# WILDLIFE MANAGEMENT AREAS IN OKLAHOMA: A STUDY OF ECONOMIC IMPORTANCE AND VISITOR SATISFACTION

By

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Abstract: Wildlife Management Areas (WMAs) in Oklahoma are public lands managed by the Oklahoma Department of Wildlife Conservation (ODWC) and are open to the public for hunting, fishing, and other wildlife-related recreational activities. This research was conducted to provide data on the economic and human aspects of WMA visitation, specifically, to analyze the economic importance of and visitor satisfaction with WMAs. To accomplish the study objectives, WMA visitor surveys were administered among resident and non-resident Oklahoma hunting and fishing license and conservation passport holders during the 2020-2021 hunting season. A travel cost model of demand for recreation access to WMAs showed that the net benefit of access to WMAs in the state vary between $15.95-$28.09, depending on the modeling assumptions. Aggregation of individual benefits to the population of WMA users yielded an aggregate net benefit between $42.6-$75.1 million for Oklahoma. A statewide input-output analysis showed that WMA-related spending, directly and indirectly, created a total of 8,341.4 jobs that provided a labor income of $297.3 million and contributed a total of $39.6 million in state and local taxes and $57.1 million in federal taxes in Oklahoma in 2020. Unique county-wide input-output models revealed how WMAs with differing visitation levels can support local economies. Results of the CUB (Covariates in a Uniform and shifted Binomial mixture) model used to analyze visitor satisfaction revealed that hunters and anglers have higher feelings of satisfaction compared to non-consumptive visitors, and WMA visitors are either most uncertain or least satisfied with their feeling of safety and privacy while visiting WMAs. ODWC can use the results of this research while allocating budget funds, determining best management practices, making management decisions, or acquiring new lands for the WMA system. Ultimately, by understanding and meeting visitors' preferences, ODWC aspires to aid in the increase in demand for WMAs, which could lead to an increase in positive economic impacts in the state and local communities.

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# CHAPTER I

## INTRODUCTION

Wildlife in the United States (US) is subject to the Public Trust Doctrine, which declares that certain resources cannot be privately owned (Organ et al. 2012). As a public trust, wildlife is owned by no one and is held in trust by the government for the benefit of present and future generations (Organ et al. 2012). This is the first component of The North American Model of Wildlife Conservation, which sets principles for wildlife management in the US and Canada. Since wildlife is a public trust, the public has the right to access it for hunting, fishing, wildlife-watching, and other wildlife-related activities. Wildlife Management Areas (WMAs) are publicly owned lands that are managed by state government agencies across the US for the benefit of wildlife populations. WMAs are typically opened for the public to participate in hunting, fishing, hiking, camping, wildlife-watching, and a host of other outdoor recreation activities. State wildlife agencies typically consider both science and public input when making management decisions for WMAs (Title 800. Department of Wildlife Conservation; TWRA 2022; DNR 2021).

Like many other southern and Great Plains states, wildlife-based recreation has a strong cultural value in Oklahoma (Manfredo et al. 2017). Hunting and fishing are particularly important to Oklahomans and non-residents who hunt and fish in the state. In 2019, there were an estimated 263,585 deer hunters in Oklahoma (Patra 2019) and more than 686,000 Oklahoma residents held a fishing license (York 2019). The Oklahoma Department of Wildlife Conservation (ODWC) is responsible for managing 82 WMAs across the state of Oklahoma, which are open to public

for hunting, fishing, and other wildlife-related recreation activities (Where to Hunt 2022). ODWC must spend money to acquire, manage, and protect these WMAs, but the economic benefits and contribution provided by WMAs as well as visitor satisfaction with WMAs had yet to be investigated.

When analyzing the economic importance of WMAs, it is important to consider both their non-market and market values, as it widens the scope of potential management and policy applications that can be addressed by the results (Bowker, Bergstrom, and Gill 2007). Questions regarding economic efficiency, cost-benefit analysis, and economic development questions can all be addressed after estimating both the net economic benefits (non-market value) and the economic impacts (market values) (Bowker, Bergstrom, and Gill 2007). Estimating these parameters for WMAs in Oklahoma will provide valuable data on their economic importance to WMA visitors themselves and the state and local economies.

