Economic valuation of recreation access to wildlife management areas in Tennessee

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Abstract

Maintaining visitation at public lands is critical to public land managers in order to continue conservation efforts and offer recreation opportunities. Wildlife management areas (WMAs) are public lands set aside for wildlife conservation, education, and recreation and differ from other kinds of public lands in their relative size, proximity to rural areas, and types of outdoor activities allowed. These areas are utilized by a variety of users ranging from consumptive groups, such as hunters, to non-consumptive groups, such as wildlife watchers. While previous studies have explored the demand for public lands in general or specific types of public lands such as national or state parks, information regarding how WMAs are valued by various users is lacking. In addition, justification for investment of public funds in acquisition and development of new WMAs or similar conservation areas will require demonstrating the economic benefit to stakeholders, including visitors. The objective of this research was to estimate a model of demand for visits to WMAs and quantify the economic value of recreation access to visitors. By combining primary data collected from a mixed-mode survey of visitors on trip profile and visitor demographics, with secondary data on WMA site characteristics, a travel cost model was estimated to characterize the economic value of WMA visitation. Visitor characteristics and WMA characteristics that relate to WMA visitation demand were also identified. The aggregate annual economic value of WMA access in Tennessee was estimated to be between $137.37 and $293.62 million depending on the modeling assumptions. Per trip economic value of WMA access was found to be significantly different among user groups. In addition, personal characteristics, including party size and the primary visitation purpose being hunting, and WMA characteristics including camping allowed, boat access, and wheelchair accessible blinds were found to have a positive effect on WMA visitation, whereas age,

education, and ATVs being allowed were found to have a negative effect. New insights regarding the economic value of WMA access can provide stakeholders with information on public interest and can help managers to better serve the public while ensuring conservation for the future.

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Chapter 1: Introduction

Public lands and outdoor recreation are important to the public and to the economy in the United States. They also serve to protect natural and cultural resources as well as make nature and outdoor recreation accessible to all. For example, federal land management agencies, including the National Park Service, Forest Service, and Fish and Wildlife Service manage nearly 700 million acres with an estimated 870 million visits annually (Leggett et al. 2017). Similarly, state parks, managed by state natural resources agencies, receive over 759 million annual visits (Leung et al. 2016). These visits have a significant economic impact on local communities and regional economies. Outdoor recreation contributed $427.2 billion to the US gross domestic product in 2017 (Cologer et al. 2019), and federal public land visitation alone contributed $108 billion to the economy in 2016 (Cline & Crowley 2018).

Maintaining visitation at public lands is critical to land managers in continuing conservation efforts and offering recreation opportunities. Visitation can have a variety of influences on support for and maintenance of protected areas. Funding for these areas and conservation practices in general vary over time depending on politics and public support. Decline in fee revenue due to low visitation can result in lack of funding for conservation and facility operation (Poudyal et al. 2008). Visitors also bring in expenditures that can have significant economic impacts to rural communities in terms of jobs, tax revenue, wages, etc. (Mozumder et al. 2007). Also, through positive experiences at public lands, visitors may develop a sense of appreciation for nature, have pro-environmental behavior, and become supportive of conservation programs (Larson et al. 2014). To maintain public use of these resources, it is important to fully understand the demand for visitation of these areas and how they are valued by their users.

Literature on public land visitation has mostly focused on visitation demand and economic assessment in the context of national forests, national parks, and state parks (Loomis et al. 2001; Heberling & Templeton 2009; Sardana et al. 2016; Chapagain et al. 2021). However, little information exists on understanding the demand for and economic value of wildlife management areas (WMAs). WMAs are public lands set aside and managed by state wildlife agencies primarily for wildlife conservation, education, and recreation and differ from other kinds of public lands, such as state or national parks. These areas are unique types of public land with their relatively large size, location in rural areas, and types of outdoor activities allowed. Hence, the conclusions drawn from empirical studies of other types of public lands (Metcalf et al. 2015; Mingie et al. 2017; Matthews et al. 2018; Sari 2019) may not be generalized. Hussain et al. (2019) is one of the few studies to explore the economic value of WMAs, but no other study to our knowledge has fully explored the demand for WMA use by users other than hunters.

In Tennessee, the Tennessee Wildlife Resources Agency (TWRA) manages over 150 WMAs that vary in size from 53 acres to 625,000 acres and offer amenities for activities such as hunting, fishing, camping, wildlife watching, ORV riding, and shooting ranges. These WMAs are especially popular among hunters who may lack access to privately owned hunting land or who may be seeking a particular hunting opportunity, such as migratory game birds, and thus WMAs may be crucial to the retention of hunters and preserving hunting as a cultural tradition. Results from a mixed-mode survey of 3,037 sportspersons conducted in 2019 showed that around 140,000 annual users visited Tennessee WMAs in 2018 and spent over 3.44 million recreation days (Poudyal & Watkins 2019). While the economic impact (i.e., the effect of consumer spending on the entire market and economy) of WMA visitation has been evaluated in Tennessee (Poudyal et al. 2020), the economic value (i.e, the benefit of a good or service to an

individual) of Tennessee WMAs was previously unknown. Analyzing the economic value of WMA access can provide stakeholders, such as TWRA, with information on opportunities in monitoring and managing WMA visitation, and can help managers better serve the public while ensuring conservation for the future.

The objectives of this study were 1)- to characterize the economic value of recreation access to WMAs, and compare the value among user groups (i.e., hunters, anglers, and non-consumptive users) and 2)- to evaluate visitor demographics and WMA characteristics that influence demand for WMA visitation.

I hypothesize the economic value of recreation access to WMAs is substantial, and the economic value varies by type of recreation activity. I expect that consumptive users, such as hunters, place a higher value on recreation access than non-consumptive users because of a lack of substitutes for consumptive users. Demand for WMA use and visitation is expected to be influenced by characteristics and amenities of a WMA as well as sociodemographic characteristics of the visitors.

Chapter 2: Literature Review

Determinants of Public Land Visitation

An individual's decision to visit public land for recreation and their choice of a site among alternative sites may be influenced by a variety of factors related to characteristics of a site as well as their own circumstances, such as motivation and demographic characteristics. Common site characteristics that may influence visitation include positive influences of site size (Romano et al. 2008; Agimass et al. 2018; Birdsong 2019) and available game harvest (Hussain et al. 2016; Mingie et al. 2017), negative influence of population density (Hussain et al. 2016; Mingie et al. 2019), and varying influences of land cover and physical attributes, such as presence of lakes or rivers (De Valck et al. 2017; Mingie et al. 2017; Agimass et al. 2018).

In addition to site and demographic characteristics, travel cost has been established as a key predictor in economic theory of visitation demand (Champ et al. 2003). Romano et al. (2008) explored this concept by surveying Italian households to estimate visitation rates and site selection of protected areas in relation to sociodemographic factors. They found households that visited protected areas more often were generally younger, more educated, wealthier, and spent more time on outdoor activities as a whole. They also found travel cost was a significant predictor of visitation, with sites associated with higher travel cost receiving less visits. Agimass et al. (2018) explored Denmark forest site choice using a web survey. Using a random parameter logit model, the authors found that size of the site and presence of historical sites had a positive relationship with visitation while distance from an individual's home had a negative relationship. De Valck et al. (2017) used a discrete choice experiment to find that distance had a negative relationship with visitation of outdoor recreation areas in Belgium, while number of facilities available and presence of trails had a positive effect on visitation.

While it is clear recreation site choice has been studied globally and across different land types, areas managed specifically for wildlife habitat are lacking in research. While these areas are used by visitors for a variety of activities, they are commonly used by hunters as is represented by the 2019 Tennessee WMA survey (Poudyal & Watkins 2019), in which 85% of respondents reported they were a hunter or trapper. Hunters are a commonly studied group in demand literature and considering their use of WMAs, this literature may be relevant.

Hussain et al. (2016) used data collected from a mail survey of hunters in a nested logit model to estimate hunter choice of WMAs in Mississippi. Using this model, they found population density of WMA county and travel cost had negative influences on a hunter's choice to visit, and acreage and number of deer harvested at that WMA in the previous season had a positive relationship with an individual's likelihood to visit. Mingie et al. (2017) examined big game hunter preference of leased land in Georgia using a choice experiment and a multinomial probit regression. They revealed hunters preferred larger areas to hunt and smaller member groups, which could relate to hunters preferring less crowding on public lands. Similarly, Birdsong (2019) modeled hunters' choice of WMAs in Alabama using a logistic regression analysis. Based on an individual's constraints and motivations to hunt, as well as site attributes, they found that proximity was a primary predictor of decision to visit a particular WMA. Presence of wild turkey or whitetail deer, presence of a boat launch, campsite availability, and the number of gun choice days (gun hunting for bucks or does) were also significant predictors. Research on hunter use and preference of public and private land and site attributes is clearly well represented in the literature. However, few studies explore the demand for WMAs and those that do focus only on hunter demand. Tennessee WMAs are used for a variety of uses by hunters

as well as by other consumptive and non-consumptive user groups, so examining the demand across all users will better estimate the collective demand for WMAs.

Economic Valuation of Public Land Visitation

The economic value of outdoor recreation access to public lands is also well represented in the literature, although as with visitation demand, WMA specific studies are lacking. Wildlife refuges could provide a background, though research on these areas are lacking as well, with only one example in the literature focusing on a household's willingness to pay to visit one particular US wildlife refuge (Klocek 2004).

Comparisons of valuation between user groups or land attributes that has been explored for other public land types can provide a background for the theoretical concepts explored in this research. Loomis et al. (2001) surveyed hikers and bikers in Colorado national forests to estimate their cumulative and comparative demands for recreation trips after forest fires. Using a Poisson regression model, they found hikers took more trips and experienced more benefit than bikers in the years following a fire. The influence of income and age also varied in whether demand increased or decreased for trips among these user groups. Englin and Moeltner (2004) used a negative binomial model to estimate the value of winter sports trips to skiers and snowboarders in Nevada and California. They found skiers had a higher per trip value than snowboarders, and snowboarders were more responsive to price changes. Knoche and Lupi (2012) also compared user groups in their estimation of the economic value of public hunting lands to archery and firearm deer hunters in Michigan. They estimated firearm hunters experienced a slightly higher benefit than archery hunters and also estimated this value between public land types, with state land being valued significantly higher than federal and commercial forest act land (publicly

accessible, privately-owned land) among both hunt type groups. Clearly, user groups differ in their demand for and valuation of their recreation trips.

