alternative i is composed of both an observed portion (v) and an unobserved portion (ε). Z is a vector of attributes for alternative i, p is the price for alternative i, and y is individual k's income. The observed potion of the indirect utility function is commonly specified as a linear function of the alternative attributes. Thus, equation 1 can be rewritten as follows:

$$V_{ik} = \beta_0 + \boldsymbol{\beta_1 z_i} + \lambda(y_k - p_i) + \varepsilon_{ik} \quad (2)$$

where λ is the marginal utility of income. The stochastic nature of the unobserved portion of indirect utility (ε) naturally lends itself to the use of probabilistic statements. From the analyst's perspective, the probability that individual k selects alternative i over any other alternative (j) is given by:

$$P_{ik} = \Pr\left[V_{ik} > V_{jk}\right] \forall j \quad (3)$$

A common way to interpret the resulting attribute parameter estimates is to calculate a marginal rate of substitution (MRS) between each of the attributes and the marginal utility of income (or driving time, as we will discuss below). MRS can be defined as follows:

$$MRS_{1,2} = -\frac{\partial V/\partial z_2}{\partial V/\partial z_1} = -\left(\frac{\beta_2}{\beta_1}\right) \quad (4)$$

It should be noted that in this study, costs are presented to respondents in terms of driving time as opposed to direct monetary expenditures. Thus, λ is a coefficient that represents the marginal utility of minutes spent driving, a value that is likely negative. Framing costs in this manner is more realistic and credible for respondents because visitors to the Michigan Elk Range do not face direct monetary costs for site choices. However, they do indirectly pay for recreation site choice in terms of additional travel costs incurred as well as possible accessibility issues. Throughout the pretesting phase, respondents had no problem conceptualizing the costs of different sites in terms of additional driving time (Johnston et al. 2017). Appendix V estimates MRS values for the elk-related attributes and money (using estimated travel costs). In sum, RUM theory says that decisions are based upon the relative attribute levels of two or more choices as well as unobserved stochastic elements influenced by personal preferences.

V. Modelling Heterogeneity in Random Utility Models

When conducting choice experiments, analysts must make modelling assumptions regarding the unobserved, stochastic component (ε) of decision makers' choices. The simplest approach is to assume that this component is independently identically distributed (IID) and follows a Type-I extreme value distribution. Conditional logit models also assume a substitution pattern known as independence from irrelevant alternatives (IIA). This means that the probability ratio for choosing between two alternatives is independent of any other alternatives in the choice

set. This is not always a realistic assumption, as the probability ratio for two alternatives is likely to change when a substitute good is added to the choice set (Train 2009). When these conditions do hold, however, a conditional logit model is an appropriate estimation technique. According to a conditional logit model, the probability that individual *k* selects alternative *i* over alternatives $j \in C$ (where C is the individual's choice set) can expressed as:

$$P_{ik} = \frac{\exp(\boldsymbol{\beta z_i})}{\Sigma_{j \in C} \exp(\boldsymbol{\beta z_j})} \quad (5)$$

The assumptions required to use conditional logit models are strict and not always realistic. A second way to model choice is to use a latent class approach (Boxall and Adamowicz 2002). This estimation approach uses additional information to divide the population into classes (*s*). Within each class, it is assumed that the unobserved heterogeneity of the unobserved component (ε) follows an IID Type-I extreme value distribution, and the IIA assumption is weakened. Under a latent class logit model, the probability that individual *k* selects alternative *i* over alternatives $j \in C$ given that the individual belongs to class *s* can be expressed as:

$$P_{ik|s} = \frac{\exp(\boldsymbol{\beta_s Z_i})}{\Sigma_{j \in C} \exp(\boldsymbol{\beta_s Z_j})} \quad (6)$$

This differs from the conditional logit estimate in that it results in separate attribute coefficients for each class. Membership to these classes follows from a latent membership likelihood function. This membership function is made up of a vector of membership explanatory variables (X), a vector of parameters (λ), and a vector of error terms (ζ). The membership explanatory variables can include psychometric data, sociodemographic data, and other known latent attitudes or values. The probability that individual *k* is a member of class *s* can be expressed as:

$$M_{ks} = \boldsymbol{\lambda_s X_k} + \boldsymbol{\zeta_{ks}} \quad (7)$$

Assuming that the error term (ζ) follows an IID Type-I extreme value distribution, the probability that individual *k* is a member of segment *s* can be restated as:

$$P_{ks} = \frac{\exp(\boldsymbol{\lambda_s X_k})}{\Sigma_{s=1}^{S}\exp(\boldsymbol{\lambda_s X_k})} \quad (8)$$

One can combine the probability of an individual belonging to class *s* with the probability of choosing alternative *i* given membership in class *s* to express the overall, *unconditional* probability of choosing alterative *i* for individual *k*. This is stated as follows:

$$P_{ik} = \sum_{s=1}^{S}\left[\frac{\exp(\boldsymbol{\lambda_s X_k})}{\Sigma_{s=1}^{S}\exp(\boldsymbol{\lambda_s X_k})}\right]\left[\frac{\exp(\boldsymbol{\beta_s Z_i})}{\Sigma_{j\in C}\exp(\boldsymbol{\beta_s Z_j})}\right] \quad (9)$$

Another way to address heterogeneity in the unobserved, stochastic component of the indirect utility function is to use a mixed logit model. Whereas the conditional logit results in a point estimate for the parameter ($\boldsymbol{\beta}$) values, the mixed logit provides those same parameter ($\boldsymbol{\beta}$) estimates over a density. A mixed logit model can be expressed as follows:

$$P_{ik} = \int\left(\frac{\exp(\boldsymbol{\beta z_i})}{\sum_{j\in C}\exp(\boldsymbol{\beta z_j})}\right) f(\beta)\, d\beta \quad (10)$$

The latent class logit (mentioned above) is just a special type of the mixed logit that uses a discrete set of parameter ($\boldsymbol{\beta}$) values. The mixing distribution ($f(\beta)$) can be specified using any distribution. The most common distribution to use is normal, but analysts have been known to use lognormal, triangular, uniform, and gamma distributions as well. The biggest advantage of a mixed logit model is that it captures preference heterogeneity and allows for more flexible substitution patterns (the model does not exhibit IIA). Mixed logit models are also advantageous

when using panel data, as is the case in this study, because it can control for correlation errors across repeated choices from the same respondent (Hole 2007; Train 2009).

VI. Overall Results

Table 2.2: Overall Conditional Logit Estimates with "None" and "Outside of Elk Range" Interactions

Variables	(1)	(2)	(3)
See One Elk	0.0279***	0.0279***	0.0271***
	(0.00497)	(0.00496)	(0.00498)
Hear Elk Bugle	0.0299***	0.0298***	0.0303***
	(0.00528)	(0.00528)	(0.00524)
See Bull Elk	0.00431	0.00430	0.00456
	(0.00417)	(0.00417)	(0.00419)
See 10 Elk	0.00649	0.00646	0.00700
	(0.00514)	(0.00515)	(0.00510)
Distance (additional driving time)	-0.0117***	-0.0117***	-0.0117***
	(0.00233)	(0.00232)	(0.00230)
Outside of Elk Range	1.418***	1.420***	3.192**
	(0.296)	(0.297)	(1.460)
None	-1.632***	0.949	-1.647***
	(0.346)	(2.302)	(0.347)
None x Driving Time		-0.00383	
		(0.00419)	
None x Male		0.00726	
		(0.585)	
None x Education Level		-0.152	
		(0.130)	
None x Income		0.00276	
		(0.00664)	
Outside of Elk Range x Driving Time			-0.00727***
			(0.00257)
Outside of Elk Range x Male			-0.519
			(0.424)
Outside of Elk Range x Education Level			-0.0424
			(0.0939)
Outside of Elk Range x Income			0.00279
			(0.00396)
Respondents	309	309	309
Choice Sets	913	913	913

Standard errors clustered by respondent reported in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The simplest estimation approach involves using a conditional logit model, and these results are reported in Table 2.2.[19] Table 2.2 shows both the "None" (opt-out option indicating when respondents prefer neither area) variable interacted with several demographic variables as well as the "Outside of Elk Range" (selection of an area where all elk-related attributes have a 0% chance of occurring) variable interacted with the same demographic variables. These interactions are included to see whether respondents are more likely to opt-out or pick an area outside the elk range based on individual characteristics. Neither of these sets of interactions result in significant differences to the parameter estimates, and the one significant interaction ("Outside of Elk Range" x Driving Time) will be explored in a later section. The most important finding from these results is that the parameter estimates for seeing at least one elk and hearing an elk bugle are significant while the parameter estimates for seeing a bull elk and seeing 10 or more elk are not significant. This is not entirely surprising given the feasibility constraints we imposed on the design. Both significant attributes, seeing at least on elk and hearing an elk bugle, were allowed to independently assume their entire range whereas the other two attributes, seeing a bull elk and seeing 10 or more elk, were constrained to be less than the probability of seeing at least one elk (i.e., since there is less independent variation in these two attributes, the design has less power to identify these effects with the available sample size).

In the simple case without interactions, the MRS between seeing at least one elk and additional driving distance is 2.38. This can be interpreted to mean that, on average, respondents would be willing to drive an additional 2.38 minutes for a one percent increase in the chance of seeing at least one elk. Put another way, respondents would be willing to drive an additional 23.8 minutes for a 10% increase in the chance of seeing elk. Hearing an elk bugle appears to have a

[19] The standard errors are clustered by respondents

higher value, as respondents would be willing to drive an additional 25.5 minutes for a 10% increase in the chance of hearing a bugle. It should also be noted that the variable for selecting "none" (the opt-out choice) is significant and negative, and this is not surprising because this option was not chosen very often. The variable for choosing an area when it is outside the elk range (i.e. 0% likelihood for all elk-related attributes) is significant and positive.

Table 2.3: Overall Mixed Logit Estimates

Variables	Parameter Estimates	SD Estimates	% with Parameter >0
Seeing One Elk	0.0222** (0.00871)	0 .0004 (0.04231)	100%
Hearing an Elk Bugle	0.0318*** (0.00893)	0.0611*** (0.01533)	70%
Seeing a Bull Elk	0.0203* (0.0108)	0.0549*** (0.0158)	64%
Seeing 10 Elk	0.0420*** (0.0155)	0.1094*** (0.0271)	65%
Distance[20]	-0.0226*** (0.00359)		
Outside of Elk Range	0.896** (0.404)		
None	-2.414*** (0.340)		
Respondents	309	309	309
Choice Sets	913	913	913

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In order to get a better sense of coefficient estimate variation, it is worthwhile to examine a mixed logit estimation model as well. As stated previously, the mixed logit is more flexible than a conditional logit, allows for heterogeneous preferences, and works well with panel data.

[20] The distance parameter is not given a distribution because it could lead to an undefined marginal rate of substitution.

Table 2.3 presents the results from the mixed logit model estimated with full correlation in the random parameters and with panel data structure for preferences and error terms. The results show significant variation in the parameter estimates for three of the four elk viewing attributes. The exception is seeing at least one elk, which does not have a standard deviation significantly different than zero. Additionally, the seeing one elk parameter also has a smaller MRS (close to 1) than what was estimated using a conditional logit model.

The second parameter, hearing an elk bugle, also has a smaller estimated MRS (1.41) than estimate found using a conditional logit model. Regarding the hearing an elk bugle attribute, the mixed logit model estimates a mean parameter of 0.032 and an estimated standard deviation of 0.061. This indicates that roughly 30% of respondents have a zero (or negative) value for elk bugling. The parameter for seeing a bull elk exhibits a similar pattern, though the estimated mean coefficient is not significant at the 5 percent level.

The biggest change, when compared to the conditional logit estimate, comes from the attribute seeing 10 or more elk. In the conditional logit model, the estimated parameter was not even significant. With a mixed logit model, the MRS (1.86) is higher than any of the other parameters. One reason this may have not shown up in the earlier conditional logit estimation is because of the large variation. The estimated standard deviation of seeing 10 or more elk is over 2.5 times as large as the mean parameter estimate itself. This means about 65% of respondents prefer seeing 10 or more elk, and the remaining 35% do not. The parameter estimate for seeing a bull elk is significant at the 10% level, and the MRS value is 0.90.

Our mixed logit model assumes a normal mixing distribution with infinite support. Because of this, we have to be cautious about interpreting the results. Taken literally, these results imply that someone, somewhere has an infinitely negative value for hearing an elk bugle.

While it is possible that someone could have slightly negative values for some of these elk-related attributes, the more likely scenario is that a portion of respondents simply do not care about the attributes. The key takeaway from the mixed logit approach to estimation is that there is significant variation in how respondents value the various elk-related attributes that was otherwise masked in the conditional logit model. While the mixed logit approach is helpful insomuch as it revealed the extent of the variation in the parameter estimates, it does not provide much in the way of explanations as to which visitors to the Michigan Elk Range would have either a positive or zero value for an elk-related attribute. The follow section will attempt to explain where this variation is occurring. The first step will be to return to a conditional logit model. However, this time it will be run using separate models for each of the different activity groups identified in each respondent's choice scenarios. Then, we will explore a latent class logit approach, which uses respondent characteristics to explain the variation in the estimated elk-related attribute parameters.

Table 2.4: Primary Activities (*per respondent*) in Choice Experiment Scenarios

Activity (Activity Group in Bold)	*Frequency*	*Percent*
Water Activities	**71**	**22.9%**
Fishing at a Lake	29	9.4%
Fishing at a Stream	27	8.7%
Kayaking, Canoeing, or Boating	9	2.9%
Swimming or Wading in Water	6	1.9%
Hunting	**56**	**18.1%**
Hunting	56	18.1%
Path Activities	**64**	**20.8%**
Hiking, Trail Running, or Backpacking	45	14.6%
Bicycling	11	3.6%
Horseback Riding	8	2.6%
Wildlife Activities	**47**	**15.2%**
Viewing Elk	35	11.3%
Viewing/Photographing Wildlife or Scenery	11	3.6%
Mushroom Picking	1	0.3%
Camping	**71**	**23.0%**
Camping	70	22.7%
Picnicking or Family Day Gatherings	1	0.3%
Total	309	100%

Table 2.5: Conditional Logit Estimates by Primary Activity Group

Variables	Path Activities	Wildlife Viewing	Hunting	Camping	Water Activities
See One Elk	0.0202**	0.0697***	0.0158	0.0299***	0.0309***
	(0.00957)	(0.0248)	(0.0140)	(0.00957)	(0.00944)
Hear Elk Bugle	0.0225	0.0660***	0.00304	0.0271**	0.0350***
	(0.0117)	(0.0141)	(0.0131)	(0.0117)	(0.0126)
See Bull Elk	-0.000437	-0.00276	0.0315***	0.00224	-0.000158
	(0.00973)	(0.0217)	(0.00951)	(0.00928)	(0.00787)
See 10 Elk	-0.0110	0.00480	0.0241*	0.00532	0.0117
	(0.0126)	(0.0129)	(0.0141)	(0.0111)	(0.0110)
Distance	-0.00907*	-0.0170**	-0.0138**	-0.0142***	-0.0185***
	(0.00512)	(0.00664)	(0.00638)	(0.00521)	(0.00577)
Outside of Elk Range	0.647	1.768	0.688	1.004	1.931***
	(0.627)	(1.319)	(0.631)	(0.590)	(0.652)
None	-3.024***	-0.491	-1.715**	-1.982**	-0.993
	(0.886)	(0.963)	(0.831)	(0.773)	(0.701)
Respondents	64	47	56	71	71
Choice Sets	191	139	164	211	208

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The choice scenario was set up so that respondents chose between two hypothetical recreational areas for a *specified recreational activity*. Table 2.4 lists these primary activities and organizes them into similar groups. Table 2.5 shows the results from running individual conditional logit models for each of the primary activity groups. The rationale behind running separate conditional logit models for each activity group is that the approach may reveal insights into secondary elk viewing effects (e.g. "*how much do hunters value seeing elk?"*). Another benefit from separating the models is that it could improve the parameter estimates for elk-related attributes. As was stated earlier, the strict assumptions of the conditional logit are more likely to be realized when using separate models because there is likely to be more homogeneity between respondents of the same activity group than across activity groups. That being said, the cost to splitting up the overall sample is that these models lose statistical power.