Understanding WMA visitor satisfaction is important for ODWC, as it gives an indication of management practices that are effective and ones that need improvement. Positive visitor satisfaction typically leads to more visits and expenditure, thus, understanding visitor satisfaction can also aid ODWC in understanding WMA visitation levels and economic impacts (Disegna and Osti 2016; Loomis 2000).

This study provides a two-fold contribution for informing WMA management in Oklahoma. First, estimating both the net economic benefit and economic contribution provides valuable economic data for ODWC to consider when allocating budget funds, determining best management practices, making management decisions, or acquiring new lands for the WMA system. Second, understanding WMA visitor satisfaction can help ODWC alter management practices to meet visitors' preferences, which could aid in increasing demand for WMAs,

potentially leading to an increase in positive economic impacts in the state and local communities.

The following thesis provides an estimation of the economic importance of and visitor satisfaction with WMAs in Oklahoma. It is organized as follows: Chapter II estimates the net economic benefit and economic contribution of WMAs, Chapter III analyzes visitor satisfaction with WMAs, and Chapter IV provides a summary of the overall findings.

# CHAPTER II

## ECONOMIC SIGNIFICANCE OF WILDLIFE MANAGEMENT AREAS IN OKLAHOMA

Abstract

The establishment of public recreation lands such as Wildlife Management Areas (WMAs) involves significant costs and efforts in terms of acquisition of land and maintenance of resources and visitor facilities. Given inherent costs, state wildlife agencies like the Oklahoma Department of Wildlife Conservation (ODWC) and other conservation organizations interested in expanding more land into the WMA system may benefit from the information pertaining to the economic valuation and contribution of WMAs. This study analyzed the economic significance of WMAs in Oklahoma by estimating the net economic benefits provided to visitors by accessing WMAs and the economic contribution of WMAs on the state economy. To accomplish the study objectives, WMA visitor surveys were administered among resident and non-resident Oklahoma hunting and fishing license or conservation passport holders during the 2020-2021 hunting season. A travel cost model of demand for recreation access to WMAs showed that the net benefit of access to WMAs in the state vary between $15.95-$28.09, depending on the modeling assumptions. Aggregation of individual benefits to the population of WMA users yielded an aggregate net benefit between $42.6-$75.1 million for Oklahoma. A statewide input-output analysis showed that WMA-related spending, directly and indirectly, created a total of 8,341.4 jobs that provided a labor income of $297.3 million and contributed a total of $39.6 million in state and local taxes and $57.1 million in federal taxes in Oklahoma in 2020. Unique county-wide input-output models revealed how WMAs with differing visitation levels can support local economies. Findings are helpful in demonstrating the public value of WMAs and comparing the cost of WMA management against the benefit to the user community.

*Keywords:* public lands, net economic benefits, economic contribution

## 1. Introduction

State wildlife agencies must spend money to acquire, manage, and protect WMAs. For example, many WMAs in Oklahoma have food plots planted in them to attract certain wildlife species and/or are regularly burned to maintain a habitat type. Other brush control measures like mechanical thinning and brush clearing activities are also taken to increase accessibility and maintain wildlife habitat. While the cost of WMAs in Oklahoma can be quantified, the economic benefit and contribution of them have yet to be explored. Government agencies like the Oklahoma Department of Wildlife Conservation (ODWC) need reliable information regarding the economic benefit and contribution of WMAs to justify investment in land purchases for new WMAs or investments in currently managed WMAs. Considering that conservation areas like WMAs are typically taken off the tax roll of local governments, understanding and demonstrating the economic benefit of recreational access to the user community and estimating economic contribution such as employment, labor income, and tax revenue created by the presence of WMAs may be helpful in alleviating political resistance to land acquisition plans while establishing new WMAs or similar conservation areas (Poudyal, Watkins, and Joshi 2020).