Estimating economic value of access by land type, as done by Knoche and Lupi (2012), is another common method of comparing benefits to users. Mingie et al. (2019) used a zero-truncated binomial regression method, similar to many others in the travel cost literature (Englin & Moeltner 2004; Hussain et al. 2016), to compare the economic benefit of forestland access for big game hunting in Georgia across land ownership type. They found leased and self-owned forestlands have the highest value to hunters, in comparison to non-leased private lands and public forestlands. Sardana et al. (2016) estimated the value of outdoor recreation trips, comparing values of different site types with different amenities within Southeastern US national forests. Though this study compared site types, it could be considered a use-type comparison as well. Although multiple uses may be available in each setting, each setting is most appropriate for more specific uses, such as wildlife-based activities in wilderness areas and camping in overnight-use developed settings. They found wilderness areas provides the highest net benefit/person/trip, which may be attributable to the lack of substitutes for this site type. Travel cost, income, and party size negatively influenced demand for all site types and age and travel cost to a substitute site varied in influence.

While previous research represented in the literature shows valuation of public lands has been widely studied across types of public lands and user groups, information on the economic value of WMAs in particular is lacking. In addition, previous results have shown value between use types can differ. Thus, when estimating the value of WMAs, it is important to consider the different use types (hunting, fishing, non-consumptive) and how their valuation could compare.

These different values can be aggregated for each type of user group to accurately characterize the public value of WMAs through recreational use.

Non-Market Valuation of Recreation Sites

Economists have developed a variety of methods to characterize the economic value of non-market goods and services, such as recreation access to natural areas (e.g., parks, fishing areas). Some involve stated preference methods, such as contingent valuation methods, where potential users of a recreation site are directly asked to state how much they are willing to pay to visit the site. Other methods involve revealed preference approaches, such as the travel cost method (TCM), in which users are not directly asked about the value but are asked to report their visitation behavior and cost incurred. That information is used to derive a demand curve, showing the relationship between frequency of visit and cost of visit per trip. From that demand curve a measure of monetary value of access per trip, or consumer surplus, can be estimated.

Many recent studies have used the TCM for valuation of recreation sites using a 0.33 wage rate, which was adopted for this research. Others have used a 0.25 or 0.5 wage rate, but by evaluating economic value for both no wage rate opportunity cost of time and the 0.33 wage rate, we provide both a lower and a conservative upper estimate of value. Literature using similar methodology for various comparable use types can provide some insight into the concepts explored in this research.

Sardana et al. (2016) is one recent example of this methodology, who estimated the value of US national forests using a Poisson regression. This study estimated the valuation for multiple site types including wilderness, overnight-use developed settings, day-use developed settings, and general forested areas using demographic and site characteristics. Using a 0.33 wage rate, they found overnight-use developed settings to be valued the lowest at $49.43 per person per trip

and wilderness areas to be valued the highest at $85.76. This variation is likely due to the amenities available and user motivations at each site type. Chapagain et al. (2021) examined the value of nonmotorized boating access in US national forest rivers using a truncated negative binomial and the TCM. Results showed access was valued at $73 per person per trip using a 0.33 wage rate model. Chapagain et al. (2018) used the TCM and truncated negative binomial regression to estimate the value of downhill skiing and snowboarding in US national forests. Results showed this activity was valued at $185 per person per trip with a 0.33 wage rate model.

Mingie et al. (2019) used the TCM to estimate the value of forestland access for Georgia big-game hunters. Using a truncated negative binomial regression, results of this study showed public forestlands were valued lower than other ownership types such as leased and owned private land, with a value of $37.73 using a 0.33 wage rate model. Chapagain et al. (2020) found that elk-viewing in Tennessee was valued at $53 per person per trip using a 0.33 wage rate and an inflated negative binomial model. Larsen et al. (2020) found snowmobile recreation on public lands in Valley County, Idaho was valued at $47 using a 0.33 wage rate in a similar model. Though Hussain et al. (2019) investigated the value of Alabama WMAs and deer harvest to hunters, no TCM study has reported the full value of WMAs to all user groups. And while demand for and valuation of recreation sites by a variety of user groups has long been explored in the literature, wildlife management areas are clearly underrepresented. The research presented here fills gaps surrounding the valuation of WMAs as well as this valuation compared at specific user group level, as motivation and values likely differ between user group.

Chapter 3: Methodology

Study Area

This study was conducted in Tennessee and focused on WMAs in the state. According to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 833,000 Tennessee residents participated in angling activities in 2011, 286,000 residents participated in hunting activities, and 1,733,000 participated in wildlife-watching (US Department of the Interior 2014). This equates to approximately 13.1%, 4.5%, and 27.3% of the 2010 population participating in these activities, respectively (US Census Bureau 2019). These activities take place on both private and public lands. In Tennessee, federally owned lands account for nearly 27 million acres of the state (Congressional Research Service 2020). State-owned public lands are managed mostly by the Tennessee Wildlife Resources Agency (TWRA) and the Department of Environment and Conservation, which manages 261,280 acres of state parks and natural areas (Tennessee Department of Environment and Conservation 2020).

TWRA manages over 150 WMAs for public use and wildlife habitat protection, which vary in size from 53 to 625,000 acres. All WMAs in the state are available to the public for hunting, fishing, and trapping but are also used for many other purposes such as hiking, biking, boating, ATV/OHV riding and more. Activities permitted and availability to public may vary by season and by specific WMA regulations. The most popular activities performed at WMAs in Tennessee include hunting, fishing, hiking, and ATV riding. Amenities available also vary, and include camping, boat access, shooting ranges, festivals hosted at the WMAs, and wheelchair accessible hunting blinds.

An estimated 140,000 users annually participate in a variety of outdoor recreation activities at Tennessee WMAs, for a total of over 3.44 million annual recreation days. The three

most popular WMAs based on these recreation days were North Cumberland, North Cherokee, and Catoosa WMAs. During 2018, WMA users in Tennessee spent an estimated $427 million in counties where WMAs they visited are located, and $108 million elsewhere for these trips. In total, expenditures for these WMA related activities contribute more than $576 million to Tennessee's GDP, $69 million in state and local taxes, and $83 million in federal tax revenue. (Poudyal & Watkins 2019).

Data Collection

Data for this study was collected through a mixed-mode survey of resident and non-resident sportspersons in Tennessee. Sampling frame was constructed from valid TWRA license holders with privileges to access Tennessee WMAs during 2018. License holder data was provided by TWRA Information Technology Department. License types included lifetime sportsman, annual sportsman, non-resident daily and annual licenses, WMA specific permits, and high impact conservation permits.

Since there is no specific list of WMA users, there are two ways to sample this group: either by on-site survey of visitors at WMAs or by taking a sample of those who purchased a permit to participate in activities typically occurring at WMAs. We adopted the sportspersons license holders as the sampling frame for this study because participating in most outdoor recreation activities in WMAs (e.g., hunting, fishing, ATV riding, boating, camping) requires users to have a license and WMAs are primarily places for wildlife-based recreation activities. Therefore, the license holder database constitutes the approximate population of potential WMA users. A sample of 10,000 sportspersons was chosen from the pool of license holders using stratified random sampling to ensure sampling was representative of all license types. Sample

distribution across license categories and geographic regions were determined based on size of categories, following previous literature (Mingie 2015; Paudyal et al. 2015).

Of the 10,000 sportspersons in the sample, 4 questionnaires were returned because the recipient was deceased and 2 were deemed ineligible because the recipient was a TWRA employee who worked directly with WMAs in administration. This resulted in a final sample size of 9,994, all of whom received a mail questionnaire using a modified Tailored Design Method described by Dillman (2009). Individuals who did not return the mail version and who had provided an email address to TWRA with license purchase then received the online version. 3,037 survey questionnaires were returned, resulting in a response rate of 30.40%, which is consistent with recent surveys of TWRA license holders and landowners (Caplenor 2016: 33%; Watkins et al. 2018: 36%).

The questionnaire consisted of 23 questions over eight pages mailed to participants along with a prepaid return envelope. Both the mail and web version of the questionnaire consisted of Likert scale, short answer, and yes/no type questions along with a comment section. The survey questionnaire also included a list of all Tennessee WMAs for participants to reference and refer to by number. Questions were developed in collaboration with TWRA management personnel in order to meet agency goals while ensuring appropriate survey design.

Questionnaires were split into three sections. The first section included questions on which Tennessee WMAs the sportsperson visited in 2018, which recreation activities they participated in, and if they attended any festivals or special events at WMAs. They were then asked their level of satisfaction with the activities they participated in. This section also included questions on personal expenditures during trips to WMAs.

The second section asked participants about their perception of WMAs, and whether and to what extent various improvements in WMAs would likely motivate them to visit WMAs in the future. Questions regarding perception were measured on a 5-point Likert scale (1-Highly unlikely, 5-Highly likely) and questions regarding likelihood to visit in future were measured in similar scale (1-Not likely at all, 5-Certainly likely). Finally, the third section asked about demographics and collected data on household and personal characteristics.

Data on WMA amenities and characteristics were obtained from the TWRA Hunting and Fishing Guide, which provides information on area regulations and permitted activities. Zip code and income data were retrieved from the US Census Bureau.

Model Specification

The objective of this study was to model WMA trip demand, thus the dependent variable was defined as the number of trips taken to a Tennessee WMA for the primary purpose of stated recreation activity (i.e. hunting, fishing, non-consumptive) in 2018. This is a standard practice in measuring demand variables in travel cost studies (Loomis et al. 2001; Knoche & Lupi 2012; Knoche & Lupi 2013; Hussain et al. 2016; Mingie et al. 2019).

Following previous literature (e.g. Blaine et al. 2015, Mingie et al. 2019, and Chapagain et al. 2021), data for each site were pooled to create one demand curve for Tennessee WMAs. Variables distinguishing primary purpose for site visit as indicated by the respondents were created for hunting, fishing, and non-consumptive uses. Non-consumptive uses included target shooting, hiking, biking, bird/wildlife watching, camping, boating, ATV riding, horseback riding, picnicking, and other uses. Hunting as the primary purpose for visiting was the reference category and each of the binary use variables were run with travel cost to create an interaction term, which allowed for comparison of consumer surplus (CS) values by use type. Consumer

surplus for site access can be considered the amount which an individual's willingness to pay exceeds their cost to participate. CS is an approximation of an individual's welfare derived from a resource. Bowker et al. (2007) points out that while CS is not necessarily comparable to market value, it is commonly used in economic valuation analysis. Figure 1 illustrates demand for trips, with number of trips taken to a site measured on the horizontal axis and cost per trip (travel cost) measured on the vertical axis. An individual's demand curve is represented by line D. Given this demand curve, the individual would take Q1 trips at cost P1 per trip. The individual's cost for Q1 trips at cost P1 is illustrated by the rectangular area P1, b, Q1, 0, and the willingness to pay above cost, or consumer surplus, is illustrated by the triangular area P1, a, b.