Despite this concern about statistical power, each activity group has a significant distance attribute as well as at least one significant elk-related attribute. This suggests the presence of incidental elk viewing value (i.e. value from elk viewing that occurs simultaneously with or as a subordinate component of other forms of recreation). Path activities (hiking, biking, and horseback riding) have an MRS of 2.23 for seeing at least one elk (significant at the 10% level). Path activity respondents are also the least likely of any activity group to select the opt-out option. Respondents whose primary activity was some sort of water activity have MRS estimates of 1.67 for seeing at least one elk and 1.89 for hearing an elk bugle. The "None" (opt-out choice) variable is not significant, but the "Outside of Elk Range" variable is significant and positive. Respondents in this activity group were the most likely to choose areas outside of the elk range, and a comparison between the significant estimates shows that it takes, on average, a 30% chance of seeing at least one elk and hearing an elk bugle before water activity respondents

change their choice from an area outside of the elk range to an area inside of the elk range. This is not entirely surprising given that water activities are ostensibly the most removed from elk viewing.[21]

Camping has significant coefficients for seeing at least one elk, hearing an elk bugle, and a significantly negative coefficient on the none (opt-out choice) variable. The MRS values for campers are 2.11 for seeing at least one elk and 1.91 for hearing an elk bugle. The hunting activity group presents an interesting case because it is one of the only places in the entire study where we see a significant parameter estimate for seeing a bull elk. The MRS of seeing a bull elk for hunters is 2.29, meaning that a hunter would be willing to drive an additional 23 minutes to see a bull elk. As one would expect, the wildlife viewing group places the highest value on the elk-related attributes. Wildlife viewers would be willing to drive around 40 additional minutes for either a 10% increase in the chance of seeing at least one elk or a 10% increase in hearing an elk bugle. Neither the "None" (opt-out choice) nor are "Outside of Elk Range" variables are significant for wildlife viewers.

[21] Although rare, a few respondents to the intercept survey did report seeing elk at Cornwall Flooding, one of the lakes in the Michigan Elk Range.

Table 2.6: Summary of Elk Experience Variables used in Latent Class Logit

Question or Variable	Description	Choices	Percentage
Question 24 *(follow-up survey)*	Have you ever gone elk viewing in Michigan?	1=Yes 0=No	80.83% 19.17%
Question 28 *(follow-up survey)*	Have you ever seen wild elk outside of Michigan?	1=Yes 0=No	60.35% 39.65%
Question 17 *(intercept survey)*	What role did the chance of seeing elk play in your decision to visit?	1=Primary Reason 2=Played Some Role 3=No Role	16.48% 38.79% 44.73%
		Mean	*SD*
Approximate Driving time to MI Elk Range	An approximate driving time to the Michigan Elk Range was given to each respondent based on their home zip-code (in minutes).	151.19	87.24

Apart from running separate conditional logit models, another way to explain the variation in the elk-related attribute parameter estimates is with a latent class logit approach that segments respondents into classes using explanatory variables of our choice. There is no hard and fast rule for selecting class membership variables, as it depends on the specific research question and the available data. We chose to use information on respondents' elk viewing experience in order to explain class membership. The idea behind this choice was to see whether past elk viewing experience affects future recreational decisions. If there is a novelty effect (similar to "listing" in the birding community), we would expect those with lower elk viewing experience to be willing to drive farther in order to experience the elk-related attributes. Additionally, a novelty effect would likely result in higher values for the relatively rare attributes (e.g. seeing a bull elk) as opposed to the relatively common attributes (e.g. seeing at least one elk). Conversely, results indicating that those with more elk viewing experience are willing to drive farther to experience the elk-related attributes could indicate a type of habit formation or

enthusiasm informed by past experience. Class membership explanatory variables include whether the respondent has ever gone elk viewing in Michigan, whether the respondent has ever seen elk outside of Michigan, whether elk viewing was the primary reason for their intercepted visit, and their approximate distance from the Michigan Elk Range. These explanatory variables are described in Table 2.6.[22]

Table 2.7: Class Membership for Latent Class Logit Model for Two Classes when using Elk Experience as Explanatory Variables (*Class 2=Reference Class)*

Variables	Class 1
Have you ever gone elk viewing in Michigan? (Q24 Follow-Up)	-0.709** (0.351)
Have you ever seen elk outside of Michigan? (Q28 Follow-Up)	-0.553* (0.298)
Was seeing elk the primary reason for visiting on the intercepted visit? (Q15 Intercept)	-2.55*** (0.801)
Approximate Driving Time (in minutes)	-0.00602*** (0.0018)
Constant	1.668*** (0.473)
Class Share	41%

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[22] In addition to the explanatory variables found in table 2.6, we checked for other significant elk viewing experience variables from follow-up survey questions. We also checked demographic variables (age, income, gender, and education level), but only age was significant, and its significance went away when combined with the elk viewing experience variables.

Table 2.8: Preferences for Latent Class Logit Model for Two Classes Explained by Elk Experience

Variables	Class 1	Class 2
See One Elk	0.0163*	0.0281**
	(0.00979)	(0.0124)
Hear Elk Bugle	-0.0137	0.0536***
	(0.00927)	(0.00949)
See Bull Elk	0.0084	0.0170
	(0.0107)	(0.0114)
See 10 Elk	-0.0164	0.0310**
	(0.0120)	(0.0145)
Distance	-0.022***	-0.0163***
	(0.00556)	(0.00397)
Outside of Elk Range	0.702*	-0.553
	(0.406)	(0.914)
None	-2.468***	-0.626
	(0.395)	(0.548)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The latent class logit model results in two sets of estimates for two classes of respondents. We chose to use two classes because this choice minimizes the consistent Akaike information criterion (CAIC) and the Bayesian information criterion (BIC) suggesting two classes are preferred to more classes (Pacifico and Yoo 2013). Table 2.7 displays the class membership composition, where class 2 is the reference class. On average, members of class 1 are likely to be closer to the Michigan Elk Range and are less likely to have ever gone elk viewing (inside or outside of Michigan). They are also less likely to have reported that their intercepted visit was primarily related to seeing elk. Broadly speaking, we can think of class one as having less elk experience and/or enthusiasm and class 2 as having more elk viewing experience and/or enthusiasm.

Table 2.8 shows parameter estimates for each group. Members of class 1, made up of those with less elk experience, have an MRS estimate of 0.74 (at the 10% level) for the seeing at

least one elk, and none of the other elk-related attributes are significant. Class 1 is also less likely to opt-out and select neither area but more likely to select an area that is outside the elk range. On the contrary, members of class 2, the farther class and those more likely to have gone elk viewing before, value seeing at least one elk, hearing an elk bugle, and seeing 10 or more elk. The MRS values for class 2 are 1.72 for seeing at least one elk, 3.29 for hearing an elk bugle, and 1.90 for seeing 10 or more elk. About 40% of respondents fall into class 1, and about 60% of respondents fall in class 2.

These results suggest a type of habit formation when it comes to elk viewing, but a word of caution is in order. Class membership is defined by both elk viewing experience and approximate driving time to the Michigan Elk Range. It's possible that the reason local visitors place a lower value on elk-related attributes is because they may have seen them unintentionally in the past and thus have little interest in seeing again in the future. This kind of attitude toward elk would suggest a type of novelty effect. We tried to get at this possible attitude by asking respondents to the follow-up survey about their experience with unintentional elk sightings (i.e. seeing elk while doing something else), and this the resulting variable was not significant in explaining class membership. It is possible that respondents did not understand what this question was asking, in which case we would expect to see an undercount in that category.

VIII. Reflections on the Results using Auxiliary Data

Perhaps the most surprising finding from this study was that visitors to the Michigan Elk Range seemingly have little or no value for viewing bull elk. The only times we saw significant parameter estimates for this attribute was with hunters, when we ran individual conditional logit models for each of the primary activity groups, and with the overall mixed logit model.[23] This

[23]Both estimates are significant at the 10% level.

general lack of interest in bull elk is surprising because bull elk are rarer than female elk. Besides that, they are larger, have antlers, and engage in sparring during the rutting season. Another puzzling related aspect is that elk bugling, a sound that bull elk make during the fall, is generally a significant attribute throughout this study, so this would suggest that people enjoy hearing but not seeing bull elk.

There are several reasons why this finding could be wrong. As was discussed earlier, we imposed several feasibility constraints to make all possible choice sets realistic. Chiefly, we required that the chances of seeing a bull elk and chances of seeing 10 or more elk be less than the chances of seeing at least one elk. This constraint reduced the amount of independent variation for these two attributes, and this necessarily made the attribute parameters harder to identify (Appendix VI presents the correlation matrix that shows that the feasibility constraints resulted in a design with high correlation among the attributes). Still, we seemed to have had better luck in estimating the "see 10 or more elk" parameter (i.e. the other constrained attribute), as it has a higher significance level in both the mixed logit model as well as the latent class logit model. Another possible problem could stem from the fact that we did not provide a detailed definition of what a bull elk is—nor did we provide a detailed definition of any of the elk-related attributes.[24] Accordingly, if respondents did not associate antlers with the term "bull elk", this lack of context could have caused the low valuation. Lastly, there could have been unintentional problems that resulted from splitting the attribute for seeing a bull elk from the attribute for hearing a bull elk.

[24] In the auxiliary question preceding the choice experiment, we used the term "seeing a bull (male) elk"

Table 2.9: Cross Tabulation for questions on experience with elk-related attributes and importance of elk-related attributes for future recreation

	Not Important (%)	Somewhat Important (%)	Very Important (%)
Seeing at least One Elk Attribute			
Has not seen at least one elk (n=58)	51.72%	29.31%	18.97%
Has seen at least one elk (n=255)***	32.55%	49.80%	17.65%
Seeing 10 or more Elk Attribute			
Has not seen 10 or more elk (*at one time*) (n=137)	72.26%	22.63%	5.11%
Has seen 10 or more elk (*at one time*) (n=175)*	59.43%	33.71%	6.86%
Seeing a Bull Elk Attribute			
Has not seen a bull elk (n=82)	71.95%	15.85%	12.20%
Has seen a bull elk (n=230)***	43.48%	43.91%	12.61%
Hear an Elk Bugle Attribute			
Has not heard an elk bugle (n=94)	62.77%	27.66%	9.57%
Has heard an elk bugle (n=218)***	37.16%	47.35%	13.78%

One way to check the validity of the models is to compare these findings to additional data collected elsewhere in the follow-up survey. Table 2.9 compares respondent's experience with each elk viewing attribute (seeing a bull elk, hearing an elk bugle, and seeing 10 or more elk) with a rating of how important that same attribute is in the context of future recreation. The results in Table 2.9 seem to confirm our intuition about the problem with the bull elk parameter. About one-half of respondents say that seeing a bull elk is not important when considering future recreation in the Michigan Elk Range. This is 15 percentage points lower than the seeing 10 or more elk attribute (where 65% of respondents rated it as not important) and only about 5

percentage points higher than the hearing an elk bugle attribute (where 45% of respondents rated it as not important). It is not clear why there appears to be a discrepancy between what respondents told us in these auxiliary questions with what respondents told us in the choice experiment, but it does confirm our suspicion that the value of elk viewing may be understated by the choice experiment.

The results from Table 2.9 also seem to give credence to the lesson we took from the latent class logit models. Remember that Class 2, the class that lives farther away and has more elk experience, exhibited significant parameter estimates for the seeing at least one elk, hearing an elk bugle, and seeing 10 or more elk attributes. Class 1, on the other hand, only had a significant parameter estimate for seeing at least one elk. These results suggested that those with more elk viewing experience are more likely to show future interest in elk. This finding does not suggest that interest in elk viewing is driven by a type of novelty effect. Table 2.9 provides further support for this idea. For all four elk-related attributes shown, those who had not previously experienced the elk-related attribute were more likely to say that the attribute was unimportant in future recreational decisions and less likely to say that the attribute was somewhat or very important in future recreational decisions.

IX. Discussion

Overall, the results of this study suggest that the best way to think about the values of elk-related attributes is to bifurcate visitors into two groups-those who value elk-related attributes and those who do not. One of the assumptions underlying recreation demand modelling is that recreation site choice is, in part, a function of a visitor's distance to that site. All else being equal, we expect those living closer to a given recreational site will take more trips than those living farther away. One way to think about the results of this study, then, is that the class that doesn't

value elk-related attributes (Class 1) is made up of local visitors whose site demand function is driven primarily by distance. There are many substitute sites in the region for fishing, hunting, hiking, etc., so if they found themselves farther away from the Michigan Elk Range it is conceivable that they would select another recreational site. The class that does value the elk-related attributes, on the other hand, exhibit a site demand model that is driven by both the value of elk viewing and distance. In other words, they are willing to bypass substitute sites for the opportunity to experience some form of elk viewing.

The visitors that value elk-related attributes have, on average, more experience viewing elk. This finding suggests that novelty (or variety-seeking) is not a major factor in visitors' decisions to go elk viewing. In this sense, our finding is closer to the findings of Brock et al. (2017) than to that of Kolstoe and Cameron (2017). Brock et al. found that the people who hold the highest value for backyard bird-feeding are those with more experience, and they find no evidence that species rarity is an important attribute for backyard bird-feeding. Kolstoe and Cameron find that birders (who travel away from home) place a premium on sites they have not visited before (indicating novelty) as well as sites that feature an endangered species. Our results are limited in the sense that elk experience was determined using a few general questions in the follow-up survey. Future studies could provide greater clarity in this area by using a dynamic choice model to estimate recreation demand (Smith 2005).