Most studies derive demand curves based on the individual, though some use group or travel party. In group estimates, the characteristics of the survey respondent are assumed to represent the characteristics of the group. Both individual and group approaches are common in the literature, but this study used the individual estimate in order to better estimate consumer surpluses at individual level.

Parsons (2003) suggested that to fully estimate travel cost one must include costs of travel, time, equipment, as well as admission or access fees associated with the trip. Though Tennessee WMAs do not impose access fees, users may face fees associated with hunting, fishing, campsite, or other special use (e.g., ATV riding) fees. However, these fees vary widely, and many Tennessee residents hold lifetime licenses which involve a one-time fee at purchase. This makes the per-trip cost of fee very small if not negligible. Other users who engage in non-consumptive and non-impacting activities (e.g., bird watching, hiking) may face no fees to

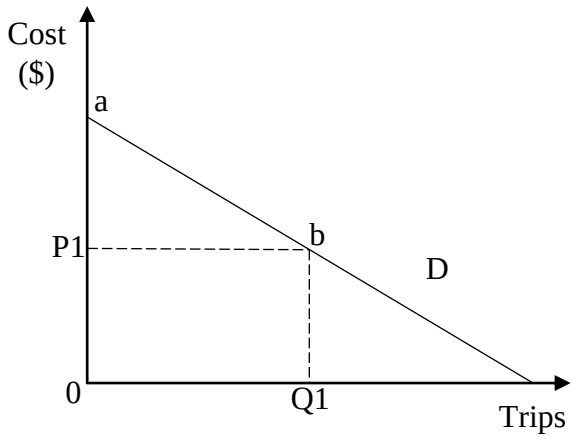

Figure 1. Demand curve illustrating the relationship between travel cost, trips to a recreation site, and value derived from site access.

participate in recreation at Tennessee WMAs. Because of these challenges, access fees were not included in the travel cost model.

AAA's 2019 Your Driving Costs publication (American Automobile Association 2019) was used to estimate round-trip transportation costs. The four-wheel drive crew cab pickup estimates were used because this type of vehicle is often necessary for hunters and other outdoor recreators to transport equipment to the site (Mingie et al. 2019). The operating costs for this category was $0.24 per mile (American Automobile Association 2019). The reported distance between the respondent's residence and the WMA visited was doubled to estimate round-trip travel distance. The round-trip travel distance was then multiplied by the $0.24 per mile operating cost to compute the travel cost in the absence of time cost related to wage rate.

To estimate travel time and costs, a speed of 45 miles per hour was used, which is an approximation of average travel speed in Tennessee and is similar to approximations for previous travel cost studies in other states (Knoch & Lupi 2012: 40 mph; Blaine et al 2015: 55 mph; Mingie et al. 2019: 50 mph). Considering the sensitivity of the income in surveys, many respondents have the tendency of dropping out of the survey which yields a low response rate. For this reason, income data was not collected. When income data is not available, it is common practice in travel cost modeling to use median income data for the respondent's zip-code as a reliable proxy of income. Following Heberling and Templeton 2009, Knoche and Lupi 2012, Blaine et al. 2015, and Sardana et al. 2016, median zip-code level income was used because the questionnaire did not collect data on household income. Following multiple examples in the literature, two wage rates were used (0 and 0.33) (Knoch & Lupi 2012; Knoch & Lupi 2013; Hussain et al. 2016; Sardana et al. 2016). Wage estimates were calculated by dividing median

household income for the respondent's zip code by a 2,000-hour work year (Sardana et al. 2016). Round-trip travel time was then calculated using the following formula:

$$\text{Travel time} = [(O+0.25) \times 2]/45 \quad \text{Eq(1)}$$

Where O is the one-way travel distance reported by the respondent and 45 is the average travel speed in miles per hour. A value of 0.25 was added to this one-way distance to account for those who reported zero for miles traveled. The time cost for the 0.33 wage rate assumption was then calculated using the following formula:

$$\text{Time cost} = T \times W \times 0.33 \quad \text{Eq(2)}$$

Where T is the round-trip travel time, W is the individual's hourly wage, and 0.33 is the wage rate. The sum of this time cost value and the travel cost resulted in a total estimate of travel cost with the 0.33 wage rate assumption.

Other covariates, as described in Table 1, considered for the model include party size, WMA substitute, and West Regions dummy variable. Party size included the average number of adults and children that usually accompanied the respondent on a typical WMA trip, plus the respondent themselves (Sardana et al. 2016; Mingie et al. 2019). Substitute WMA accounted for if the respondent indicated they would have visited another WMA for the same activity had the WMA they visited been unavailable. As discussed by Mingie et al. (2019), use of substitute variables in travel cost modeling varies due to data and travel cost estimate limitations, and many studies have failed to account for substitutes at all. Because of the unique offerings of WMAs, the binary variable served as an estimate of substitute site availability. The West Regions dummy variable accounted for the fact that more Tennessee WMAs are located in TWRA management regions 1 and 2 and for differences in amenities, as western Tennessee offers more opportunities for migratory bird hunting and community fishing lakes. Blaine et al. (2015) suggests that

income, though also used to estimate travel costs, should be considered on its own in a travel cost model because a higher income means an individual may have more opportunities for visiting a recreation site. Median household income for respondent zip-code was used as a proxy for income in this model.

Following previous travel cost estimation studies, sociodemographic variables of age and education level were included to account for the differences among respondents in individual tastes and preferences. Also included was distance to one of eight metro regions in Tennessee. This variable serves as an indicator of proximity to population centers, which has been included in previous studies (Hussain et al. 2016; Mingie et al 2019). This variable could help account for sites that may see more visitation and a higher demand due to more potential visitors living in proximity to the WMA.

A conceptual model of WMA visitation, similar to a travel cost model of trip demand was developed as shown in Eq(3):

$$Trips = f(C, S, A, D) \qquad \text{Eq(3)}$$

Where C is the travel cost to a WMA, S is a group of variables related to WMA site characteristics, A is a group of variables related to recreation amenities available at a WMA, and D is a group of variables related to a sportsperson's demographic characteristics.

Estimation Technique

Count data models are usually used for travel cost modelling because of the dependent variable being discrete and nonnegative/zero-truncated integers. In these models, a discrete probability distribution is assumed for the dependent variable. Poisson and negative binomial are two common modelling techniques with this type of count data, but because of the variance in trip frequency, the trip data does not meet Poisson modelling's assumption that the data's mean

and variance are approximately equal. The data was also limited to those who had taken at least one trip to a Tennessee WMA in 2018, because those who had not visited any would not have any travel or WMA use information for that year. A zero-truncated negative binomial model was used to account for this limitation in the data and the overdispersion, similar to many other examples in the literature (Englin & Moeltner 2004; Hussain et al. 2016; Mingie et al. 2019).

Economic Values

Using the parameters from regression model of trip demand models, consumer surplus (CS) was then derived. Following Creel and Loomis (1990), per-person per-trip CS was estimated by taking the negative reciprocal of the travel cost coefficient. These estimates for both wage rates are derived using the following formulas:

$$CS_0 = [(O + 0.25) \times 2] \times 0.24 \quad \text{Eq(4)}$$

Where O is the total one-way distance, 0.25 is added to account for those who reported zero miles traveled, and 0.24 is the average operating cost per mile (AAA Association Communication 2019).

$$CS_{33} = CS_0 \times T \times W \times 0.33 \quad \text{Eq(5)}$$

Where CS_0 is the CS assuming no wage rate, T is the total travel time, W is the individual's hourly wage, and 0.33 is the wage rate.

These equations provided a CS estimate for the group visiting the WMA. Per-person, per-trip CS estimates were then derived from these CS values by dividing by the average party size for each primary use type. Confidence intervals (CI) for group and individual CS estimates were obtained using the inverse of the CI coefficient from the model.

Price elasticity measurements are a method of determining the stability of demand as price changes. This is helpful in in examining the sensitivity of demand in relation to travel cost.

Table 1. Definitions and descriptive statistics used in modeling demand for Tennessee WMAs in 2018 (n = 3,876).

Variable	Definition	Mean	SD
Trips	Number of trips taken in 2018 to a Tennessee WMA	7.14	11.25
Travel Costs ($) - no wage	Travel costs ($) assuming no opportunity cost of time	31.27	45.23
Travel Costs ($) - 0.33 wage	Travel costs ($) assuming 0.33 wage rate opportunity cost of time	58.11	85.67
Fishing	1 = primary purpose for WMA visit was fishing, 0 = otherwise	0.16	0.37
Fishing x TC – no wage	Interaction term of Fishing and Travel Cost ($) – no wage to test for differences among purposes for visiting	4.99	21.46
Fishing x TC – 0.33 wage	Interaction term of Fishing and Travel Cost ($) – 0.33 wage to test for differences among purposes for visiting	9.49	41.65
Non-consumptive	1 = primary purpose for WMA visit was a non-consumptive use, 0 = otherwise	0.21	0.41
Non-consumptive x TC – no wage	Interaction term of Non-consumptive and Travel Cost ($) – no wage to test for differences among purposes for visiting	8.12	30.55
Non-consumptive x TC – 0.33 wage	Interaction term of Non-consumptive and Travel Cost ($) – 0.33 wage to test for differences among purposes for visiting	15.18	57.56
Substitute WMA	1 = Respondent indicated they would visit another WMA for their purpose had the WMA they visited been closed or unavailable, 0 = otherwise	0.27	0.44
Income	Median household income of respondent's home zip-code	54403.74	18431.63
Age	Age of respondent	49.99	15.33
Party size	Number of people usually accompanying respondent on a trip to WMA, plus the respondent	3.98	3.06
Education	Education level of respondent (1 = Some high school, 2 = High School diploma, GED, 3 = Some college, 4 = Associate degree, 5 = Bachelor's degree, 6 = Post-graduate degree)	3.40	1.45
Acres	Size of WMA in thousands of acres	42.26	76.35
Camping	1 = WMA allows camping, 0 = otherwise	0.21	0.41

Table 1 Continued.

Variable	Definition	Mean	SD
ATV	1 = WMA allows ATV and OHV riding, 0 = otherwise	0.17	0.38
Boat access	1 = Boating allowed in WMA, 0 = otherwise	0.48	0.50
Wheelchair access blind	1 = WMA offers wheelchair accessible hunting blinds, 0 = otherwise	0.11	0.31
Shooting range	1 = WMA operates a public shooting range, 0 = otherwise	0.26	0.44
West Regions dummy	1 = WMA is located in TWRA management regions 1 or 2, 0 = otherwise	0.32	0.47
Miles to metro	Distance in miles from WMA to nearest Tennessee metro area	35.89	16.83

Price elasticity estimates for count data models can be derived using the following formula (Bowker et al. 2007):

$$\text{Price elasticity} = \beta_1 \times TC \qquad \text{Eq(6)}$$

where β_1 is the travel cost coefficient, and TC is the average travel cost. Price elasticity estimates for a travel cost interaction term can be derived using the following formula (Bowker & Leeworthy 1998):

$$\text{Price elasticity of user group} = (\beta_1 + \beta_t) \times TC_t \qquad \text{Eq(7)}$$

where β_1 is the travel cost coefficient of the reference group, β_t is the travel cost coefficient for the interaction term for the other user group, and TC_t is the average travel cost for the user group.

Chapter 4: Results

Characteristics of Survey Respondents

The survey respondents were 95.66% male and 95.15% were Tennessee residents, in comparison to the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation reporting Tennessee hunters being 95% male and 74% in-state residents (US Department of the Interior 2014). The average respondent was 50 years old and had an average household size of 2.77 with a median household income of $54,403.74. About 62.90% of survey respondents reported hunting as their primary purpose for visiting a WMA, 16.15% reporting fishing as their primary purpose, and 20.95% reported a non-consumptive purpose. Among respondents, 87.8% reported they participated in any hunting or trapping inside or outside of WMAs in Tennessee.

Visitation Demand Dataset

Following the practice in non-market valuation studies (Englin & Moeltner 2004; Mingie et al. 2019), multiple WMA visits by an individual respondent were treated as individual responses. As is common in travel cost modeling to remove outliers (Sardana et al. 2016; Chapagain et al. 2021), 152 responses with excessively high visits (over 100) were dropped to avoid outliers and responses from likely non-recreationists, such as hunting or fishing guides, or other service providers. A one-way travel distance of 0.25 miles was added to each observation to account for those who reported a distance traveled of zero. Party size was calculated using the reported number of adults and children who usually accompanied an individual on trips, plus the one for the respondent themselves. The resulting dataset of WMA visitation (n = 3,876) was then used to model Tennessee WMA demand and economic valuation.

Results showed an average of 7.14 trips were taken by respondents, with an average party size of 3.98. Respondents reported traveling an average of 130.31 miles round-trip to visit

Tennessee WMAs. About 32% of visitation took place in TWRA Region 1, 21% in Region 2, 28% in Region 3, and 19% in Region 4.

Travel Cost Model Results

Regression estimates from travel cost models are presented in Table 2. Coefficients on independent variables are shown for alternative models based on varying opportunity cost of time assumed. The log of alpha value being greater than zero confirms the presence of overdispersion in the data, showing the truncated negative binomial model is a better fit than the Poisson. A large chi-square statistic value also confirms the use of this model, and a test of interactions shows no multicollinearity issues. Travel cost had a negative and significant influence on demand for trips in each model. This indicates demand for Tennessee WMA visitation decreases with the increase in cost of travel from respondent residence to a WMA.

Respondents who visited with a larger party size reported more visits to WMAs. Annual trips to a WMA were higher among younger respondents compared to their older counterparts. Annual trips were also higher among those with a lower education level. Respondents who would consider visiting another WMA if the site they visited did not exist or were closed were likely to report fewer visits than their counterparts. Those who visited a WMA with the primary purpose of fishing or a non-consumptive use visited less often than those who visited to hunt. A larger WMA was likely to see more visits compared to a WMA with less acreage. A WMA with amenities for boat access and those with wheelchair accessible blinds were also visited more than those without these amenities, and camping being allowed in a WMA resulted in that site having less visitation.

Table 2. Results from zero-truncated negative binomial regression of WMA-trip demand based on alternative wage rate assumptions (n = 3,876).

	No wage model		One-third wage model	
Independent Variable	Coef.	P-value	Coef.	P-value
Travel Costs ($) - no wage	-0.0063	<0.001	---	---
Travel Costs ($) - 0.33 wage	---	---	-0.0030	<0.001
Fishing	-0.1835	0.040	-0.1726	0.053
Fishing x TC	-0.0078	<0.001	-0.0045	<0.001
Non-consumptive	-0.7635	<0.001	-0.7447	<0.001
Non-consumptive x TC	-0.0054	<0.001	-0.0034	<0.001
Substitute WMA	-0.2806	<0.001	-0.2830	<0.001
Income	0.0000	0.614	0.0000	0.137
Age	-0.0049	0.008	-0.0050	0.007
Party size	0.0354	<0.001	0.0351	<0.001
Education	-0.0736	<0.001	-0.0783	<0.001
Acres	0.0037	<0.001	0.0038	<0.001
Camping	-0.2648	0.016	-0.2627	0.018
ATV	-0.0336	0.697	-0.0290	0.738
Boat access	0.2118	<0.001	0.2186	<0.001
Wheelchair access blind	0.1661	0.070	0.1592	0.084
Shooting range	-0.0348	0.632	-0.0480	0.512
West Regions dummy	-0.0525	0.422	-0.0488	0.458
Miles to metro	-0.0029	0.114	-0.0028	0.122

Individual Consumer Surplus and Price Elasticity

Per trip CS estimates for the models based on varying wage rate assumptions are presented in Table 3. CS estimates were higher when a higher wage rate was assumed for opportunity cost of time. CS is highest for respondents whose primary purpose for their visit was hunting, which was $43.21 when no opportunity cost of time is assumed and $92.54 when 0.33 of wage rate is assumed in travel cost. Respondents with a primary purpose of fishing or a non-consumptive use were lower, with CS values for anglers being $19.02 with no wage rate and $36.10 with wage rate, and non-consumptive users having a CS of $16.66 with no wage assumption and $30.90 with wage rate.

Aggregate CS estimates were calculated by determining the average number of visits and average party size for each user group. This was then multiplied by the per person trip CS, the estimated 140,000 annual visitors to Tennessee WMAs (Poudyal & Watkins 2019), and the percentage of visits made up by each user group. The aggregate CS for hunters was $116.18 million with no opportunity cost of time and $248.79 million with the wage rate assumption. For the same opportunity cost of time assumptions, the aggregate CS for the fishing user group was $10.08 million and $19.13 million, and for non-consumptive users was $10.49 million and $19.46 million, respectively. Aggregate estimates for non-consumptive users was higher than that of the fishing group because the former's party size was larger.

Price elasticity estimates varied from -0.47 to -0.18 for no wage rate, and -0.48 to -0.15 for the 0.33 wage rate assumption (Table 4). Mingie et al. (2019) found a price elasticity of -.24 for a one-fourth wage rate assumption of Georgia public land big game hunters. My results are similar to this, though hunters in both wage assumptions were the most inelastic. Under the 0.33 wage rate, hunters had a price elasticity of -0.16, meaning a 10% increase in travel cost for this

Table 3. Per-trip per-person consumer surplus estimates ($) from travel cost modeling results based on alternative wage-rate specifications (95% confidence intervals).

Wage rate	Hunt	Fish	Non-consumptive
0	$43.21	$19.02	$16.66
	($36.10, $53.82)	($14.19, $28.85)	($12.43, $25.26)
0.33	$92.54	$36.10	$30.90
	($75.89, $118.56)	($27.17, $53.79)	($23.25, $46.07)

Table 4. Price elasticity estimates from the travel cost model based on alternative wage-rate assumptions.

Wage rate	Hunt	Fish	Non-consumptive
0	-0.18	-0.43	-0.47
0.33	-0.16	-0.43	-0.48

group would result in a 1.6% decrease in visitation. In comparison, respondent's whose primary purpose was fishing had a price elasticity of -0.43 which would result in a 4.3% decrease in visits for the same 10% travel cost increase.

Chapter 5: Discussion

Travel costs having an inverse relationship with trip demand is consistent with previously reported findings (Englin & Moeltner 2004; Sardana et al 2016; Mingie et al. 2019) and suggest the demand for WMA visits decrease with increase in cost of travel. Results from this study suggest sportspersons in Tennessee enjoy a significant net benefit from visiting WMAs for recreation activities. Per-trip value of recreation benefit or consumer surpluses associated with WMA access were highest among respondents who reported hunting as their primary purpose for visiting, with a CS of $43.21 for no wage rate assumption and $92.54 for a 0.33 opportunity cost of time. This is in line with previous findings on CS experienced by public land hunters, such as $235.74 for Michigan ruffed grouse hunters (Knoche & Lupi 2013), $82.92 for Michigan firearm deer hunters, and $88.71 for Michigan archery deer hunters (Knoche & Lupi 2012), each at a 0.33 wage rate. Using a meta-analysis, Rosenberger and Loomis (2001) found an average CS of $43.17 for big game hunting in the United States.

This model estimates CS for anglers at $19.02 for no wage rate assumption and $36.10 for 0.33 wage rate. This is lower than Hwang et al. (2021) who found a CS of $56.68 for black crappie fishing trips in Florida with a 0.33 wage rate model, but more similar to Rosenberger and Loomis (2001) who reported an average CS of $35.89 in a meta analysis of US recreation valuation studies. Non-consumptive WMA users in the model saw a CS of $16.66 for no wage rate and $30.90 for 0.33 wage rate. This is similar to previous results in the literature. Joshi et al. (2017) found a CS of $24.71 for general recreation trips to Georgia state parks at a 0.25 wage rate and Sardana et al. (2007) found CS values at US national forests to be between $49.73 and $85.76 at a 0.33 wage rate depending on the site use type. In the meta analysis by Rosenberger and Loomis (2001), the average CS for general recreation trips was $24.26.