One of the unique contributions of this study was to separate elk viewing into four component attributes and to define the attribute levels as the chance of experiencing these attributes. One advantage of this approach is that it adds precision to the results when compared to qualitative attribute levels often found in the literature. With the quantitative attributes, we were able to present MRS values that express the trade-off between the number of minutes a

visitor would be willing to drive in exchange for a 1% increase in the chance of experiencing an elk-related attribute. While intuitively useful, this approach made it difficult to econometrically identify the separate elk-related attributes. The attributes feature a high level of correlation (principally due to the feasibility constraints we imposed), and this made it especially difficult to estimate respondents' WTP for seeing a bull elk and seeing 10 or more elk. Appendix VI explores this multicollinearity issue in more detail. In it, we show the correlation between each of the elk-related attributes and re-run the models from this paper with a single elk-related attribute made up of the sum of all four elk-related attributes. While this aggregated approach cannot identify the separate effects of the elk attributes, it demonstrates the same general pattern of results: namely, across all visitors, there is a preference for elk but this preference exhibits significant heterogeneity; among user groups, elk viewers care the most about elk, but some activity groups also have preferences for incidental elk viewing; and there is a class of visitors that are indifferent to elk.

REFERENCES

REFERENCES

Boxall, P.C., & Adamowicz, W.L. (2002). Understanding Heterogeneous Preferences in Random Utility Models: A Latent Class Approach. *Environmental and Resource Economics*, *23*(4), 421-446. doi-org.proxy1.cl.msu.edu/10.1023/A:1021351721619

Boxall, P. C., & Macnab, B. (2000). Exploring the preferences of wildlife recreationists for features of boreal forest management: A choice experiment approach. *Canadian Journal of Forest Research, 30*(12), 1931-1941. doi:10.1139/cjfr-30-12-1931

Brock, M., Perino, G., & Sugden, R. (2017). The Warden Attitude: An Investigation of the Value of Interaction with Everyday Wildlife. *Environmental and Resource Economics, 67*(1), 127-155. doi:10.1007/s10640-015-9979-9

Christie, M., Hanley, N., & Hynes, S. (2007). Valuing enhancements to forest recreation using choice experiment and contingent behaviour methods. *Journal of Forest Economics, 13*(2-3), 75-102. doi:10.1016/j.jfe.2007.02.005

Donovan, G., & Champ, P. (2009). The Economic Benefits of Elk Viewing at the Jewell Meadows Wildlife Area in Oregon. *Human Dimensions of Wildlife, 14*(1), 51-60. doi:10.1080/10871200802545773

Edwards, P. E., Parsons, G. R., & Myers, K. H. (2011). The Economic Value of Viewing Migratory Shorebirds on the Delaware Bay: An Application of the Single Site Travel Cost Model Using On-Site Data. *Human Dimensions of Wildlife, 16*(6), 435-444. doi:10.1080/10871209.2011.608180

Freeman, A. M., Herriges, J. A., & Kling, C. L. (2014). *The measurement of environmental and resource values: Theory and methods*. Abingdon, Oxon: RFF Press.

Hole, A. R. (2007). Fitting Mixed Logit Models by Using Maximum Simulated Likelihood. *The Stata Journal: Promoting Communications on Statistics and Stata, 7*(3), 388-401. doi:10.1177/1536867x0700700306

Holmes, T., Adamowicz, W., & Carlsson, F. (2017). Choice Experiments. In P. A. Champ, K. J. Boyle, & T. C. Brown (Authors), *A primer on nonmarket valuation* (pp. 133-186). Dordrecht: Springer.

Horne, P., Boxall, P. C., & Adamowicz, W. L. (2005). Multiple-use management of forest recreation sites: A spatially explicit choice experiment. *Forest Ecology and Management, 207*(1-2), 189-199. doi:10.1016/j.foreco.2004.10.026

Johnston, R. J., Boyle, K. J., Adamowicz, W. (Vic), Bennett, J., Brouwer, R., Cameron, T. A., … Vossler, C. A. (2017). Contemporary Guidance for Stated Preference Studies. *Journal of*

the Association of Environmental and Resource Economists, *4*(2), 319–405. doi.org/10.1086/691697

Kolstoe, S., & Cameron, T. A. (2017). The Non-market Value of Birding Sites and the Marginal Value of Additional Species: Biodiversity in a Random Utility Model of Site Choice by eBird Members. *Ecological Economics, 137*, 1-12. doi:10.1016/j.ecolecon.2017.02.013

Loomis, J. B., & Caughlan, L. (2004). *Economic analysis of alternative bison and elk management practices on the National Elk Refuge and Grand Teton National Park: A comparison of visitor and household responses* (Report No. 2004–1305). doi.org/10.3133/ofr20041305

Loomis, J., Yorizane, S., & Larson, D. (2000). Testing Significance of Multi-Destination and Multi-Purpose Trip Effects in a Travel Cost Method Demand Model for Whale Watching Trips. *Agricultural and Resource Economics Review, 29*(2), 183-191. doi:10.1017/s1068280500005311

McFadden, D. (1974). Conditional Logit Analysis of Qualitative Choice Behavior. In P. Zarembka (Author), *Frontiers in econometrics* (pp. 105-142). New York.

Michigan Department of Natural Resources (MDNR). (2007). A Concept of Management for the Pigeon River Country. Retrieved from https://www.michigan.gov/documents/dnr/PRC_Concept_of_Management_481226_7.pdf, accessed on 6/30/2019.

Michigan Department of Natural Resources (MDNR). (2012). Michigan Elk Management Plan. Retrieved from https://www.michigan.gov/documents/dnr/ElkPlanFinal_382059_7.pdf, accessed on 6/30/2019.

MDNR (Michigan Department of Natural Resources). (2019). Michigan's Elk Viewing Guide, Retrieved from https://www.michigan.gov/documents/dnr/DNR_Elk_Brochure_401828_7.pdf, accessed on 7/8/2019.

Mladenov, N., Gardner, R. J., Flores, E. N., Mbaiwa, E. J., Mmopelwa, G., & Strzepek, M. K. (2007). The value of wildlife-viewing tourism as an incentive for conservation of biodiversity in the Okavango Delta, Botswana. *Development Southern Africa, 24*(3), 409-423. doi:10.1080/03768350701445525

Pacifico, D., & Yoo, H. I. (2013). Lclogit: A Stata Command for Fitting Latent-Class Conditional Logit Models via the Expectation-Maximization Algorithm. *The Stata Journal: Promoting Communications on Statistics and Stata, 13*(3), 625-639. doi:10.1177/1536867x1301300312

Richardson, L., Huber, C., & Loomis, J. (2017). Challenges and Solutions for Applying the Travel Cost Demand Model to Geographically Remote Visitor Destinations: A Case Study

of Bear Viewing at Katmai National Park and Preserve. *Human Dimensions of Wildlife, 22*(6), 550-563. doi:10.1080/10871209.2017.1369196

Richardson, L., Rosen, T., Gunther, K., & Schwartz, C. (2014). The economics of roadside bear viewing. *Journal of Environmental Management, 140*, 102-110. doi:10.1016/j.jenvman.2014.01.051

Segerson, K. (2017). Valuing Environmental Goods and Services: An Economic Perspective. In P. A. Champ, K. J. Boyle, & T. C. Brown (Authors), *A primer on nonmarket valuation* (pp. 1-25). Dordrecht: Springer.

Shafer, E. L., Carline, R., Guldin, R. W., & Cordell, H. K. (1993). Economic amenity values of wildlife: Six case studies in Pennsylvania. *Environmental Management, 17*(5), 669-682. doi:10.1007/bf02393728

Smith, M. D. (2005). State dependence and heterogeneity in fishing location choice. *Journal of Environmental Economics and Management, 50*(2), 319-340. doi:10.1016/j.jeem.2005.04.001

Train, K. (2009). Mixed Logit. In *Discrete choice methods with simulation* (pp. 134-147). Cambridge: Cambridge University Press.

U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

APPENDICES

Appendix I: Survey Disposition Tables

Intercept Survey

Table A1.1: Intercept Survey Method of Contact

Method	Frequency	Percent
In-person Interview *(if group completed in-person interview)*	367	17.9%
Paper Survey *(if a paper survey was left at a vacant vehicle or campsite)*	1,365	66.7%
Already Surveyed *(groups were not given surveys if they already completed an interview or paper survey in the previous month)*	305	14.9%
Refuse *(if group refused to complete an interview or accept a paper survey)*	11	0.5%
Total	2048	

This table indicates how groups were contacted during the intercept survey

In total, we counted 2,463 vehicles in the Pigeon River Country State Forest in the summer (June 7-September 1) and fall (September 9- November 24). 2,048 vehicle groups were invited to participate in this survey. The number of vehicle groups (2,048) is less than the total vehicle count (2,463) because we only surveyed one person from groups that contained more than one vehicle. We treated unoccupied campsites (i.e. tent with no people or vehicles) the same as an unoccupied vehicle and left a paper survey.

Each of the vehicle groups fits into one survey method category, and the breakdown of these categories is shown in Table A1.1. 367 vehicle groups (about 18% of total) were interviewed. 1,365 (about two thirds) vehicle groups were provided with a mail-back paper survey. 305 (about 15%) vehicle groups were already surveyed. This is a flexible category, but it

generally means that the visitor either told us that they had already completed the survey or that we recognized the visitor/vehicle/campsite and did not leave an additional paper survey. Only 11 vehicle groups directly refused to participate in the study. These refusals were all in-person, as no visitors sent in a refusal via mail.

Table A1.2: Response Rate for Paper Surveys (*by season*)

	Overall	Summer	Fall
Did not Return	972 (*71.2%*)	454 *(71.7%)*	518 *(70.8%)*
Returned	393 (*28.8%*)	179 *(28.3%)*	214 *(29.2%)*
Total	1,365	633	732

Table A1.3: Response Rate for Paper Surveys (*by select sites*)

	Overall	Elk Sites	Campgrounds	Pigeon Bridge	Cornwall Flooding
Did not Return	972 (*71.2%*)	94 *(62.25%)*	162 *(71.05%)*	88 *(64.23%)*	110 *(75.86%)*
Returned	393 (*28.8%*)	57 *(37.75%)*	66 *(28.95%)*	49 *(35.77%)*	35 *(24.14%)*
Total	1,365	151	228	137	145

Table A1.2 reports paper survey response rate. Out of the 1,365 paper surveys we distributed, 393 or 28.8% of them were returned. The response rate did not vary much from summer to fall, as is shown in Tables A1.2.In addition, the response rate for the 151 paper

surveys left at elk sites was 37.75%, and the response rate for the 228 paper surveys left at state forest campgrounds was 29%. In the end, the intercept survey resulted in 756 usable intercept surveys.

Follow-Up Survey

The final question on the intercept survey asked respondents to provide an email address for a follow-up online survey. Of the 756 usable intercept surveys, we collected 580 email addresses (77%) and 102 mail addresses (13.5%). Table A1.4 shows the disposition of the 580 email invitations, and Table A1.5 provides a schedule of when survey invites were sent to our sample.

Table A1.4: Follow up Survey Email Distribution

Survey Invitations Sent Out	**580**	
Undeliverable Emails	24	4.14%
Surveys Started but not Completed	39	6.72%
Refused	1	0.17%
Completed Surveys	**316**	**54.48%**

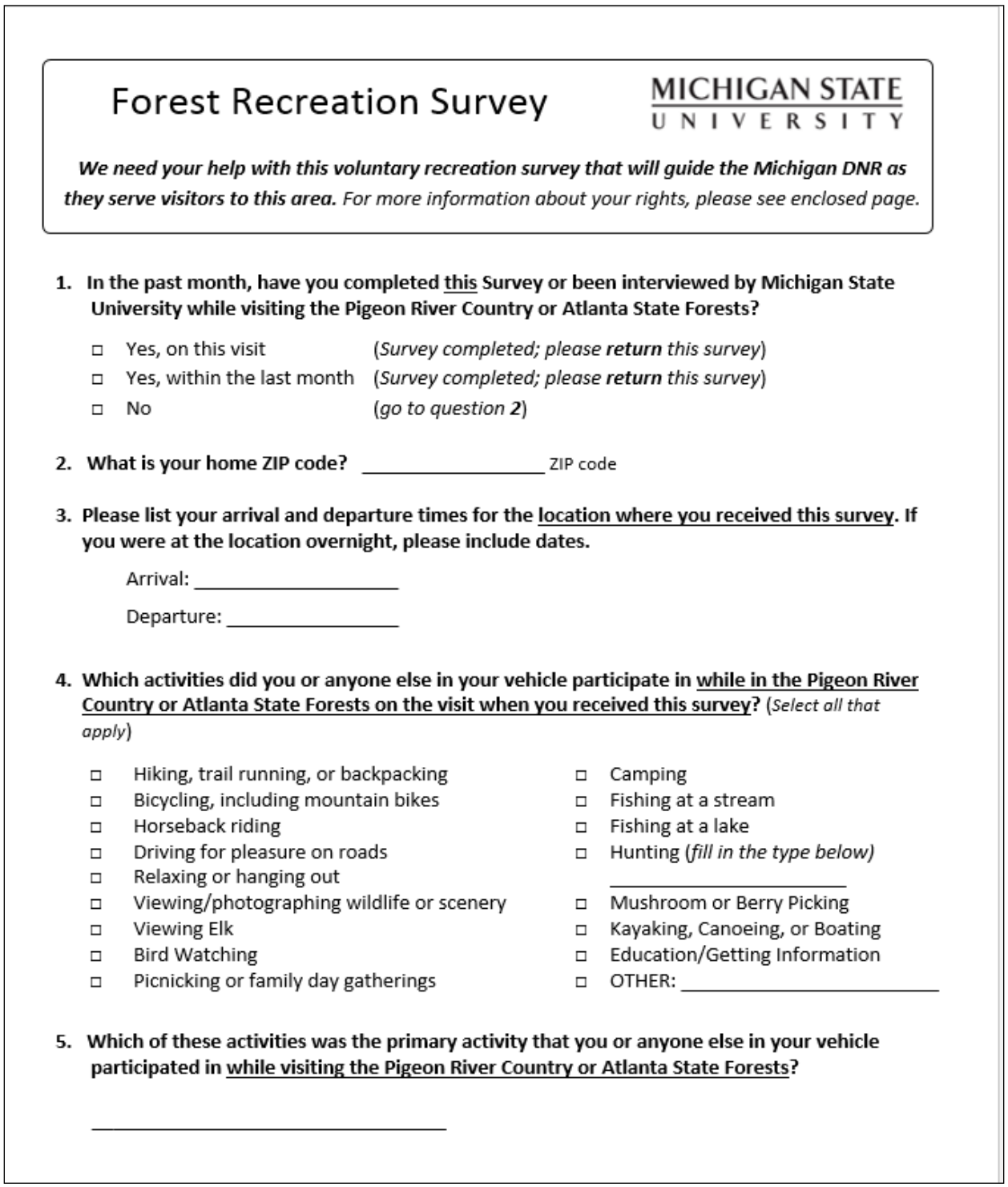
Table A1.5: Distribution of Follow-Up Survey Invitations

1st Invitation	March 29, 2019
2nd Invitation	April 2, 2019
3rd Invitation	April 5, 2019
4th Invitation	April 10, 2019
5th Invitation	April 13, 2019
6th Invitation	April 20, 2019

Appendix II: Intercept Survey

The survey below was left on the windshields of parked cars in the Michigan Elk Range when no visitors were around. The survey was placed an envelope, along with a map of the PRC, a map of entrance points, and a postage paid return envelope. If weather conditions warranted, the materials were placed in a clear plastic sleeve. Images of the envelope and maps follow the survey images.

Figure A2.1: Intercept Survey (Paper Version)



Forest Recreation Survey

MICHIGAN STATE UNIVERSITY

We need your help with this voluntary recreation survey that will guide the Michigan DNR as they serve visitors to this area. *For more information about your rights, please see enclosed page.*

1. **In the past month, have you completed this Survey or been interviewed by Michigan State University while visiting the Pigeon River Country or Atlanta State Forests?**

   - ☐ Yes, on this visit (*Survey completed; please **return** this survey*)
   - ☐ Yes, within the last month (*Survey completed; please **return** this survey*)
   - ☐ No (*go to question **2***)

2. **What is your home ZIP code?** _____ ZIP code

3. **Please list your arrival and departure times for the location where you received this survey. If you were at the location overnight, please include dates.**

   Arrival: _____

   Departure: _____

4. **Which activities did you or anyone else in your vehicle participate in while in the Pigeon River Country or Atlanta State Forests on the visit when you received this survey?** (*Select all that apply*)

   - ☐ Hiking, trail running, or backpacking
   - ☐ Bicycling, including mountain bikes
   - ☐ Horseback riding
   - ☐ Driving for pleasure on roads
   - ☐ Relaxing or hanging out
   - ☐ Viewing/photographing wildlife or scenery
   - ☐ Viewing Elk
   - ☐ Bird Watching
   - ☐ Picnicking or family day gatherings
   - ☐ Camping
   - ☐ Fishing at a stream
   - ☐ Fishing at a lake
   - ☐ Hunting (*fill in the type below)*
     _____
   - ☐ Mushroom or Berry Picking
   - ☐ Kayaking, Canoeing, or Boating
   - ☐ Education/Getting Information
   - ☐ OTHER: _____

5. **Which of these activities was the primary activity that you or anyone else in your vehicle participated in while visiting the Pigeon River Country or Atlanta State Forests?**

   _____

Figure A2.1: (cont'd)

6. **On the visit in which you received this survey, did you or anyone else in your vehicle visit any other locations in the forest?**
   - ☐ Yes (go to question **7**)
   - ☐ No (go to question **8**)

7. **<u>If you answered yes to question 6</u>, please indicate whether you visited any of the following locations. A map is enclosed to help you.** (*Select all that apply*)

   - ☐ Elk Site 1 (Fontinalis Road)
   - ☐ Elk Site 2 (E Sturgeon Valley Road)
   - ☐ Elk Site 4 (CCC Fields)
   - ☐ Elk Sites 6&7 (E Sturgeon Valley/Tin Shanty Rd)
   - ☐ Elk Site 10 (CR 622)
   - ☐ Inspiration Point
   - ☐ Pigeon Bridge Trailhead/Parking
   - ☐ Cornwall Flooding Day Use Area
   - ☐ Green Timbers Trailhead/Parking
   - ☐ Pigeon River Country Headquarters
   - ☐ Pigeon River CG/ "Tubes"
   - ☐ Elk Hill CG
   - ☐ Pickerel Lake CG
   - ☐ Round Lake CG
   - ☐ Pine Grove CG
   - ☐ Town Corner Lake CG
   - ☐ Sinkhole Lakes
   - ☐ OTHER: _____

   - ☐ I did not visit any of these locations

8. **Did you stay away from home overnight on the visit in which you received this survey?**
   - ☐ Yes (*go to question* **10**)
   - ☐ No (*go to question* **9**)

9. **If you <u>were not</u> away from home overnight, how much time did you spend <u>overall</u> in the Pigeon River Country or Atlanta State Forests (see green areas on the enclosed map)?**

   _____ Hours, _____ Minutes (*go to question **16***)

10. **If you <u>were</u> away from home overnight, how many nights did spend away from your home during this trip?** _____ Nights

11. **What type of lodging did you use during the visit in which you received this survey?**
    - ☐ A campground in Pigeon River Country or Atlanta State Forest

      if so, which one? _____ (*go to question **15**)*
    - ☐ A dispersed campsite on state forest land (*go to question **15**)*
    - ☐ A campground outside the state forests (*go to question **12**)*
    - ☐ A hotel, motel or rental (*go to question **12**)*
    - ☐ A friend/relative's house (*go to question **12**)*
    - ☐ A second home/cottage (*go to question **12**)*

Figure A2.1: (cont'd)

12. **If you were on an overnight trip and stayed outside of the state forests, how many days did you visit the Pigeon River Country or Atlanta State Forests?**

_____ Day(s)

13. **Over the day(s) that you indicated in question 12, how many total hours did you spend in the Pigeon River Country or Atlanta State Forests?**

_____Total hours

14. **If you were on an overnight trip and stayed outside of the state forests, what city is this campground/hotel/cabin/friend's home located in?**

_____ city name _____ name of campground/hotel (*if applicable*)

15. **If you were on an overnight trip, was recreation in the Pigeon River Country or Atlanta State Forests a main reason for your overall trip?**

- ☐ Yes, recreating in these State Forests was a main reason for taking the trip
- ☐ No, recreating in these State Forests was not a main reason for taking the trip

16. **Did you leave and re-enter Pigeon River Country State Forest before leaving the final time?**
Please refer the map for the entry and exit roads for Pigeon River Country State Forest.

Atlanta State Forest users should skip this question if they did not enter the Pigeon River Country State Forest on the visit in which they received this survey.

Example: A visitor camped 4 nights in Pigeon River Country State Forest, and went to town twice for gas and ice. This visitor would check "Yes" and enter "2" times.

- ☐ No
- ☐ Yes → If yes, how many times? _____

17. **The areas in and around the Pigeon River Country State Forest are home to Michigan's only wild elk herd. What role did the chance of seeing elk play in your decision to visit?** (*Select one*)

- ☐ The chance of seeing elk was my primary reason for visiting
- ☐ The chance of seeing elk played a role in my decision to visit, but was not my primary reason
- ☐ The chance of seeing elk played no role in my decision to visit

18. **Did you see any elk on the visit in which you received this survey?**

- ☐ No
- ☐ Yes If yes, where? _____

Figure A2.1: (cont'd)

19. Including this visit, about how many times have you visited the Pigeon River Country or Atlanta State Forests for recreation in the past 12 months? _____ times

20. How many people, including you, travelled to the Pigeon River Country or Atlanta State Forests in the same vehicle as you? _____ people

21. How many of those people are less than 18 years old? _____ children

22. What is your age? _____ years

23. What is your gender?

- ☐ Female
- ☐ Male

24. What is the highest level of education you have completed?

- ☐ Did not complete High School
- ☐ High School/GED
- ☐ Some College
- ☐ Bachelor's Degree
- ☐ Postgraduate Degree

25. Please provide an e-mail address where we can send a short follow-up survey. The invitation would come in about a month from Michigan State University. The survey is confidential and your e-mail would not be used in any other way.

E-mail: _____

If you cannot share an e-mail for the follow-up survey, please share your mailing address.

Full name: _____

Address: _____

City, State, Zip: _____

Thank you for your help!

Please return in the postage paid envelop or mail to:

Prof. Frank Lupi
301b Agriculture Hall, Box 1700
Michigan State University
East Lansing, MI 48824

Figure A2.2: Map of Recreation Sites and Map of Entrance/Exit Roads

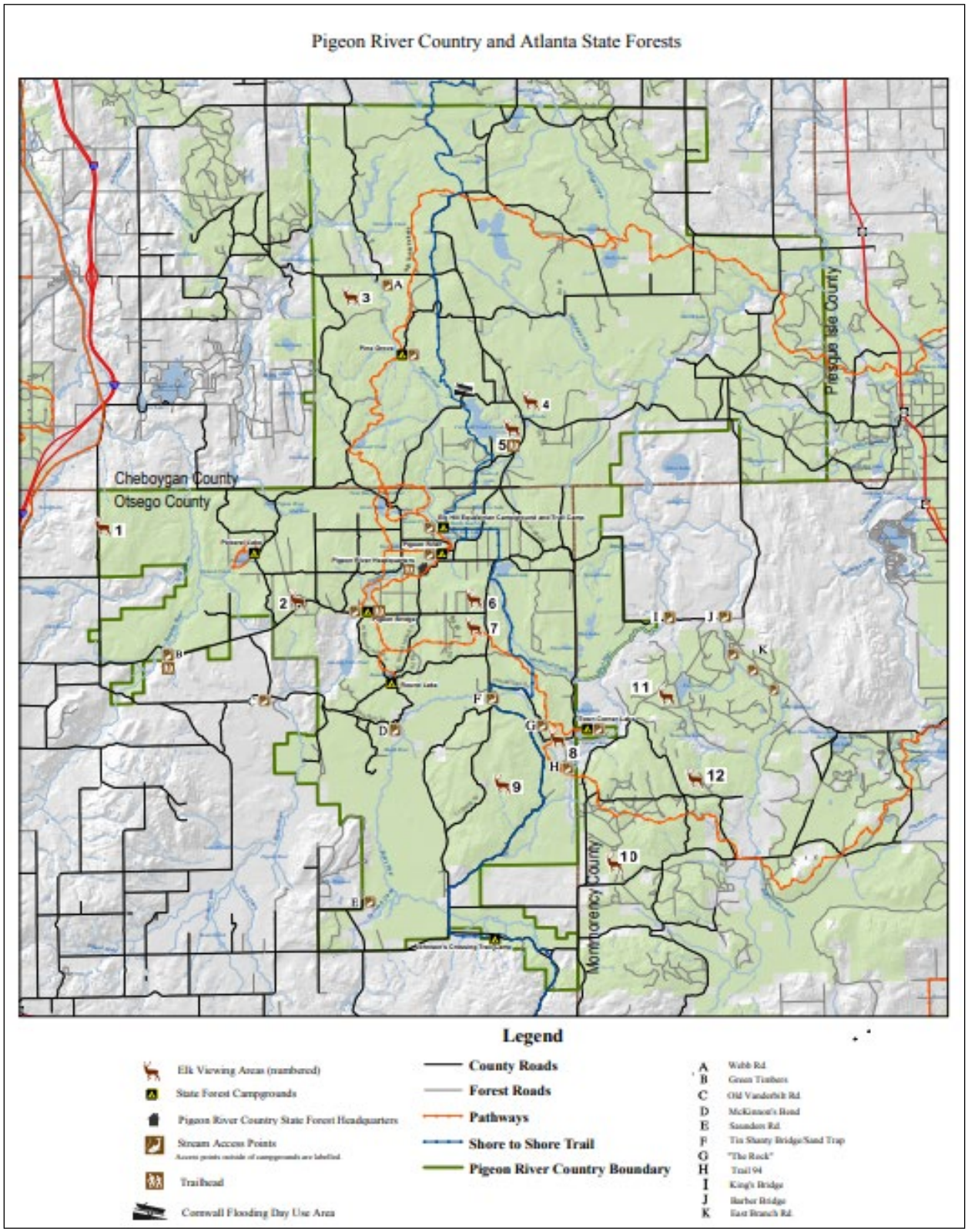


Figure A2.2: (cont'd)