Aggregation of individual level benefit to the population of WMA users in the state shows the total annual economic value of WMA access is $136.75 million when no opportunity cost of time is considered in travel cost and $287.39 million when 0.33 of wage is considered as opportunity cost of time involved in travel cost. Considering the limitation of the study that estimated total visitation to WMAs (Poudyal & Watkins 2019), aggregated value of benefit presented here could be conservative estimates of the economic value of recreation benefit to WMA users in Tennessee. TWRA manages over 1.59 million acres of WMAs and public hunting areas, suggesting the approximate annual value of recreation access to WMA users is $85.88 per-acre assuming no opportunity cost of time and $180.48 per-acre assuming 0.33 of the wage rate is considered in opportunity cost of time. Respondents who used these areas for hunting accounted for a majority of the annual economic value, with an annual CS of $116.18 million and $248.79 million for no wage rate and 0.33, respectively. These values are comparatively higher than the economic values enjoyed by anglers and non-consumptive users, with an annual CS for anglers of $10.08 million and $19.13 million and similar annual CS for non-consumptive users of $10.49 million and $19.46 million for no wage opportunity cost and 0.33 wage rate, respectively.

Results also indicated the price responsiveness of demand for WMA visitation was different among user groups. In other words, different user groups may respond differently in adjusting their use behavior in response to change in cost of travel. The hunting user group had a more inelastic demand than fishing and non-consumptive user groups for both wage rate assumptions. For example, a $10 increase in travel costs under the 0.33 wage rate assumption for the hunting user group would result in the average number of annual trips decreasing by only 0.2, from 8.3 days to 8.1 days. In comparison, the fishing user group would reduce their average

number of visits by 0.5, from 6.3 to 5.8 days, for the same $10 travel cost increase. This shows that the hunting user group is less sensitive to change in price or the cost of travel to WMA site. This is likely because hunters have fewer substitutes for land to participate in their chosen activity than other user groups. While most public lands allow hiking and wildlife watching, and most rivers and public lakes allow fishing, few public areas other than WMAs allow hunting. This is particularly relevant for hunters who do not own land, cannot afford to lease, or want particular hunting experiences (e.g., duck blinds in WMAs). WMAs are one of the few places these hunters have available for use, thus even as price changes they will still visit.

Mingie et al. (2019) found an aggregate CS of $26 million for Georgia public land hunters. Knoch and Lupi (2012) reported a CS of $80.61 million for Michigan hunters using public land each season. As previously discussed, WMAs are a unique public land type and thus likely attract users unique from previously studied land types. WMAs provide hunting access as well as amenities for a variety of other outdoor activities. Tennessee Wildlife Resources Agency manages over 150 WMAs throughout the state, whereas Mississippi Department of Wildlife, Fisheries, and Parks manages just 50 WMAs. Hussain et al. (2016) reported a larger travel cost coefficient and thus a smaller CS for hunters visiting WMAs in Mississippi. Tennessee having such a large variety of WMAs in their spatial dispersion across the state and the amenities they offer may influence how visitors value their use and specific amenities.

In addition to travel cost, demand for WMA visits appears to be affected by the demographics of the sportsperson and the characteristics of WMAs. The positive effect of WMA acreage suggests a WMA of bigger size may be more desirable than smaller ones which is also consistent with other findings in the literature that have indicated public land users prefer larger areas (Hussain et al. 2016; Birdsong 2019). A similar observation on boating access suggests

WMAs that provide boating opportunities may have higher demand for visitation, indicating it is a desirable amenity for respondents. The observed positive effect of party size on trip demand suggests respondents that traveled in larger groups tended to visit more often. This differs from previous studies that have found larger party sizes to have a negative influence on annual trips (Bowker et al. 2007; Sardana et al. 2007; Chapagain et al. 2021). However, the effect of party size on trips may depend on the nature of the recreation activity involved. For example, compared to non-consumptive activities, such as picnicking, camping, etc., hunting may be more suitable for smaller party sizes. Furthermore, negative effects of education and age suggested sportspersons who are more educated and older tend to take fewer trips to WMA. This is consistent with the previous findings (Bowker et al. 2007) and Mingie et al. (2019), who reported older individuals and those with higher incomes took fewer recreation trips, as well as Chapagain et al. (2021), who found similar results surrounding age and wildlife viewing trips. Hussain et al. (2016) reported conflicting results with older WMA users visiting more often in Alabama, though higher income still resulted in fewer trips.

A variable indicating respondents would visit another WMA should the one they visited not be available had a negative influence on the model. This suggests respondents who have no substitute WMA, or are unwilling to substitute their site, have a higher demand for the site. As it is important to control for substitutes in a typical demand model, this variable was included to account for whether a visitor would consider visiting other similar sites. While public lands like WMAs may not be similar to private lands, it is possible those who choose to recreate on WMAs may find recreation experience between WMA sites to be a reasonable substitute of each other.

Chapter 6: Conclusion and Implications

Quantifying the demand for and economic value of public land for outdoor recreation can inform and provide support for management and policy decisions. This study can help us to better understand how wildlife management areas, which conserve wildlife and provide space and amenities for a variety of outdoor recreation activities, are valued by their users. Previous research has demonstrated that different user groups may value sites differently.

Findings from this study confirm that sportspersons place significant value on access to wildlife management areas for recreation. The access values presented in this study represent the potential welfare loss WMA users may experience if the WMAs are no longer available for recreational access. The estimates of net benefit of access can be used to characterize the public value of wildlife management areas and also to use in benefit-cost analysis of new investment in WMA management. As new acquisition of land for conservation purpose often face resistance from locals, showing the economic benefit of recreational access may help demonstrate its significance to local user communities and secure support for WMA management.

Furthermore, evidence from this study suggests the economic value of access to WMAs varies among user groups, as those taking trips for consumptive activities (hunting, fishing) place higher value than those visiting for non-consumptive activities (hiking, biking, etc.). This implies that not all visitors derive the same welfare from the use of WMAs. In other words, the welfare burden of potential closure of WMAs may be relatively higher on consumptive recreationists. The activity-specific estimates of per-trip economic value of access will be useful to managers and practitioners interested in precise estimates of the value of ecosystem services provided by public lands.

Public visitation to public lands including WMAs can positively impact local, state, and federal economies as well as support for conservation efforts (Poudyal et al. 2020). Maintaining or increasing visitation is important to management agencies for these reasons and to support their mission of conserving fish and wildlife, their habitats, and providing for public use and enjoyment. These results can help support this mission along with informing management and policy decisions. Tennessee WMAs are clearly valued highly by hunters, and the economic value placed on these areas by other users is significant as well. Because of their focus on wildlife habitat protection, these areas are especially popular among hunters and are often marketed by agencies more heavily towards this group of users, which could help explain the higher demand by hunters. Hunting also often requires more space and less crowding than fishing or non-consumptive uses, thus public land is important to hunters who may not have access to private land to hunt on.

As revealed by the demand elasticity of price estimated in this study, WMA visitation may be sensitive to the cost of travel of visitors. When aggregate consumer surplus values are considered, a seemingly small increase (say $10) in travel cost, which could potentially be caused by an increase in license, entrance, or parking fees, could have a significant impact. Across all user groups, this hypothetical $10 increase in travel costs would result in a $46.79-$54.35 million annual loss in economic welfare for Tennessee WMA users. Policy makers should consider this potential reduction in visitor welfare while considering changes in costs and fees for users.

Respondents reported larger group sizes when visiting than some previous studies, and larger groups visited more often, which is also unique from these other studies (Hussain et al. 2016; Birdsong 2019). This could present an opportunity for stakeholders to provide more group-

friendly events or amenities to participate in outdoor recreation as a group. One popular hunting activity at Tennessee WMAs is waterfowl hunting. In Tennessee, many WMAs offer an annual lottery system for blinds to hunt waterfowl. These lottery events, as well as the hunting itself, are popular group activities. However, non-consumptive users actually had the largest group size, with an average group consisting of 5.13 visitors. Providing amenities for group activities such as hiking, biking, wildlife and bird watching, or camping could be important to visitors.

While this study provides new information on how users value WMAs and their amenities, these results have limitations. The first limitation lies in the sampling population of TWRA license holders, which excluded non-consumptive, non-impacting users, such as hikers and wildlife watchers that do not need a license to access WMA. As a result, aggregate benefit presented in this thesis represent a conservative estimate of the total economic value of recreation access to WMA users in Tennessee. In addition, wildlife management areas vary widely by the state they are located in and by the region's resources, as well as the managing agency's goals and strategies. Culture also varies widely by location, and what Tennessee WMA visitors value may not be applicable to other states or regions.

Demand can also change over time, especially when faced with extreme events, a recent example being the Coronavirus pandemic. During lockdowns related to the pandemic, many states saw dramatic increases in license sales and public land visitation. In 2020, Michigan observed a 67% increase in new license buyers (Brown 2020) and Pennsylvania State Parks saw a 31% increase in visitors compared to 2019 (Sauro 2021). New visitors and new outdoor recreation participants are likely to have their own unique values and preferences. Management agencies can take lessons learned from this experience to be better prepared for future demand and interest shifts. This study provides information on demand of land managed primarily for

wildlife by a variety of users, and future studies could further explore specific amenity preference and values of each user group.