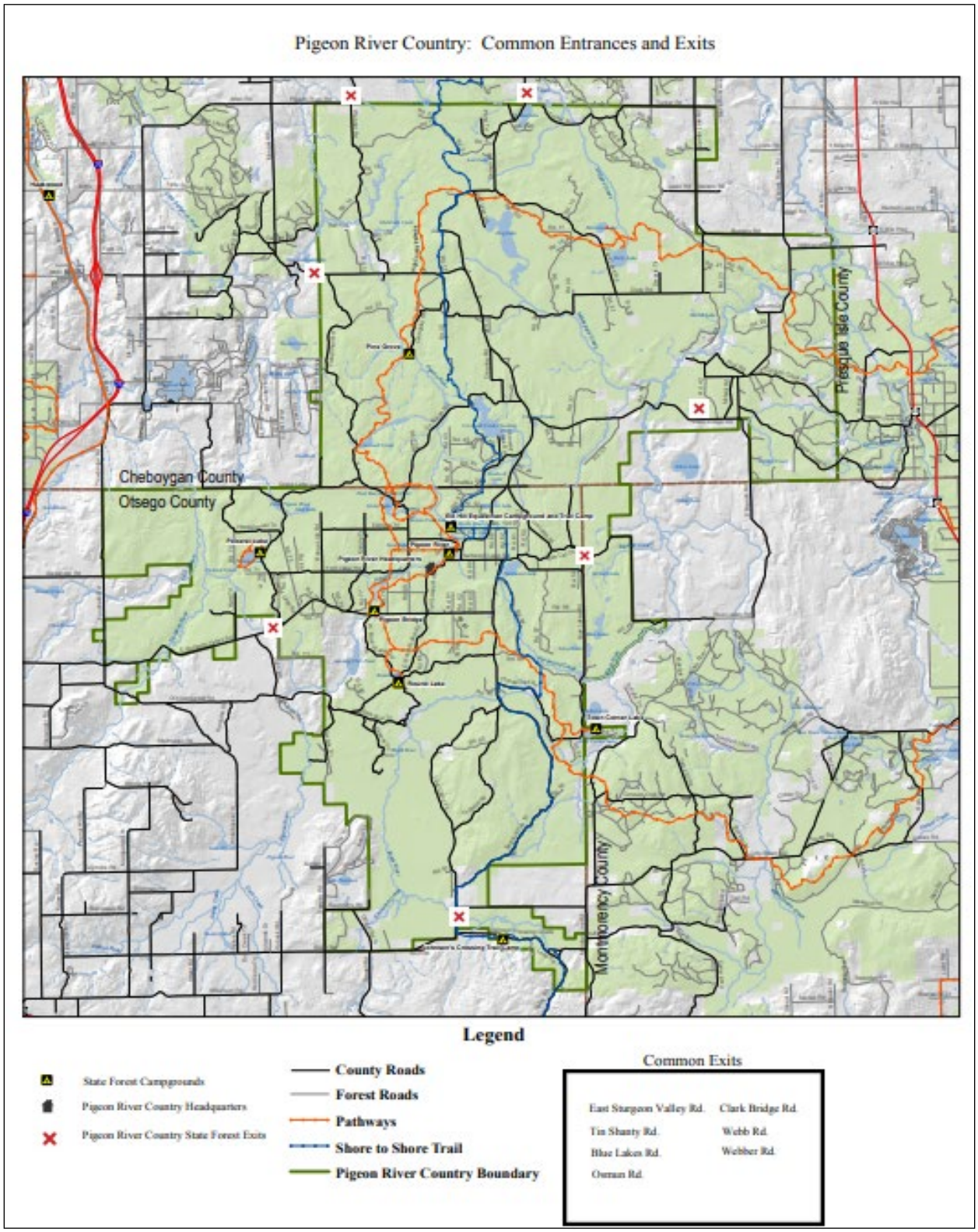
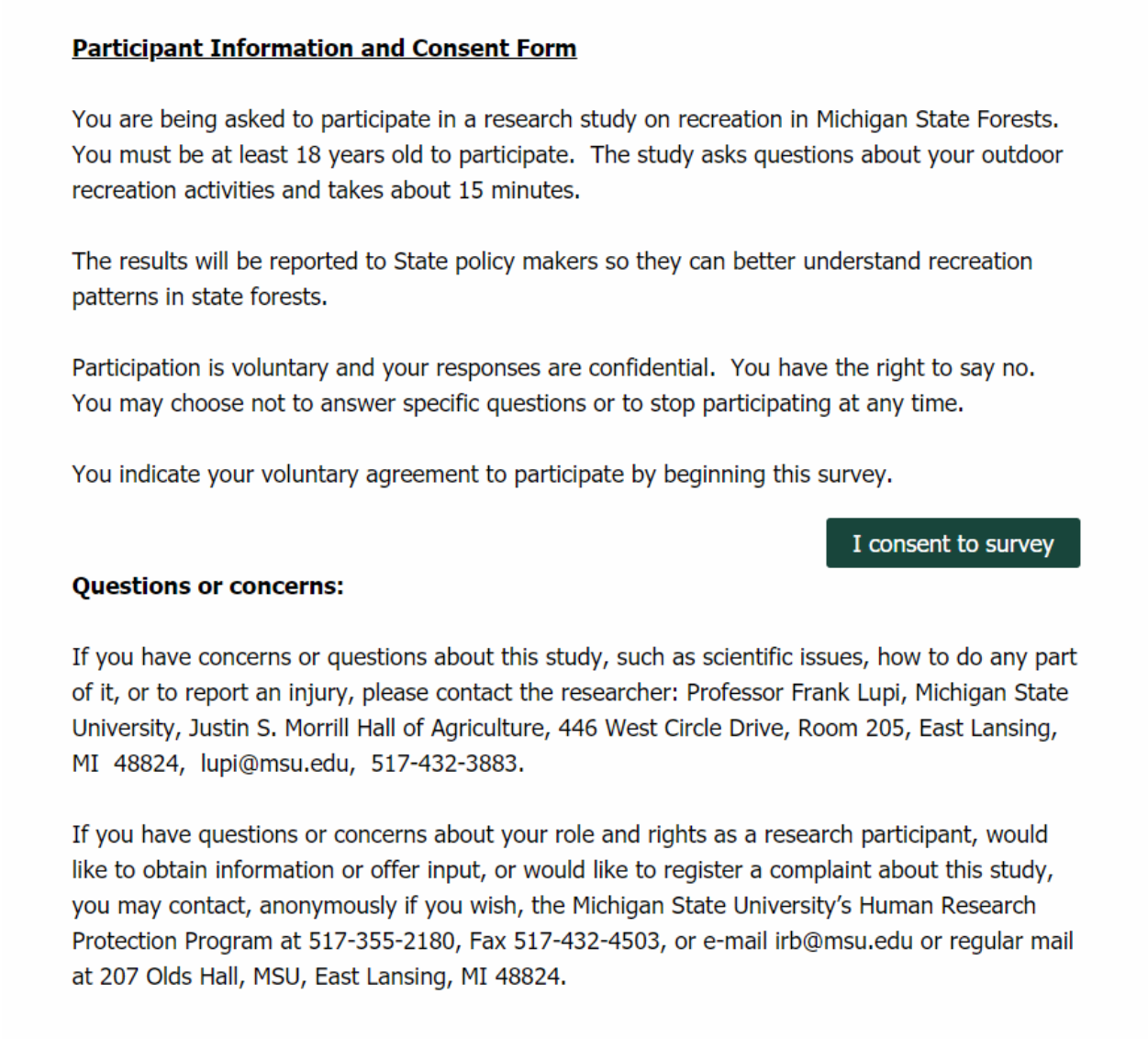


Figure A2.3: Intercept Survey Outer Envelope

Appendix III: Follow-Up Online Survey

Figure A3.1: Screen Shot of Online Follow-Up Survey



Participant Information and Consent Form

You are being asked to participate in a research study on recreation in Michigan State Forests. You must be at least 18 years old to participate. The study asks questions about your outdoor recreation activities and takes about 15 minutes.

The results will be reported to State policy makers so they can better understand recreation patterns in state forests.

Participation is voluntary and your responses are confidential. You have the right to say no. You may choose not to answer specific questions or to stop participating at any time.

You indicate your voluntary agreement to participate by beginning this survey.

I consent to survey

Questions or concerns:

If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact the researcher: Professor Frank Lupi, Michigan State University, Justin S. Morrill Hall of Agriculture, 446 West Circle Drive, Room 205, East Lansing, MI 48824, lupi@msu.edu, 517-432-3883.

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 207 Olds Hall, MSU, East Lansing, MI 48824.

Figure A3.1: (cont'd)

Hello,

Thank you for contributing to this recreation study by Michigan State University. The information you gave us in the last survey was very helpful. We now have a few more questions about your 11/3/2018 trip and your recreation in Michigan.

We left you a mail survey in the **Pigeon River Country State Forest** on 11/3/2018. Here are a few more details to remind you about this trip.

Date	11/3/2018
Name of site or nearby road	Pigeon River Campground
Recreational Activites	Hiking, trail running, or backpacking, Driving for pleasure, Relaxing or hanging out, Camping

Several survey questions will ask about your "11/3/2018 trip". If your visit to the Pigeon River Country or Atlanta State Forest was more than one day, this term, "11/3/2018 trip", refers to your entire visit in these state forests.

Was your 11/3/2018 trip the first time you ever visited the Pigeon River Country State Forest?

- ○ Yes
- ○ No

Did you visit the Pigeon River Country State Forest Headquarters or Discovery Center on your 11/3/2018 trip?

- ○ Yes
- ○ No

Figure A3.1: (cont'd)

For your 11/3/2018 trip, between the time you left your primary home until the time you returned to your primary home, was the Pigeon River Country or Atlanta State Forest the main destination of this overall trip away from home?

- ○ Yes
- ○ No, my main destination was somewhere else
- ○ No, I did not have a main destination for this trip

What is the name of the city or town nearest to your main destination on the 11/3/2018 trip?

In the last survey, you told us that you stayed overnight at a state forest campground.

How many people occupied your campsite on the 11/3/2018 trip?

people

Figure A3.1: (cont'd)

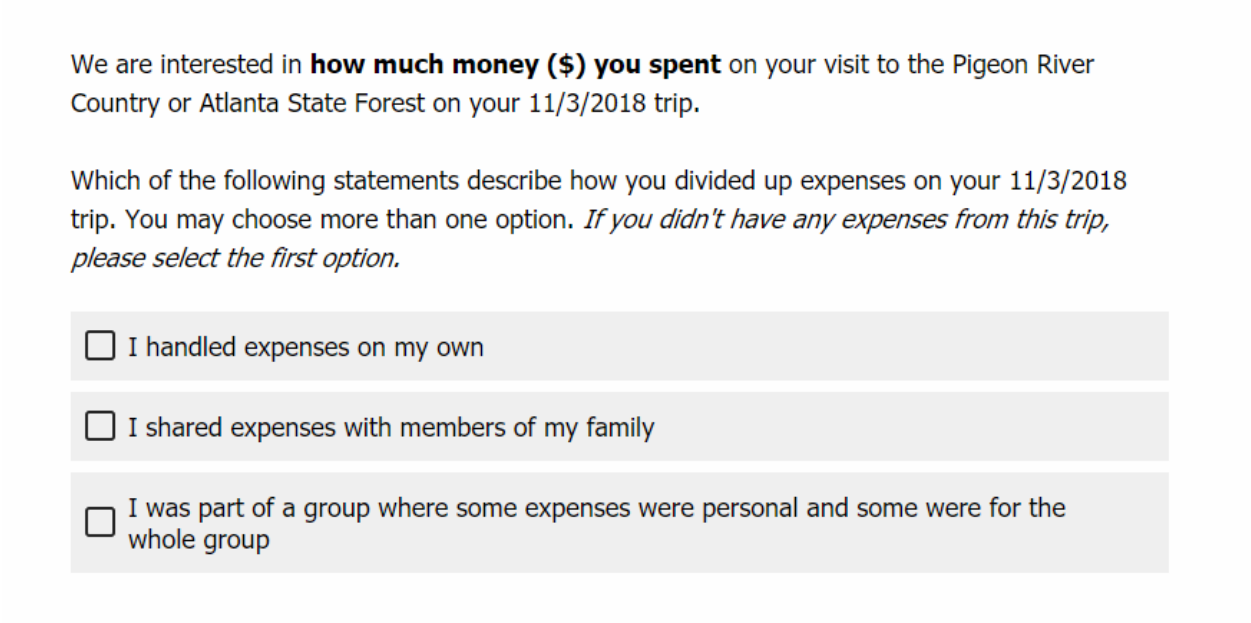


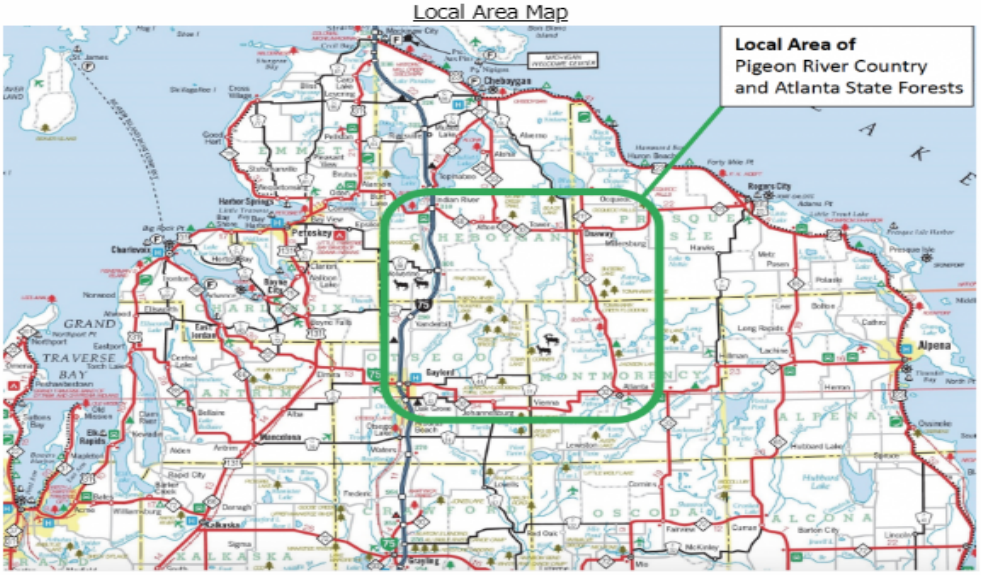
Figure A3.1: (cont'd)

Please enter the number of family members (**including yourself)** that you shared expenses with on your 11/3/2018 trip into the box below.

Then, fill out the table with expenses for this family group. If you can't remember exactly how much you spent, enter your best guess.

Family Group Size (**including yourself**) ☐

Local Area Map



	Local Spending Amount of money group spent inside the green box on the map above	**Outside Spending** Amount of money group spent outside the green box on the map above
Restaurants	☐	☐
Groceries (including drinks and snacks)	☐	☐
Fuel (cars, trucks, boats, ORVs, etc.)	☐	☐
Rental Car Expenses	☐	☐
Lodging (campground fees, hotel and motel costs, etc.) *If you used reward points, enter expected monetary value*	☐	☐
Gear and Supplies (***only*** *include items purchased for one time use on your 11/3/2018 trip*)	☐	☐
Retail/Souvenir Shopping (only for local area)	☐	☐
Other: ☐	☐	☐

Figure A3.1: (cont'd)

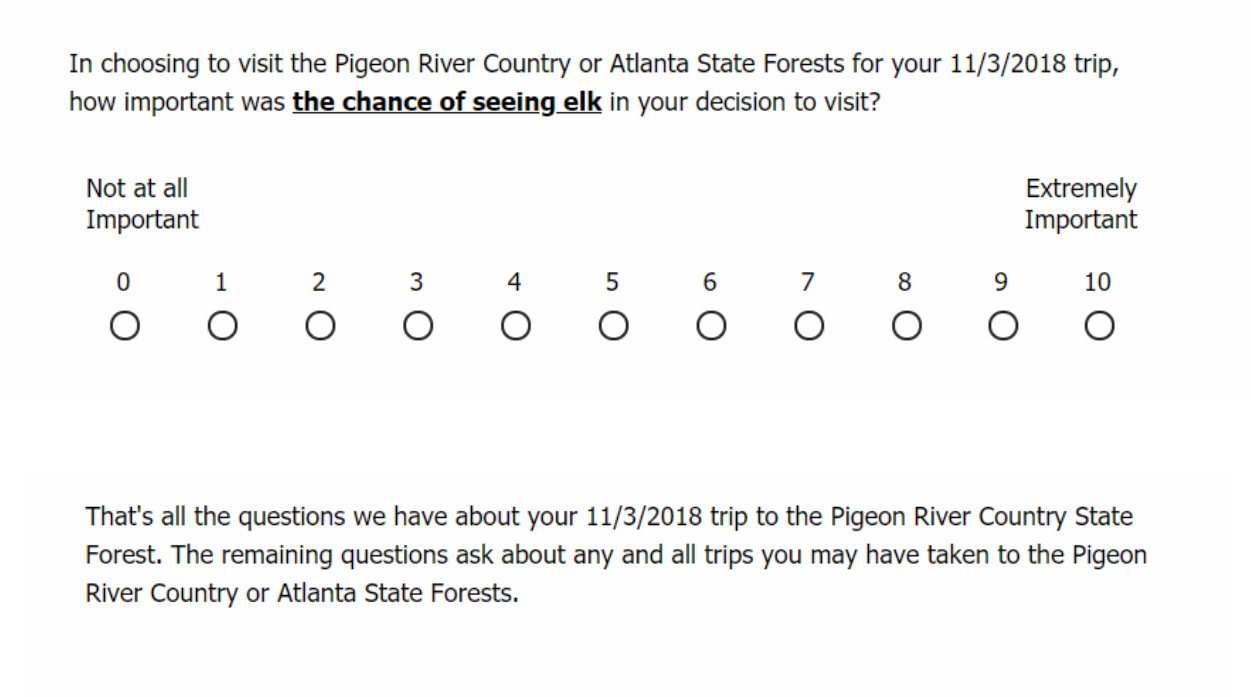
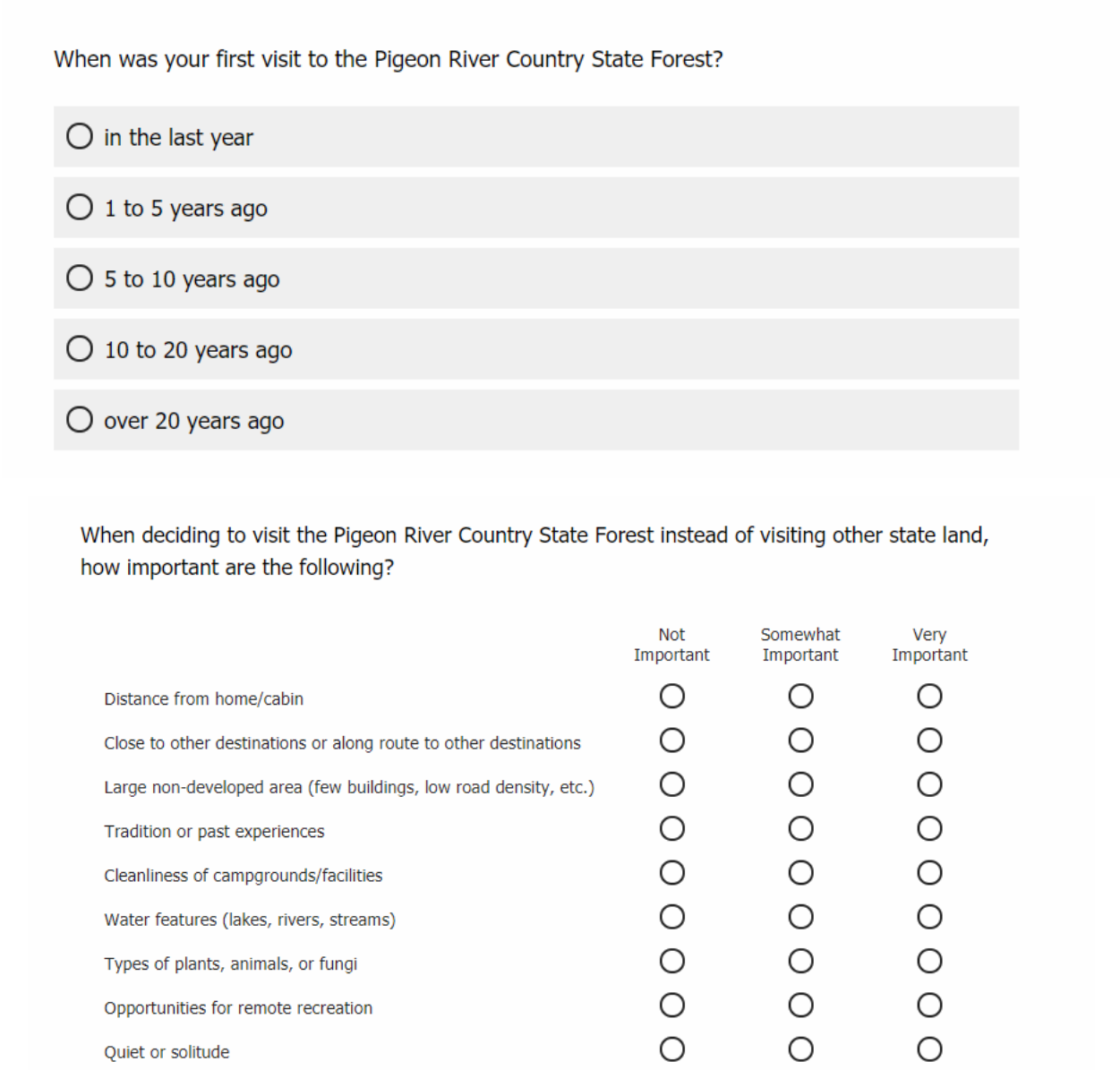


Figure A3.1: (cont'd)

Have you done any of the following recreational activities in the Pigeon River Country or Atlanta State Forests **in the past year**? *(Select all that apply)*

☐ Hiking, backpacking, or trail running	☐ Kayaking or Canoeing
☐ Bicycling	☐ Morel hunting
☐ Horseback Riding	☐ Mushroom *(besides morel)* or berry picking
☐ Driving for pleasure	☐ Viewing wildlife/scenery
☐ Hunting	☐ Viewing elk
☐ Fishing at a stream	☐ Bird Watching
☐ Fishing at a lake	☐ Picnicking
☐ Swimming	☐ Camping
☐ Boating	☐ ORV/ATV driving *(only in Atlanta SF)*
☐ Tubing	☐ Snow shoeing or Cross Country Skiing

Figure A3.1: (cont'd)



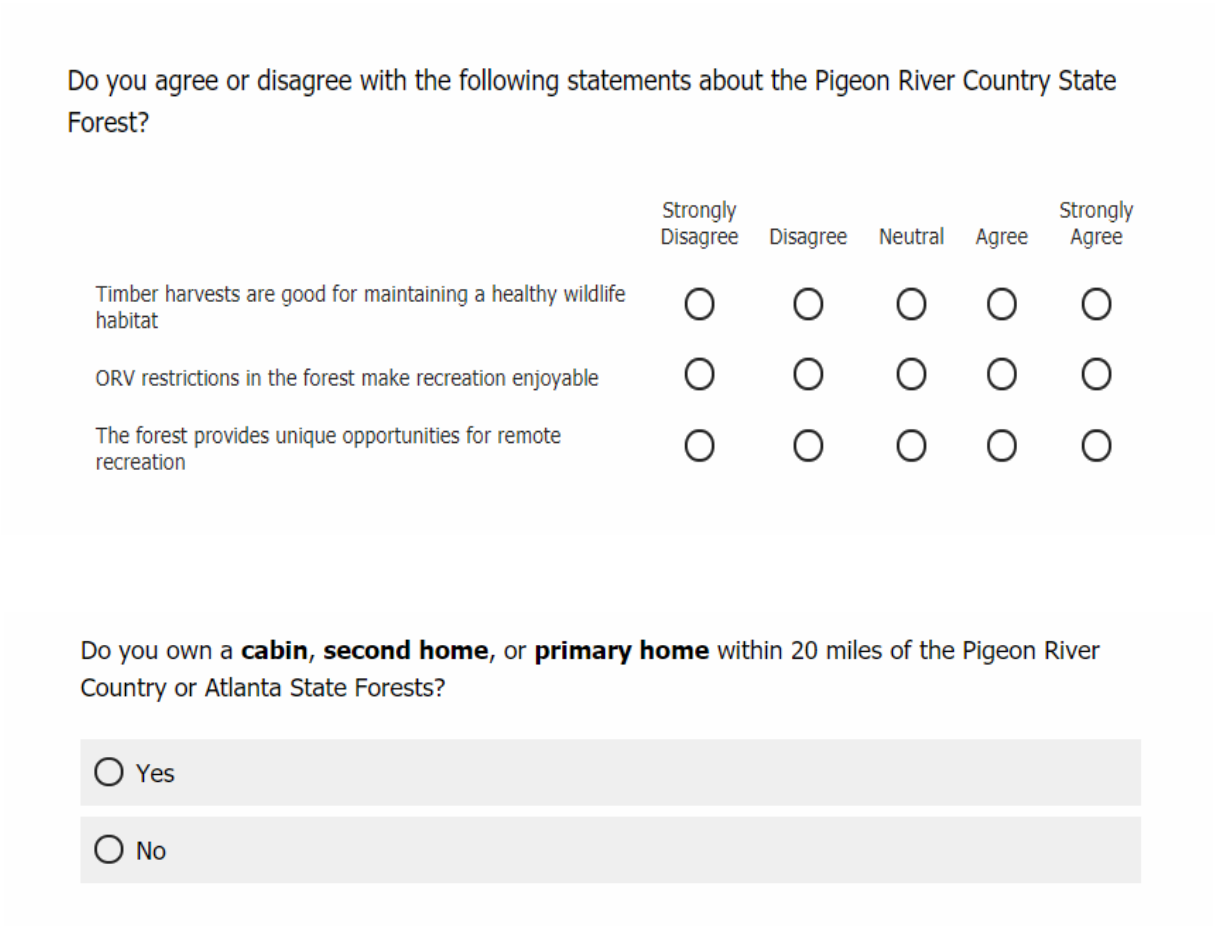
When was your first visit to the Pigeon River Country State Forest?

- ○ in the last year
- ○ 1 to 5 years ago
- ○ 5 to 10 years ago
- ○ 10 to 20 years ago
- ○ over 20 years ago

When deciding to visit the Pigeon River Country State Forest instead of visiting other state land, how important are the following?

	Not Important	Somewhat Important	Very Important
Distance from home/cabin	○	○	○
Close to other destinations or along route to other destinations	○	○	○
Large non-developed area (few buildings, low road density, etc.)	○	○	○
Tradition or past experiences	○	○	○
Cleanliness of campgrounds/facilities	○	○	○
Water features (lakes, rivers, streams)	○	○	○
Types of plants, animals, or fungi	○	○	○
Opportunities for remote recreation	○	○	○
Quiet or solitude	○	○	○

Figure A3.1: (cont'd)



Do you agree or disagree with the following statements about the Pigeon River Country State Forest?

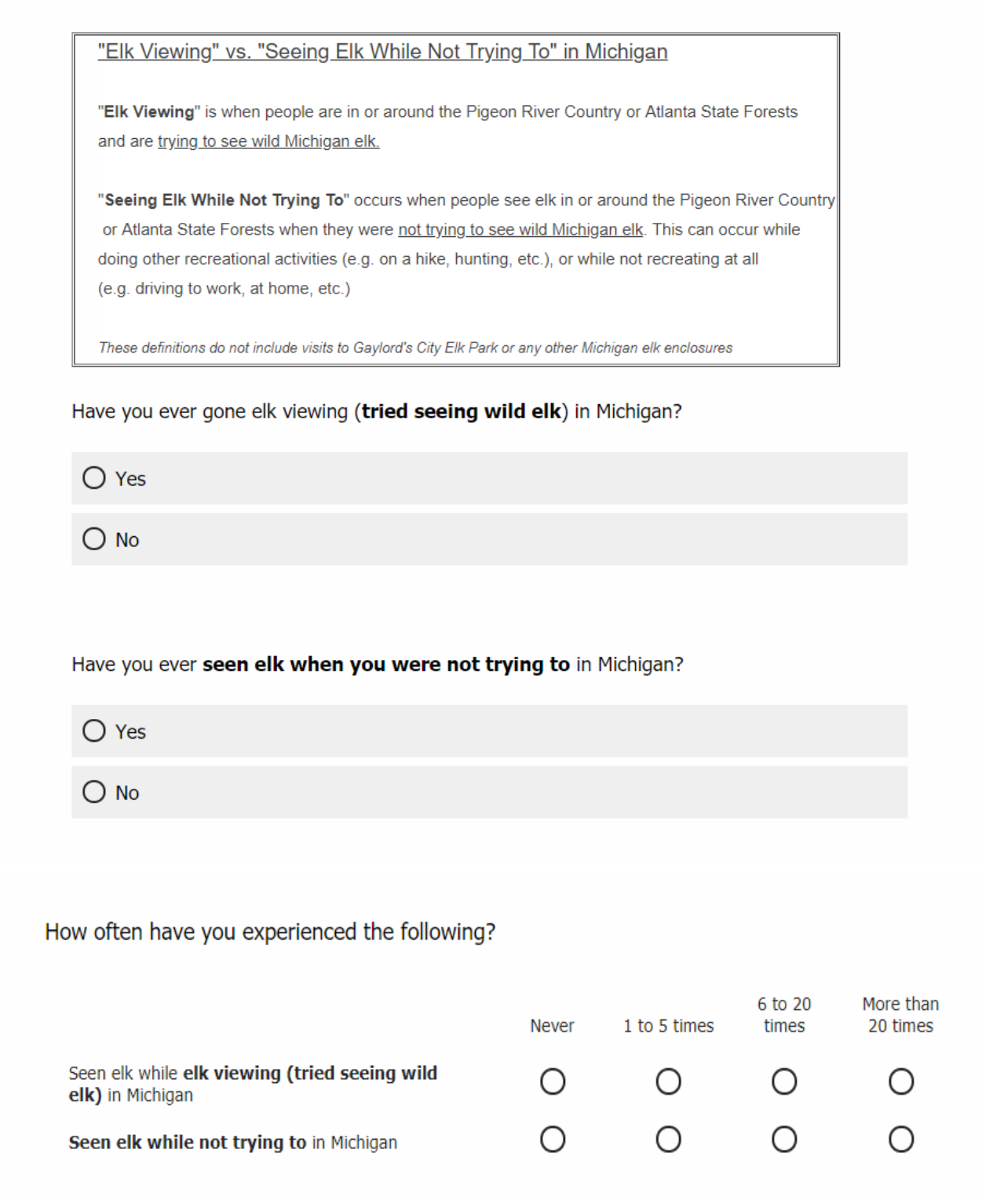
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Timber harvests are good for maintaining a healthy wildlife habitat	○	○	○	○	○
ORV restrictions in the forest make recreation enjoyable	○	○	○	○	○
The forest provides unique opportunities for remote recreation	○	○	○	○	○

Do you own a **cabin**, **second home**, or **primary home** within 20 miles of the Pigeon River Country or Atlanta State Forests?

○ Yes

○ No

Figure A3.1: (cont'd)



"Elk Viewing" vs. "Seeing Elk While Not Trying To" in Michigan

"**Elk Viewing**" is when people are in or around the Pigeon River Country or Atlanta State Forests and are trying to see wild Michigan elk.

"**Seeing Elk While Not Trying To**" occurs when people see elk in or around the Pigeon River Country or Atlanta State Forests when they were not trying to see wild Michigan elk. This can occur while doing other recreational activities (e.g. on a hike, hunting, etc.), or while not recreating at all (e.g. driving to work, at home, etc.)

These definitions do not include visits to Gaylord's City Elk Park or any other Michigan elk enclosures

Have you ever gone elk viewing (**tried seeing wild elk**) in Michigan?

- ○ Yes
- ○ No

Have you ever **seen elk when you were not trying to** in Michigan?

- ○ Yes
- ○ No

How often have you experienced the following?

	Never	1 to 5 times	6 to 20 times	More than 20 times
Seen elk while **elk viewing (tried seeing wild elk)** in Michigan	○	○	○	○
Seen elk while not trying to in Michigan	○	○	○	○

Figure A3.1: (cont'd)

About how many years ago did you first go **elk viewing (tried seeing wild elk)** in Michigan?