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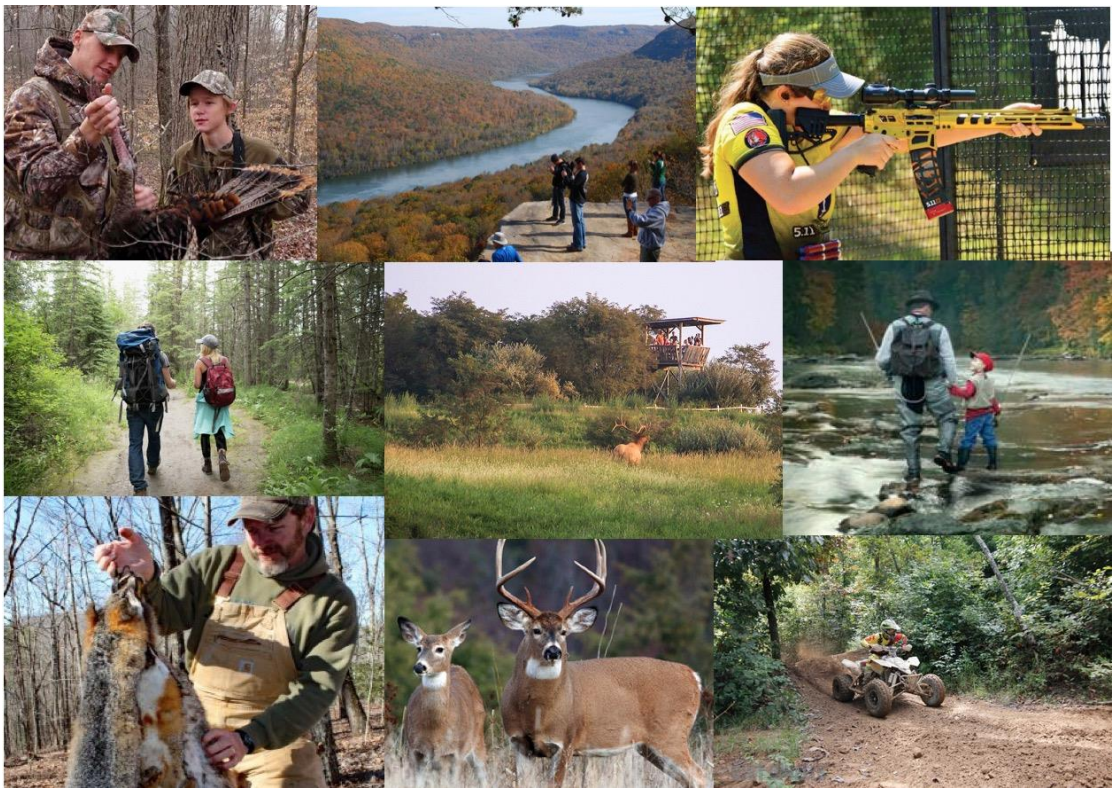
Appendices

Appendix A

Tennessee Wildlife Management Area (WMA) Visitor Survey



Department of Forestry, Wildlife, and Fisheries
University of Tennessee

You are one of the few randomly selected sportsmen and sportswomen in Tennessee to participate in this study about how the public perceive and use Wildlife Management Areas (WMAs). Regardless of your use of WMAs, the answers you provide will help the Tennessee Wildlife Resource Agency (TWRA) in understanding the recreational importance of WMAs and the economic benefits that WMA users bring to rural communities. Your responses will be fully confidential and not shared with anyone.

A study conducted by University of Tennessee with the support of Tennessee Wildlife Resource Agency.

LIST OF TENNESSEE WMAS

REGION 1		53	Tigrett WMA	104	Chickamauga WMA
1	Bailey Fork PHA	54	Tull Bottom WMA	105	Cordell Hull Refuge & WMA
2	Barkley WMA	55	Tumbleweed WMA	106	Cummings Cove WMA
3	Bean Switch Refuge	56	West Sandy WMA	107	Cummins Falls WMA
4	Beason Creek WMA	57	White Lake Refuge	108	Edgar Evans SP & WMA
5	Beech River WMA	58	White Oak WMA	109	Fall Creek Falls SP & WMA
6	Big Sandy WMA	59	Whiteville Lake WMA	110	Fourth Fractional Township
7	Black Bayou Refuge	60	Wolf River SNA & WMA	111	Hampton Crossroads PHA
8	Bogota WMA	61	Land Between the Lakes WMA	112	Harp WMA
9	Buffalo Ridge Refuge	REGION 2		113	Hiwassee Refuge
10	Camden WMA	62	A.E.D.C. WMA	114	Jackson Swamp
11	Carroll Lake	63	Arnold Hollow WMA	115	Keyes-Harrison WMA
12	Chambers Creek WMA	64	Bark Camp Barrens	116	Long Branch PHA
13	Chickasaw SF & WMA	65	Bear Hollow Mountain WMA	117	Luper Mountain
14	Col. Forrest V. Durand WMA	66	Beaver Dam Creek WMA	118	McGlothlin-Largen WMA
15	Cypress Pond Refuge	67	Bedford Lake	119	Mt. Roosevelt WMA
16	Dry Creek WMA	68	Browntown WMA	120	North Chickamauga Creek WMA
17	Eagle Lake Refuge	69	Cedar Hill Swamp	121	Oak Ridge WMA
18	Ernest Rice WMA	70	Cheatham Lake WMA	122	Paint Rock WMA
19	Fort Ridge WMA	71	Cheatham WMA	123	Pea Ridge WMA
20	Garrett Lake	72	Cowan Marsh PHA	124	Pickett SF & WMA
21	Gibson County Lake	73	Dyson Ditch Refuge	125	Prentice Cooper SF & WMA
22	Glen Springs Lake	74	Eagle Creek WMA	126	Skinner Mountain WMA
23	Gooch WMA	75	Flintville WMA	127	South Cherokee NF & WMA
24	Grays Creek WMA	76	Haley-Jaqueth WMA	128	Standing Stone SF & WMA
25	Harmon Creek WMA	77	Happy Hollow WMA	129	Tellico Lake WMA
26	Harts Mill	78	Haynes Bottom WMA	130	The Boils WMA
27	Herb Parsons Lake	79	Headwaters WMA	131	Three Bend Refuge
28	Hop-in Refuge	80	Hick Hill WMA	132	Watts Bar WMA
29	Horns Bluff Refuge	81	Laurel Hill WMA	133	Wildcat Rock Recreation Area
30	Humboldt Hatchery	82	Lock 5 Refuge	134	Whites Creek PHA
31	Indian Creek Watershed Lake	83	Maple Springs	135	William L. Davenport Refuge
32	Jarrell Switch Refuge	84	Mingo Swamp	136	Yuchi Refuge
33	John Tully WMA	85	MTSU WMA	REGION 4	
34	Lake Graham SFA	86	Normandy WMA	137	Big South Fork N.R.R.A.
35	Lake Lauderdale Refuge	87	Old Hickory WMA	138	Big Springs PHA
36	Lick Creek WMA	88	Owl Hollow Mill WMA	139	Buffalo Springs WMA
37	Maness Swamp Refuge	89	Pardue Pond Refuge	140	Chuck Swan WMA & SF
38	Meeman-Shelby Forest WMA	90	Percy Priest WMA	141	Cove Creek WMA
39	Moss Island	91	Shady Park PHA	142	Foothills WMA
40	Natchez Trace SF & WMA	92	Shelton Ferry WMA	143	Forks of the River WMA
41	New Hope WMA	93	Tie Camp WMA	144	Fort Loudoun WMA
42	Oak Dain PHA	94	Williamsport WMA	145	Henderson Island Refuge
43	Obion River WMA	95	Yanahli WMA	146	Henderson Swamp PHA
44	Parker Branch WMA	REGION 3		147	John Sevier Rifle Range
45	Perry Switch WMA	96	Alpine Mountain	148	Kyker Bottoms WMA
46	Presidents Island WMA	97	Amnicola Refuge	149	Kyles Ford WMA
47	Reelfoot	98	Anderson Pond PHA	150	Lick Creek Bottoms WMA
48	SCS Lake	99	Battle Creek PHA	151	Nolichucky WMA
49	South Fork Waterfowl Refuge	100	Blackburn Fork WMA	152	North Cherokee NF & WMA
50	Spring Creek WMA	101	Bridgestone/Firestone WMA	153	North Cumberland WMA
51	Thorny Cypress WMA	102	Catoosa WMA	154	Rankin Bottom WMA
52	Three Rivers WMA	103	Charlotte Anne Finnell Neal	155	Whites Mill WMA

SECTION A: RECREATION PARTICIPATION AT WMAs IN TENNESSEE

1. **Did you visit any Wildlife Management Areas (WMAs) in Tennessee from January 1-December 31 of 2018?**

_____Yes, go to Q. 3 ____No, continue to Q. 2

2. **Which of the following best describes your reason for answering "No"?**

☐ I usually visit WMAs in Tennessee, but did not visit in 2018, *[go to Q. 3 and answer questions based on your most recent visit].*
☐ I have never visited WMAs in Tennessee, go to Q. 14 in Section B on page 6.
☐ I quit visiting WMAs in Tennessee altogether, go to Q. 14 in Section B on page 6.

3. **Using the WMA names and corresponding numbers provided in the table on page 1, please identify the WMAs you visited in 2018 or the most recent year of your visit, and note how many trips you took to each WMA during the year.** *[A trip is defined as round-trip traveling from your home residence to a WMA for a day or overnight stay].*

WMA # (or name)	**County**	**Distance from your home (miles)**	**Number of trips throughout the year**	**Primary purpose** (e.g. hunting, trapping, hiking)
Example: 102 or Catoosa	*Morgan*	*45 miles*	*5*	*Hunting*

4. **During 2018 (or the most recent year of your visit to WMA), how many days did you participate in the following activities on a WMA?** *(Leave blank for activities that you did not participate)*

Activities	**Days**		**Activities**	**Days**
Hunting	.....		Fishing	.....
Target shooting	.....		Trapping	.....
Hiking	.....		Biking	.....
Bird/wildlife watching	.....		Camping	.....
Canoeing/kayaking	.....		Boating	.....
ATV or OHV riding	.....		Horseback riding	.....
Picnicking	.....		Others_____	.....

5. In addition to those listed previously, did you visit WMAs in Tennessee for any special events such as a birding festival, or sunflower festival?

☐ No

☐ Yes, Please specify the festival name and WMA below:

Special Event 1: ..... WMA: .....

Special Event 1: ..... WMA: .....

6. Based on your visits to WMAs reported in Question #3 , please rate the quality of experience for your primary activity. [Check a box in each row that applies if you visit for different activities throughout the year]

Activities	**Very Dissatisfied**	**Somewhat Dissatisfied**	**Neutral**	**Somewhat Satisfied**	**Very Satisfied**
Hunting	☐	☐	☐	☐	☐
Fishing	☐	☐	☐	☐	☐
Target Shooting	☐	☐	☐	☐	☐
Trapping	☐	☐	☐	☐	☐
Wildlife watching	☐	☐	☐	☐	☐
Horseback riding	☐	☐	☐	☐	☐
Mountain biking	☐	☐	☐	☐	☐
Camping	☐	☐	☐	☐	☐
Hiking	☐	☐	☐	☐	☐
ATV or OHV riding	☐	☐	☐	☐	☐

To better understand how visitors use WMAs in Tennessee, we would like to ask you some questions about your typical trips to WMAs. From among the trips reported in Question #3 above, please consider a typical trip to a WMA in answering the remaining questions.