- ○ In the past year
- ○ 1 to 5 years ago
- ○ 6 to 10 years ago
- ○ 11 to 20 years ago
- ○ Over 20 years ago

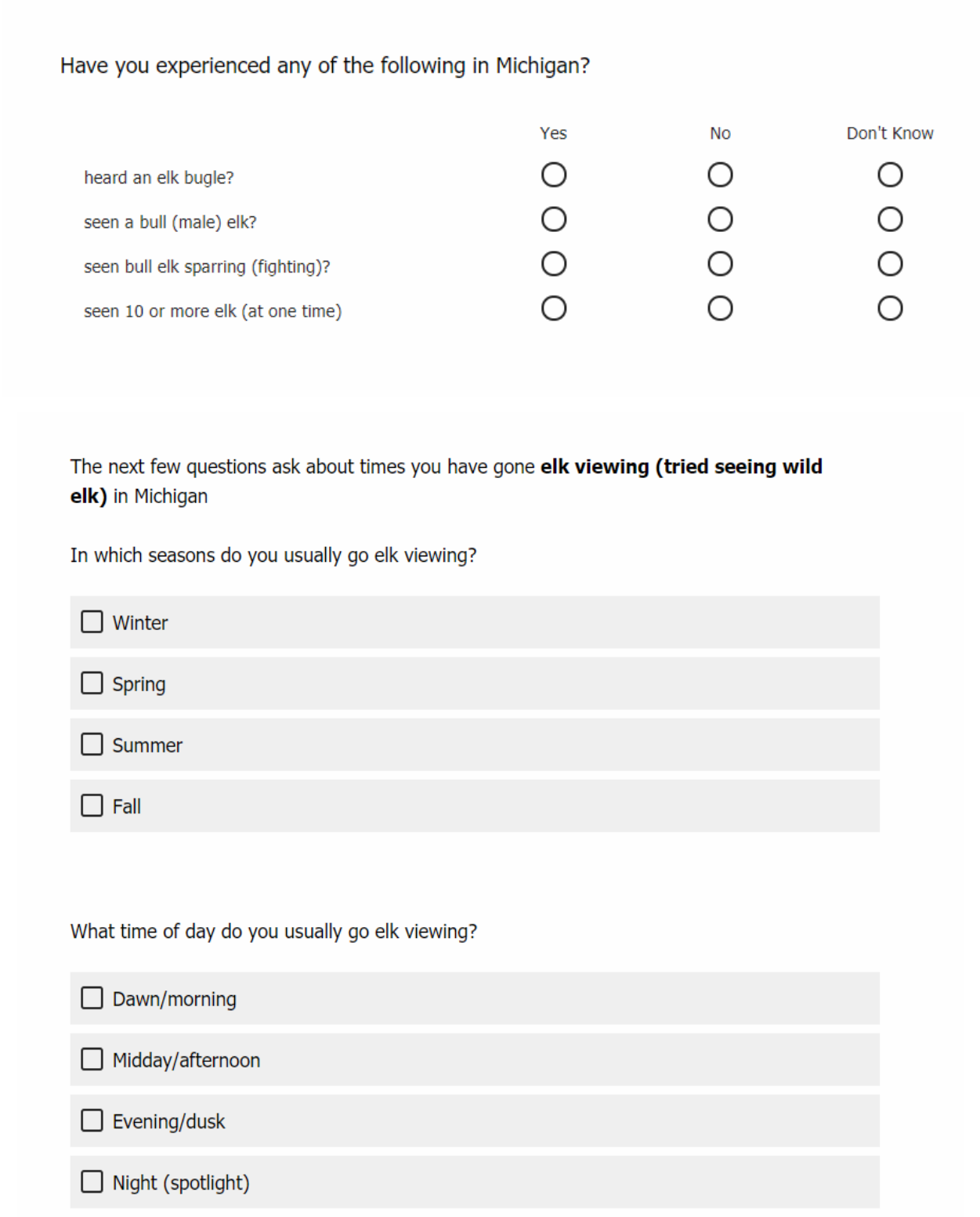
Have you ever seen wild elk **outside** of Michigan?

- ○ Yes
- ○ No

Have you ever seen elk in Gaylord's City Elk Park?

- ○ Yes
- ○ No

Figure A3.1: (cont'd)



Have you experienced any of the following in Michigan?

	Yes	No	Don't Know
heard an elk bugle?	○	○	○
seen a bull (male) elk?	○	○	○
seen bull elk sparring (fighting)?	○	○	○
seen 10 or more elk (at one time)	○	○	○

The next few questions ask about times you have gone **elk viewing (tried seeing wild elk)** in Michigan

In which seasons do you usually go elk viewing?

- ☐ Winter
- ☐ Spring
- ☐ Summer
- ☐ Fall

What time of day do you usually go elk viewing?

- ☐ Dawn/morning
- ☐ Midday/afternoon
- ☐ Evening/dusk
- ☐ Night (spotlight)

Figure A3.1: (cont'd)

Indicate how much the following statements describe your elk viewing behavior. The map above shows DNR designated elk viewing sites.

When I go elk viewing...

	Never	Sometimes	Always
I visit sites listed on the DNR elk viewing map (**see above**)	○	○	○
I visit fields/elk sites that are not on the DNR elk viewing map	○	○	○
I go to one elk viewing site and stay there for the entire time	○	○	○
I go to more than one elk viewing site to look for elk	○	○	○
I drive around the forest without parking at any sites	○	○	○

Figure A3.1: (cont'd)

How have you learned about places to go **elk viewing** in the Pigeon River Country or Atlanta State Forests? (*select all that apply*)

- ☐ I was told about an elk viewing site by someone in the Pigeon River Country State Forest Headquarters
- ☐ I learned about an elk viewing site from Michigan DNR materials (maps, brochures, web site)
- ☐ I learned about an elk viewing site from materials (maps, books, brochures, web site) created by someone other than the Michigan DNR
- ☐ I was first told or shown an elk viewing site by a friend, relative, or neighbor
- ☐ I found elk viewing sites on my own

When deciding where to go in the Pigeon River Country or Atlanta State Forests for any of your recreation activities (such as Camping), how important are the following elk related characteristics?

	Not Important	Moderately Important	Very Important
Seeing at least one elk	○	○	○
Seeing 10 or more elk (at one time)	○	○	○
Seeing a bull (male) elk	○	○	○
Hearing an elk bugle	○	○	○

This part of the survey asks you to think about possible recreation trips you might take in the future.

Figure A3.1: (cont'd)

Suppose you are planning a trip to public land within Michigan. Your main activity will be **Camping**. The table below shows two possible areas you could go for Camping.

Both areas:

- are good places for Camping and have identical features except for elk

The areas differ in:

- their distance from your home
- the chances you'll experience various elk viewing characteristics

Area A is a **200 minute** drive from your home, and Area B requires an **additional 120 minutes** of driving beyond Area A. You may experience the elk viewing characteristics while Camping in the area, or while entering or leaving the area.

Please review the characteristics of the two areas and answer the questions below.

Two Areas For Camping

	Area A	Area B
Recreation Features	campgrounds, hiking/biking trails, equestrian trails, and places for hunting, fishing, and morel hunting	campgrounds, hiking/biking trails, equestrian trails, and places for hunting, fishing, and morel hunting
Elk Range	**Inside Elk Range** **25%** chance of seeing at least one elk **20%** chance of hearing an elk bugle **10%** chance of seeing a bull (male) elk **10%** chance of seeing 10 or more elk	**Inside Elk Range** **40%** chance of seeing at least one elk **35%** chance of hearing an elk bugle **15%** chance of seeing a bull (male) elk **20%** chance of seeing 10 or more elk
Additional Driving Time Beyond Area A	**0** additional minutes	**120** additional minutes

Which of these state forest areas would you prefer to visit?

Area A ○ Area B ○

If Area A were not available, would you prefer to visit Area B or do something else?

Area B ○ Do something else ○

If Area B were not available, would you prefer to visit Area A or do something else?

Area A ○ Do something else ○

Figure A3.1: (cont'd)

Here is another scenario with two new recreation areas (Areas C and D). Area C is a **200 minute** drive from your home, and Area D is an **additional 15 minutes** beyond Area C.

Please review the characteristics of the two areas and answer the questions below.

Two Areas For Camping

	Area C	Area D
Recreation Features	campgrounds, hiking/biking trails, equestrian trails, and places for hunting, fishing, and morel hunting	campgrounds, hiking/biking trails, equestrian trails, and places for hunting, fishing, and morel hunting
Elk Range	**Inside Elk Range** **20%** chance of seeing at least one elk **5%** chance of hearing an elk bugle **15%** chance of seeing a bull (male) elk **15%** chance of seeing 10 or more elk	**Inside Elk Range** **40%** chance of seeing at least one elk **50%** chance of hearing an elk bugle **20%** chance of seeing a bull (male) elk **20%** chance of seeing 10 or more elk
Additional Driving Time Beyond Area C	**0** additional minutes	**15** additional minutes

Which of these state forest areas would you prefer to visit?

Area C	Area D
○	○

If Area C were not available, would you prefer to visit Area D or do something else?

Area D	Do something else
○	○

If Area D were not available, would you prefer to visit Area C or do something else?

Area C	Do something else
○	○

Figure A3.1: (cont'd)

This is the last scenario where you are choosing between two recreation areas (Areas X and Y). Area X is a **200 minute** drive from your home, and Area Y is an **additional 15 minutes** beyond Area X.

Please review the characteristics of the two areas and answer the questions below.

Two Areas For Camping

	Area X	Area Y
Recreation Features	campgrounds, hiking/biking trails, equestrian trails, and places for hunting, fishing, and morel hunting	campgrounds, hiking/biking trails, equestrian trails, and places for hunting, fishing, and morel hunting
Elk Range	**Inside Elk Range** **20%** chance of seeing at least one elk **20%** chance of hearing an elk bugle **10%** chance of seeing a bull (male) elk **5%** chance of seeing 10 or more elk	**Inside Elk Range** **25%** chance of seeing at least one elk **50%** chance of hearing an elk bugle **20%** chance of seeing a bull (male) elk **20%** chance of seeing 10 or more elk
Additional Driving Time Beyond Area X	**0** additional minutes	**15** additional minutes

Which of these state forest areas would you prefer to visit?

Area X	Area Y
○	○

If Area X were not available, would you prefer to visit Area Y or do something else?

Area Y	Do something else
○	○

If Area Y were not available, would you prefer to visit Area X or do something else?

Area X	Do something else
○	○

Figure A3.1: (cont'd)

Do you, or did you, have any of the following licenses or passes?

	No	Yes
2018 or 2019 Michigan Recreation Passport (license plate tag for MI State Parks and recreation areas)	○	○
2018 or 2019 Michigan ORV license	○	○
Any 2018 or 2019 Michigan fishing licenses	○	○
Any 2018 or 2019 Michigan hunting licenses	○	○

Did you apply for the 2018 Michigan elk hunt?

○ Yes

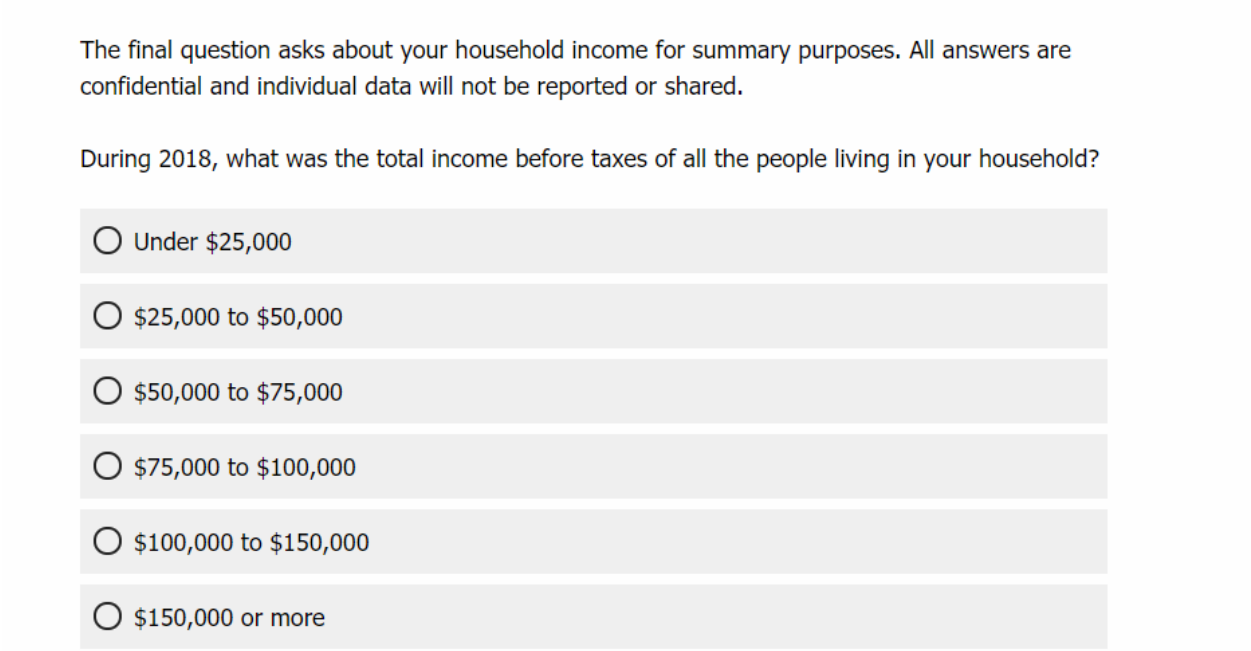
○ No

Are you a part of a hunting club or other organization that owns land within or adjacent to the Pigeon River Country or Atlanta State Forests (e.g. Black River Ranch, Beaver Dam Club, Fontinalis Club, Song of the Morning Ranch, etc.)?

○ Yes

○ No

Figure A3.1: (cont'd)



Appendix IV: Strategies for Defining a Target Population

Previous sections have alluded to the idea that the target population of Michigan Elk Range visitors is difficult to define. In some recreation demand contexts, it is possible to simply define the target population of recreationists as the total population of a state or region or as some easily identifiable percentage of the total population. In our case, however, the target population is likely quite distinct from total Michigan adults. This is because the main recreational activities in the area (e.g., hunting, fishing, elk viewing, horseback riding, etc.) are relatively specialized and have low participation rates among people in certain Michigan regions and/or demographic groups. Therefore, it would be helpful to know about how many people visit the Michigan Elk Range for recreation in a year. Additionally, this essay segments respondents by their primary activity (or activities), and we can think of these different activity groups as sub-populations of the total population. The welfare estimates shown in this paper should be thought of as *individual, per-trip* consumer surplus values. There is much we can learn from this, but it would also be useful to know the relative sizes of these sub-populations in order to estimate *aggregate* consumer surplus values by activity groups. The principal reason for aggregating these consumer surplus values is to aid forest managers as they inevitably deal with user conflicts. We have previously shown that wildlife viewers have the highest individual consumer surplus values, but this could differ when looking at aggregate measures depending on the relative size of wildlife viewers among all Michigan Elk Range visitors.

This section will identify some strategies that could be used in future research to identify the total Michigan Elk Range visitor population and their total trips as well as activity group sub-populations. The most promising way to identify total visitation to the Michigan Elk Range is through the use of traffic counters located at key entrance roads into the Pigeon River Country

State Forest (the largest surveyed area in the Michigan Elk Range). The PRCSF is large and dispersed, so there are many possible entrances into the forest. That being said, PRCSF forest management has identified seven roads that they believe to be the principal entrance points to the forest. These traffic counts are useful for determining total visitation, but there are several limitations. The first limitation is that some non-recreationists are included in the counts. The counts include people who work in the forest—MDNR employees, logging vehicles, and oil company vehicles. They also include traffic to several cabins and homes dispersed within the forest area as well as a yoga retreat also located in the area. Another limitation is that certain survey areas are not covered by traffic counters. This includes the portion of the Atlanta State Forest included in our intercept survey routes as well as the Green Timbers portion of the PRCSF (west of the E Sturgeon Valley Rd. traffic counter). A third limitation is that visitors frequently leave and reenter the forest during a single trip. In order to address this, we included a question in the intercept survey that asks how many times the visitor left and reentered the forest on the intercepted visit. The traffic counts can be combined with the vehicle counts we generated during the roving intercept survey. These intercept surveys provided us with a count of parked vehicles along predetermined routes.

One way to estimate some of the activity sub-populations is through the use of cameras we placed at key locations in the Michigan Elk Range.[25] We set up several Bushnell game cameras in the PRCSF and ASF in the summer and fall of 2018 as well as the spring/summer of 2019. The places with cameras tended to be parking areas for trailheads, lakes, and elk viewing areas. The sub-populations that we can estimate using these camera counts include hikers and/or bicyclists, lake users (mainly swimming, boating, and fishing), and elk viewers. Estimating

[25] A total of 19 locations had cameras at some point during 2018 and 2019. 14 locations were consistently monitored. There are some gaps in the images due to malfunctions and camera theft.

vehicle counts at these parking areas will not provide us with an all-encompassing count for these sub-populations (e.g. some elk viewers do not park at elk viewing areas), but it does provide some additional information. We have developed a system for processing the images using a software called TIMELAPSE (Greenberg and Godin 2015), and we hope that this method will not only provide vehicle counts but vehicle duration as well.

According to our intercept survey, 46% of the respondents on an overnight trip stayed in one of the seven state forest campgrounds located in the PRCSF. Anyone camping in a Michigan state forest campground is required to fill out a paper registration form and pay a campground user fee. The PRCSF campgrounds are administered by Otsego Lake State Park in Gaylord, MI, and they compile these registration forms and maintain statistics on the yearly campsite use nights by campground.[26] In order to convert this into a visitor count estimate, we would need to know the average number of occupants at a PRCSF campsite. We included a question in an online follow-up survey of the intercept survey visitors asking how many people occupied their campsite on the intercepted visit, and the average response was 2.7.[27] The equestrian campground, Elk Hill Equestrian Campground, uses a separate, online reservation (managed by the MDNR). Given that we know that 46% of intercepted visitors (on an overnight trip) stayed in a state forest campground, we should be able to match the traffic count estimates with the campground estimates.

Hunters are a particularly challenging sub-population to estimate because hunting is the most dispersed activity in the forest. Hunters do not park in a single area, so it would not be possible

[26] The following is an example of how this count is calculated. Say that on Day 1 seven campsites in a campground were occupied. Say that on Day 2 three campsites in the same campground were occupied. The two-day total number of nights for this campground would be 10.

[27] Only 126 people answered this question. However, this number is consistent with interviewer survey experience in the campgrounds.

to monitor them with cameras at parking areas. In light of this, one way to estimate the sub-population of hunters is through the use of MDNR hunter surveys. Among other statistics, the deer hunting survey report includes estimates for the total number of hunters as well as the total number of days spent hunting for the three counties that make up the Michigan Elk Range—Otsego, Cheboygan, and Montmorency. By making some assumptions and simple calculations, we can convert these county-level estimates into Michigan Elk Range estimates. For example, from these surveys we can get the share of hunting days that occur on private land versus public land. We would then estimate what percentage of total public land is in the elk range. This would give us the total hunting days in the Michigan Elk Range. In order to check for validity, we would then compare these estimates to what we know from the intercept survey as well as the traffic counts.

Appendix V: Robustness Checks

The following tables are made up of four columns. The first three columns show marginal rate of substitution (MRS) values for the elk-related attributes and driving time. In this context, the MRS values can be interpreted as the additional minutes a visitor would be willing to drive for a 1% increase in the chance of experiencing the elk-related attribute. The first column, "All Responses", includes both intransitive choice sets and an opt-out option (i.e. None). The second column, "Drop Intransitive Responses", shows the MRS values when we drop intransitive choice sets. The third column, "Binary Responses", shows the MRS values when we only include binary choices (i.e. no opt-out option). The fourth column uses the same responses as the "All Responses" column (i.e. keeps intransitive choice sets and an opt-out option), but it differs in that the cost (i.e. additional time driving) is converted from time to a monetary travel cost. In this context, the MRS values can be interpreted as the monetary costs ($) a visitor would be willing to incur for an additional 1% increase in the chance of experiencing the elk-related attribute. To make this conversion, we assume that visitors travel in the Michigan Elk Range at an average of 25 mph. 25 mph was chosen because road conditions in the Michigan Elk Range are poor, so travel can be slow. We assume that direct expenses for operating a vehicle are $0.285 per mile. Lastly, we assume that visitors value their time at 1/3 of their hourly wage rate.

Table A5.1: MRS using Conditional Logit Models

	All Responses	Drop Intransitive Responses	Binary Responses	MRS using Monetary Conversion
Conditional Logit (No Interactions)				
See at least One Elk	2.38***	2.23***	2.45***	2.06***
Hear an Elk Bugle	2.55***	2.59***	2.39***	2.29***
See a Bull Elk	0.37	0.29	0.29	0.29
See 10 or more Elk	0.55	0.59	0.34	0.52
Conditional Logit (Demographic Interactions with "None")				
See at least One Elk	2.39***	2.24***	N/A	2.06***
Hear an Elk Bugle	2.56***	2.59***	N/A	2.29***
See a Bull Elk	0.37	0.29	N/A	0.29
See 10 or more Elk	0.55	0.59	N/A	0.51
Conditional Logit (Demographic Interactions with "Outside Elk Range")				
See at least One Elk	2.30***	2.14***	2.37***	1.95***
Hear an Elk Bugle	2.58***	2.61***	2.42***	2.28***
See a Bull Elk	0.39	0.30	0.32	0.29
See 10 or more Elk	0.60	0.64*	0.38	0.54

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5.2: MRS using Conditional Logit separated by Activity Group

	All Responses	Drop Intransitive Responses	Binary Responses	MRS using Monetary Conversion
Path Activities				
See at least One Elk	2.22*	1.97*	2.09*	2.06
Hear an Elk Bugle	2.48	2.99*	2.28	2.35
See a Bull Elk	-0.05	-0.19	-0.15	-0.27
See 10 or more Elk	-1.21	-0.60	-1.29	-1.32
Wildlife Activities				
See at least One Elk	4.10***	3.84***	4.04***	2.90***
Hear an Elk Bugle	3.88***	3.85***	3.84***	2.70***
See a Bull Elk	-0.16	-0.16	0.03	-0.10
See 10 or more Elk	0.28	0.44	0.15	0.53
Hunting Activities				
See at least One Elk	1.15	1.01	1.30	1.09
Hear an Elk Bugle	0.22	0.32	-0.04	-0.29
See a Bull Elk	2.29*	2.06*	2.27*	3.78
See 10 or more Elk	1.75*	1.78**	1.69*	2.33
Camping Activities				
See at least One Elk	2.11***	1.93***	2.20***	1.63**
Hear an Elk Bugle	1.92**	1.88**	1.62*	1.51*
See a Bull Elk	0.16	0.25	-0.02	-0.03
See 10 or more Elk	0.38	0.10	0.18	0.33
Water Activities				
See at least One Elk	1.67***	1.83***	1.72***	1.39**
Hear an Elk Bugle	1.89***	1.91***	1.84***	1.60**
See a Bull Elk	-0.01	-0.06	-0.003	0.01
See 10 or more Elk	0.64	0.58	0.34	0.54

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5.3: MRS using Mixed Logit

	All Responses	Drop Intransitive Responses	Binary Responses	MRS using Monetary Conversion
See at least One Elk	0.98***	1.04***	1.26***	0.65*
Hear an Elk Bugle	1.40***	1.53***	1.40***	1.13***
See a Bull Elk	0.90*	0.53	0.71	0.69
See 10 or more Elk	1.86***	1.38**	1.08	1.76**

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5.4: SD of Elk-Related Attributes using Mixed Logit

	All Responses	Drop Intransitive Responses	Binary Responses	Monetary Conversion
See at least One Elk	0.0004	0.045**	0.013	0.001
Hear an Elk Bugle	0.061***	0.062***	0.072***	0.052***
See a Bull Elk	0.055***	0.047**	0.070***	0.053***
See 10 or more Elk	0.110***	0.101***	0.102***	0.121***

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5.5: MRS using Latent Class Logit (Elk Experience Class Membership)

	All Responses	Drop Intransitive Responses	Binary Responses[28]	MRS using Monetary Conversion
Class 1				
See at least One Elk	0.74*	0.61		0.51*
Hear an Elk Bugle	-0.62	-0.35		-0.55
See a Bull Elk	0.38	0.37		0.15
See 10 or more Elk	-0.75	-0.45		-0.33
Class 2				
See at least One Elk	1.72***	1.60***		1.27**
Hear an Elk Bugle	3.29***	3.08***		3.32***
See a Bull Elk	1.04	0.84		0.89
See 10 or more Elk	1.90**	1.99**		1.61**

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[28] Does not converge.

Appendix VI: Robustness Check using a Single Elk Attribute Variable

The elk-related attributes are highly correlated (Table A6.1), and this makes them difficult to separately identify. This appendix re-runs the models presented in Essay 2 with one elk-related attribute (the sum of seeing at least one elk, hearing an elk bugle, seeing a bull elk, and seeing 10 or more elk). We use principal component analysis to look for a way to combine the elk-related attribute variables (Table A6.2). The results suggest that adding up the elk-related attribute variables is a valid approach. This variable will be referred to as "All Elk Attributes" in the analysis below.

The results for all the "All Elk Attribute" models accord with those presented in the body of the chapter. Namely, for the population average based on conditional logits, there is evidence of a significant preference for elk. Based on mixed logit, there is evidence of significant heterogeneity in the preference for elk. Distinguishing preferences by activity groups reveal wildlife viewers place the highest value on elk, and there is evidence of incidental value of elk viewing since groups focused on hunting, camping or water activities also prefer elk attributes, but less so that wildlife viewers. Finally, the latent class analysis similarly finds that there is a class that significantly prefers elk and one that does not.

Table A6.1: Overall Correlation of Elk-Related Attributes

	Seeing at least One Elk	Hearing an Elk Bugle	Seeing a Bull Elk	Seeing 10 or more Elk
Seeing at least One Elk	1.000			
Hearing an Elk Bugle	0.753	1.000		
Seeing a Bull Elk	0.846	0.637	1.000	
Seeing 10 or more Elk	0.835	0.623	0.698	1.000

Table A6.2: Principal Component Analysis of Elk-Related Attributes

	Comp 1	Comp 2	Comp 3	Comp 4
Seeing at least One Elk	0.538	-0.108	-0.026	-0.836
Hearing an Elk Bugle	0.467	0.077	0.077	0.187
Seeing a Bull Elk	0.498	-0.724	-0.724	0.380
Seeing 10 or more Elk	0.494	0.685	0.685	0.350
Eigenvalue	3.20	0.40	0.30	0.10

Table A6.3: Overall Conditional Logit Estimates with "None" and "Outside of Elk Range" Interactions

Variables	(1)	(2)	(3)
All Elk Attributes	0.0166***	0.0166***	0.0166***
	(0.00228)	(0.00227)	(0.00226)
Distance	-0.0103***	-0.0102***	-0.0103***
	(0.00223)	(0.00222)	(0.00220)
Outside of Elk Range	1.100***	1.103***	2.872*
	(0.273)	(0.274)	(1.466)
None	-1.926***	0.666	-1.939***
	(0.335)	(2.318)	(0.336)
None x Driving Time		-0.00378	
		(0.00417)	
None x Male		-0.0130	
		(0.583)	
None x Education Level		-0.154	
		(0.131)	
None x Income		0.00301	
		(0.00666)	
Outside of Elk Range x Driving Time			-0.00718***
			(0.00257)
Outside of Elk Range x Male			-0.554
			(0.431)
Outside of Elk Range x Education Level			-0.0454
			(0.0946)
Outside of Elk Range x Income			0.00345
			(0.00401)
Respondents	309	309	309
Choice Sets	913	913	913

Standard errors clustered by respondent reported in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6.4: Overall Mixed Logit Estimates

Variables	Parameter Estimates	SD Estimates	% with Parameter >0
All Elk Attributes	0.0240***	0.0294***	79%
	(0.00333)	(0.00336)	
Distance	-0.0208***		
	(0.00309)		
Outside of Elk Range	0.622*		
	(0.333)		
None	-2.523***		
	(0.303)		
Respondents	309	309	309
Choice Sets	913	913	913

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6.5: Conditional Logit Estimates by Primary Activity Group

Variables	Path Activities	Wildlife Viewing	Hunting	Camping	Water Activities
All Elk Attributes	0.00667	0.0357***	0.0192***	0.0162***	0.0177***
	(0.00458)	(0.00659)	(0.00566)	(0.00477)	(0.00514)
Distance	-0.00703	-0.0140**	-0.0147**	-0.0131***	-0.0163***
	(0.00504)	(0.00559)	(0.00611)	(0.00501)	(0.00539)
Outside of Elk Range	0.233	1.015	0.860	0.663	1.475**
	(0.582)	(1.319)	(0.605)	(0.538)	(0.583)
None	-3.418***	-1.112	-1.540*	-2.285***	-1.413**
	(0.850)	(0.803)	(0.816)	(0.768)	(0.661)
Respondents	64	47	56	71	71
Choice Sets	191	139	164	211	208

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6.6: Class Membership for Latent Class Logit Model for Two Classes when using Elk Experience as Explanatory Variables (*Class 2=Reference Class)*

Variables	Class 1
Have you ever gone elk viewing in Michigan? (Q24 Follow-Up)	-0.676* (0.345)
Have you ever seen elk outside of Michigan? (Q28 Follow-Up)	-0.519* (0.289)
Was seeing elk the primary reason for visiting on the intercepted visit? (Q15 Intercept)	-2.189*** (0.658)
Approximate Driving Time (in minutes)	-0.00577*** (0.00173)
Constant	1.678*** (0.459)
Class Share	43%

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6.7: Preferences for Latent Class Logit Model for Two Classes Explained by Elk Experience

Variables	Class 1	Class 2
All Elk Attributes	0.00281 (0.00318)	0.0349*** (0.00522)
Distance	-0.0222*** (0.00570)	-0.0177*** (0.00427)
Outside of Elk Range	0.782** (0.362)	-1.005 (0.933)
None	-2.298*** (0.353)	-0.809 (0.572)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1