7. Not counting yourself, how many people usually accompany you during your typical visits to WMAs?

----------Adults ----------Children (below 16)

8. Which of the following best describes how you handled expenses during your typical recent trip to a WMA? (check one)

☐ Shared expenses with other people

☐ Paid only your own personal expenses

☐ Paid for yourself and others → How many people did you pay for including yourself?

____ Total number paid for

9. On one typical trip to WMA in Tennessee, how much do you spend for the following?
[Include the amount that you spent for all persons for whom you were financially responsible (e.g. children, spouse etc.)]
If you did not have expenses, write "0."

ITEM	SPENDING/DAY
Food & Beverages:	
Meals (Food & Drinks) at Restaurants (including tips)	$_____
Food & Drinks Purchased at Convenience/Special Food Stores	$_____
Food Purchased at a Grocery Store or Supermarket	$_____
Transportation to and from the WMA:	
Gasoline & Oil	$_____
Repair/Service for Automobile, Truck, SUV, or Trailer	$_____
Other Transportation (Bicycle, Motorcycle, ATV, etc.)	$_____
Other Transportation Costs (Please specify):_____	$_____
Activity Expenses	
Fishing Supplies	$_____
Hunting Supplies	$_____
Fishing/Hunting Fees or Licenses	$_____
Other Types of Equipment Rentals	$_____
Lodging:	
Hotel or Motel	$_____
Bed & Breakfast or Cabin	$_____
Public or Private Campground for RV, Tent, Camper, etc.	$_____
Rental Home, Cottage, or Camper	$_____
Other Expenses:	
Entertainment (Museums, Amusement, etc.)	$_____
Retail Goods Other than Groceries (General Merchandise)	$_____
Horseback Riding	$_____
Camping Supplies	$_____
Guide/Outfitter or Tour Fees	$_____
Other Expenses (please specify):_____	$_____

10. Considering all your expenses in a typical trip to WMA, about what percentage (%) of your spending takes place in the county where the WMA is located?

☐ Almost all
☐ Approximately ……Percentage (%)

11. If the WMAs in Tennessee you visited did not exist or were closed to the public, which of the following best describes how that would have affected you?

- ☐ I would have gone to a different WMA in Tennessee for the same activity
- ☐ I would have found a non-WMA location in Tennessee for the same activity
- ☐ I would have found a different outdoor activity to enjoy in Tennessee at that time
- ☐ I would have travelled outside of Tennessee for the same activity
- ☐ I would have stayed home or found a different non-outdoor activity to do
- ☐ Other (please specify) .....

12. Because public lands such as WMAs are used by a variety of users, visitors may experience positive as well as negative experiences from interactions with other groups. How does your encounter with other users of the following groups add to OR take away from your recreation satisfaction at WMAs? [check one box for each row]

Visitor Groups	Take away from my satisfaction	No effect	Add to my satisfaction
Hunters	☐	☐	☐
Anglers	☐	☐	☐
Hikers	☐	☐	☐
Trappers	☐	☐	☐
ATV Riders	☐	☐	☐
Wildlife watchers	☐	☐	☐
Horseback riders	☐	☐	☐
Mountain bikers	☐	☐	☐
Campers	☐	☐	☐
Target Shooters	☐	☐	☐
Boaters	☐	☐	☐

13. If you indicated above that any user groups take away from your satisfaction, which of the following describe the way they impact your experience? (check all that apply)

- ☐ Disturbing wildlife or fish
- ☐ Littering
- ☐ Making noise - people
- ☐ Making noise - motorized transport (e.g. motor boats, ATVs)
- ☐ Failing to be aware of others
- ☐ Other (Please specify: .....
- ☐ Being rude or discourteous
- ☐ Passing too closely
- ☐ Not yielding right of way
- ☐ Creating safety or security risk (e.g. injury, death)
- ☐ Damaging trails, roads etc.

SECTION B: PERCEPTION AND INTENDED USE OF WMAs IN TENNESSEE

14. How likely are you to visit a WMA in Tennessee for your outdoor recreation purpose in the future?

☐ Not likely at all	☐ Somewhat unlikely	☐ Neutral	☐ Somewhat likely	☐ Certainly likely

15. For a variety of reasons, some people may not be able to visit WMAs at all or as often as they like. Which of the following keeps you from visiting WMAs in Tennessee? [Check all that apply]

☐	I do not know where or how to access WMAs
☐	I am able to access private property for outdoor recreation
☐	I lease private land for hunting and other activities
☐	I feel unsafe recreating on public lands
☐	The quality of experience for my activities on WMAs is not as good as other places
☐	There are no WMAs near my home
☐	Friends and family do not like to go to WMAs
☐	WMAs have too many regulations and restrictions
☐	WMAs are too crowded
☐	I feel I have been able to visit WMAs as often as I want
☐	I go to WMAs in other states

16. How likely are you to visit more often or begin visiting WMAs if the following conditions were met or improved?[check one box in each row].

Conditions	**Highly unlikely**	**Somewhat unlikely**	**Neutral**	**Somewhat likely**	**Highly likely**
Clear information on WMA laws	☐	☐	☐	☐	☐
Uniform WMA regulations across the state	☐	☐	☐	☐	☐
Separation of hunters from other users	☐	☐	☐	☐	☐
Hunting that is not crowded	☐	☐	☐	☐	☐
Improved trail conditions	☐	☐	☐	☐	☐
Availability of WMAs near my home	☐	☐	☐	☐	☐
Good conditions of on-site roads and trails	☐	☐	☐	☐	☐
Good chance to harvest lots of big game or fish	☐	☐	☐	☐	☐

Conditions	Highly unlikely	Somewhat unlikely	Neutral	Somewhat likely	Highly likely
Availability of special use fishing ponds (e.g. kids pond, catch-&-release ponds)	☐	☐	☐	☐	☐
Good chance to harvest trophy game or fish	☐	☐	☐	☐	☐
Quality Deer Management (QDM) practices	☐	☐	☐	☐	☐
No safety concern	☐	☐	☐	☐	☐
ATV or off-road vehicles allowed	☐	☐	☐	☐	☐
ATV or off-road vehicles not allowed	☐	☐	☐	☐	☐
Primitive camping (no power, no water) available	☐	☐	☐	☐	☐
Baiting practices allowed	☐	☐	☐	☐	☐
Developed camping (power, running water) available	☐	☐	☐	☐	☐
Other.....	☐	☐	☐	☐	☐

SECTION C: DEMOGRAPHICS

Questions below will help use ensure respondents of this survey are representative of the broader population of WMA users in Tennessee. Your answers will be kept **strictly confidential**.

17. What is your gender? _____ Male _____ Female

18. What is your age? _____ years

19. Do you trap or hunt inside or outside WMAs in Tennessee?

_____No, go to Q.21 _____Yes

20. Which of the following types of game you hunt or trap (check all that apply).

___Big game ___Migratory game birds

___Small game ___Furbearers

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

_____ Some high school _____ Associate degree

_____ High School diploma, GED _____ Bachelor's degree

_____ Some college _____ Post-graduate degree

22. How many people live in your household?

_____ # total _____ # under 16 years

23. Are you a member of any of the following association or groups?

_____Tennessee Wildlife Federation
_____National Rifle Association
_____National Wild Turkey Federation
_____Tennessee Trail Association
_____The Nature Conservancy
_____Ducks Unlimited
_____Trout Unlimited
_____The Sierra Club
_____The Audubon Society
_____Local hunting or fishing club

Thank you for completing this survey!

Please use the space provided below for any additional comments about WMAs in Tennessee

If you have any additional questions, please contact

Dr. Neelam Poudyal – 865.974.8771; npoudyal@utk.edu

Please return this survey in the enclosed postage-paid envelope. If you have misplaced the envelope, send the completed survey to:

Dr. Neelam C. Poudyal ID
Associate Professor
Department of Forestry, Wildlife, & Fisheries
University of Tennessee
274 Ellington Plant Science Bldg.,
Knoxville, TN 37996

Appendix B

```
. tnbreg Q3_Trips drivingcost  FishDummy FishDummyDrivecost    NonConsumptiveDummy NonConsumptiveDummyDrivecost  MedianHousehold
>  Age partysize Q21_Education AcresK  CAMPING ATV BoatAccess WHEELCHAIRBLIND  SHOOTINGRANGE DiffWMADummy Region1and2Dummy  DIST
> ANCETOMETROmiles , ll(0)  dispersion(mean)

Fitting truncated Poisson model:

Iteration 0:   log likelihood = -19967.254
Iteration 1:   log likelihood = -19885.245
Iteration 2:   log likelihood = -19884.003
Iteration 3:   log likelihood = -19884.002

Fitting constant-only model:

Iteration 0:   log likelihood =  -10312.04
Iteration 1:   log likelihood = -9937.4677
Iteration 2:   log likelihood = -9897.7908
Iteration 3:   log likelihood = -9891.4914
Iteration 4:   log likelihood = -9891.1437
Iteration 5:   log likelihood = -9891.1428

Fitting full model:

Iteration 0:   log likelihood = -9791.8511
Iteration 1:   log likelihood = -9666.3647
Iteration 2:   log likelihood = -9642.9532
Iteration 3:   log likelihood = -9642.5244
Iteration 4:   log likelihood = -9642.5236

Truncated negative binomial regression          Number of obs     =      3,526
Truncation point: 0                             LR chi2(18)       =     497.24
Dispersion     = mean                           Prob > chi2       =     0.0000
Log likelihood = -9642.5236                     Pseudo R2         =     0.0251
```

Q3_Trips	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
drivingcost	-.0063227	.0006359	-9.94	0.000	-.0075691	-.0050763
FishDummy	-.1835404	.0894543	-2.05	0.040	-.3588676	-.0082132
FishDummyDrivecost	-.0078451	.0018259	-4.30	0.000	-.0114238	-.0042665
NonConsumptiveDummy	-.7635216	.0815801	-9.36	0.000	-.9234156	-.6036276
NonConsumptiveDummyDrivecost	-.005377	.0013968	-3.85	0.000	-.0081146	-.0026394
MedianHousehold	8.41e-07	1.67e-06	0.50	0.614	-2.42e-06	4.10e-06
Age	-.0048912	.0018565	-2.63	0.008	-.00853	-.0012525
partysize	.0354328	.0097581	3.63	0.000	.0163072	.0545584
Q21_Education	-.0736086	.0199094	-3.70	0.000	-.1126303	-.0345869
AcresK	.0037415	.0005786	6.47	0.000	.0026075	.0048755
CAMPING	-.2648017	.1099721	-2.41	0.016	-.4803431	-.0492603
ATV	-.0335706	.0862387	-0.39	0.697	-.2025954	.1354542
BoatAccess	.2118423	.0586786	3.61	0.000	.0968343	.3268502
WHEELCHAIRBLIND	.1661422	.0916676	1.81	0.070	-.013523	.3458073
SHOOTINGRANGE	-.0348224	.0727499	-0.48	0.632	-.1774096	.1077649
DiffWMADummy	-.2805985	.0597993	-4.69	0.000	-.397803	-.163394
Region1and2Dummy	-.0524627	.0652893	-0.80	0.422	-.1804273	.0755019
DISTANCETOMETROmiles	-.0028608	.0018096	-1.58	0.114	-.0064075	.0006859
_cons	2.041674	.1789595	11.41	0.000	1.69092	2.392428
/lnalpha	1.074947	.0830011			.9122676	1.237626
alpha	2.929837	.2431798			2.489962	3.44742

```
LR test of alpha=0: chibar2(01) = 2.0e+04              Prob >= chibar2 = 0.000
```

Appendix C

```
. tnbreg Q3_Trips TC24c33pct FishDummy FishTC24c33pct NonConsumptiveDummy NonConsumpTC24c33pct MedianHousehold Age partysize
> Q21_Education AcresK CAMPING ATV BoatAccess WHEELCHAIRBLIND SHOOTINGRANGE DiffWMADummy Region1and2Dummy DISTANCETOMETROmil
> es , ll(0) dispersion(mean)

Fitting truncated Poisson model:

Iteration 0:   log likelihood = -20076.951
Iteration 1:   log likelihood = -20002.562
Iteration 2:   log likelihood = -20001.457
Iteration 3:   log likelihood = -20001.456

Fitting constant-only model:

Iteration 0:   log likelihood =  -10312.04
Iteration 1:   log likelihood = -9937.4677
Iteration 2:   log likelihood = -9897.7908
Iteration 3:   log likelihood = -9891.4914
Iteration 4:   log likelihood = -9891.1437
Iteration 5:   log likelihood = -9891.1428

Fitting full model:

Iteration 0:   log likelihood = -9799.8547
Iteration 1:   log likelihood =  -9673.925
Iteration 2:   log likelihood = -9649.2166
Iteration 3:   log likelihood = -9648.7584
Iteration 4:   log likelihood = -9648.7576

Truncated negative binomial regression          Number of obs     =      3,526
Truncation point: 0                             LR chi2(18)       =     484.77
Dispersion     = mean                           Prob > chi2       =     0.0000
Log likelihood = -9648.7576                     Pseudo R2         =     0.0245
```

Q3_Trips	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
TC24c33pct	-.0029525	.0003306	-8.93	0.000	-.0036003	-.0023046
FishDummy	-.1726345	.0892337	-1.93	0.053	-.3475293	.0022603
FishTC24c33pct	-.0045133	.000922	-4.90	0.000	-.0063204	-.0027063
NonConsumptiveDummy	-.7446617	.0816779	-9.12	0.000	-.9047474	-.584576
NonConsumpTC24c33pct	-.0033557	.000729	-4.60	0.000	-.0047844	-.0019269
MedianHousehold	2.52e-06	1.70e-06	1.49	0.137	-8.04e-07	5.85e-06
Age	-.005003	.0018691	-2.68	0.007	-.0086663	-.0013396
partysize	.0351296	.009756	3.60	0.000	.0160082	.0542509
Q21_Education	-.0783037	.0200407	-3.91	0.000	-.1175828	-.0390246
AcresK	.0037715	.0005826	6.47	0.000	.0026297	.0049133
CAMPING	-.2627412	.1108426	-2.37	0.018	-.4799888	-.0454937
ATV	-.0290433	.0867538	-0.33	0.738	-.1990776	.1409909
BoatAccess	.2186014	.0590854	3.70	0.000	.102796	.3344067
WHEELCHAIRBLIND	.1592353	.0921721	1.73	0.084	-.0214186	.3398893
SHOOTINGRANGE	-.04795	.0731506	-0.66	0.512	-.1913225	.0954224
DiffWMADummy	-.2830482	.0601444	-4.71	0.000	-.400929	-.1651673
Region1and2Dummy	-.0487675	.0656612	-0.74	0.458	-.177461	.0799261
DISTANCETOMETROmiles	-.0028179	.0018206	-1.55	0.122	-.0063862	.0007503
_cons	1.940786	.1809453	10.73	0.000	1.58614	2.295432
/lnalpha	1.099669	.0842199			.9346007	1.264737
alpha	3.003171	.2529266			2.546197	3.542159

```
LR test of alpha=0: chibar2(01) = 2.1e+04              Prob >= chibar2 = 0.000
```

Appendix D

```
. sum TC24c33pct if HuntDummy == 1
```

Variable	Obs	Mean	Std. Dev.	Min	Max
TC24c33pct	2,371	52.56162	75.14167	.192083	1032.223

```
. sum TC24c33pct if FishDummy == 1
```

Variable	Obs	Mean	Std. Dev.	Min	Max
TC24c33pct	608	58.1872	88.38787	1.083826	645.0106

```
. sum TC24c33pct if NonConsumptiveDummy == 1
```

Variable	Obs	Mean	Std. Dev.	Min	Max
TC24c33pct	748	75.64725	109.2905	.1746718	797.7547

Appendix E

```
. sum Q3_Trips drivingcost TC24c33pct DiffWMADummy FishDummy FishDummyDrivecost FishTC24c33pct NonConsumptiveDummy NonConsumptiveDummy
> Drivecost NonConsumpTC24c33pct MedianHousehold Age partysize Q21_Education AcresK CAMPING ATV BoatAccess WHEELCHAIRBLIND SHOOTINGRAN
> GE Region1and2Dummy DISTANCETOMETROmiles Q22_Total Q19_TrapHunt
```

Variable	Obs	Mean	Std. Dev.	Min	Max
Q3_Trips	3,876	7.143963	11.24594	1	100
drivingcost	3,727	31.27399	45.22753	.12	480.12
TC24c33pct	3,727	58.11258	85.67456	.1746718	1032.223
DiffWMADummy	3,876	.2665119	.442192	0	1
FishDummy	3,876	.1615067	.3680452	0	1
FishDummyD~t	3,727	4.994537	21.46363	0	336.12
FishTC24c3~t	3,727	9.492304	41.65412	0	645.0106
NonConsump~y	3,876	.2094943	.4070002	0	1
NonConsum~st	3,727	8.115889	30.55226	0	480.12
NonConsum~ct	3,727	15.18222	57.55775	0	797.7547
MedianHous~d	3,876	54403.74	18431.63	17880	150425
Age	3,876	49.98684	15.33233	18	88
partysize	3,776	3.978814	3.062367	1	41
Q21_Educat~n	3,727	3.403273	1.449164	1	6
AcresK	3,855	42.25936	76.34679	.01201	334.707
CAMPING	3,876	.2149123	.4108145	0	1
ATV	3,876	.1692466	.375018	0	1
BoatAccess	3,866	.4826694	.4997642	0	1
WHEELCHAIR~D	3,876	.1070691	.309241	0	1
SHOOTINGRA~E	3,876	.2567079	.4368732	0	1
Region1and~y	3,876	.3196594	.4664048	0	1
DISTANCETO~s	3,876	35.887	16.83448	1	78
Q22_Total	3,732	2.773044	1.246896	1	12
Q19_TrapHunt	3,729	.8779834	.3273489	0	1

Appendix F

```
. sum partysize

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   partysize |      3,776    3.978814    3.062367          1         41

. sum partysize if HuntDummy == 1

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   partysize |      2,379    3.661623    2.324098          1         27

. sum partysize if FishDummy == 1

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   partysize |        608    3.717105    2.331414          1         22

. sum partysize if NonConsumptiveDummy == 1

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   partysize |        789    5.136882     4.76866          1         41
```

Appendix G

```
. sum roundtrip
```

Variable	Obs	Mean	Std. Dev.	Min	Max
roundtrip	3,727	130.3083	188.448	.5	2000.5

Appendix H

```
. tab WMAREGION
```

WMA REGION	Freq.	Percent	Cum.
1	1,239	31.97	31.97
2	818	21.10	53.07
3	1,069	27.58	80.65
4	750	19.35	100.00
Total	3,876	100.00	

Appendix H

```
. test TC24c33pct Region1and2Dummy FishDummy FishTC24c33pct NonConsumptiveDummy NonConsumpTC24c33pct MedianHousehold Age partysize Q21
> _Education AcresK CAMPING ATV BoatAccess WHEELCHAIRBLIND SHOOTINGRANGE DiffWMADummy DISTANCETOMETROmiles

 ( 1)  [Q3_Trips]TC24c33pct = 0
 ( 2)  [Q3_Trips]Region1and2Dummy = 0
 ( 3)  [Q3_Trips]FishDummy = 0
 ( 4)  [Q3_Trips]FishTC24c33pct = 0
 ( 5)  [Q3_Trips]NonConsumptiveDummy = 0
 ( 6)  [Q3_Trips]NonConsumpTC24c33pct = 0
 ( 7)  [Q3_Trips]MedianHousehold = 0
 ( 8)  [Q3_Trips]Age = 0
 ( 9)  [Q3_Trips]partysize = 0
 (10)  [Q3_Trips]Q21_Education = 0
 (11)  [Q3_Trips]AcresK = 0
 (12)  [Q3_Trips]CAMPING = 0
 (13)  [Q3_Trips]ATV = 0
 (14)  [Q3_Trips]BoatAccess = 0
 (15)  [Q3_Trips]WHEELCHAIRBLIND = 0
 (16)  [Q3_Trips]SHOOTINGRANGE = 0
 (17)  [Q3_Trips]DiffWMADummy = 0
 (18)  [Q3_Trips]DISTANCETOMETROmiles = 0

           chi2( 18) =  547.02
         Prob > chi2 =    0.0000
```

Vita

Clara Shattuck is from Portland, Michigan. She graduated from high school in 2014 and went on to attend Grand Valley State University, where she received a Bachelor of Science in Natural Resources Management in 2017. She then attended the University of Tennessee to pursue a Master of Science in Wildlife and Fisheries Science.