## 2. Economic Benefit and Contribution of WMA Visitation

Market goods and services are those provided by suppliers in exchange for monetary payments (i.e., housing, food, vehicles, etc.), whereas non-market goods and services are those for which a market does not exist (i.e., clean air and water, wilderness, etc.) (Champ, Boyle, and Brown 2017). Economic benefit and economic contributions have distinct meaning in economic literature, as economic benefit refers to the measure of social welfare associated with nonmarket goods and services, but economic contribution refers to the measure of economic activity cycling through a region's existing economy (Watson et al. 2007). For example, economic benefit refers to the monetary value of net benefit a visitor enjoys by having access to a WMA and is typically

estimated by using a stated or revealed preference method (Champ, Boyle, and Brown 2017). Whereas economic contribution is the gross changes in the existing economy of the region surrounding a WMA caused by WMA visitation, which is commonly analyzed through an input-output (IO) model (Watson et al. 2007; Poudyal, Watkins, and Joshi 2020). This study analyzes both the net economic benefit and economic contribution provided by WMAs in Oklahoma, which captures both the non-market and market importance of these public lands.

Since the nature of benefit associated with visiting a WMA is a non-market good, alternative valuation methods must be used to estimate such a value (Bowker, Bergstrom, and Gill 2007). The travel cost method (TCM) is a widely used non-market valuation approach to estimate the net economic benefit, or consumer surplus (CS), of visits to outdoor recreation sites. By modeling the demand for visitation to a recreation site (i.e., WMA), a demand curve showing the relationship between the number of trips taken and the cost of travel is developed (Figure 2.1.) (Borzykowski, Baranzini, and Maradan 2017; Hussain et al. 2016; Bowker, Bergstrom, and Gill 2007). The underlying assumption of this modeling effort is the idea that people take less trips as the travel cost increases (Benson et al. 2013). Graphically, the measure of consumer surplus is often interpreted as visitors' willingness to pay above and beyond their expenditure to access the site; therefore, it would be considered a loss in welfare if the site is closed (Parsons 2017). It should be noted that net economic benefit, consumer surplus, and willingness to pay are terms typically used interchangeably. Previous research has shown that access to Tennessee WMAs for elk hunting opportunities provided a per person CS value of $242 between 2015 and 2017, and hunters valuated the take of an additional deer between $96 and $104 while hunting on WMAs in Mississippi during the 2010-2011 hunting season (Chapagain and Poudyal 2020; Hussain et al. 2016). According to the Recreation Use Values Database, which contains 421 documents of economic recreation valuation studies from 1958 to 2015, the average daily per person CS value for wildlife watching is $64.63 in the US (Rosenberger 2016). Likewise, wildlife-related

nonconsumptive recreation activities like wildlife watching and photography had an annual aggregate CS value between $5.8 billion and $66.4 billion in the US in the 1990s and early 2000s (Zawacki, Marsinko, and Bowker 2000).

Economic contribution in the recreational literature depicts the gross changes in a region's existing economy that can be attributed to recreation visitation, which can be quantified in terms of economic outputs, value-added, labor income contribution, and employee compensation, among others (Watson et al. 2007). Economic impacts are the net changes to the economic base of a region that would not be there if people did not visit the region for recreation (Watson et al. 2007). These can be direct impacts like jobs, income, and taxes directly linked with WMA-related expenditures, indirect impacts coming from businesses nearby such as gas stations, restaurants, and hotels, or induced impacts created by the expenditures of employees of direct or indirect industries within the local economy around the recreational amenity (Frakes 2019; Poudyal, Watkins, and Joshi 2020). Some efforts have been made to understand the economic contributions or impacts of recreational demand in the United States. To this end, Poudyal, Watkins, and Joshi (2020) found that WMAs in Tennessee contributed an estimated 10,520 jobs and $373 million in labor income, $69 million in state and local tax, and $83 million in federal tax when considering direct, indirect, and induced economic impacts (2018 dollars). In Oklahoma, the US Fish and Wildlife Service estimated the economic contributions to local economies for four National Wildlife Refuges (NWR) for the 2017 fiscal year: Little River NWR, Salt Plains NWR, Tishomingo NWR, and Wichita Mountains Wildlife Refuge (Caudill and Carver 2019). Altogether, these refuges contributed a sum of 964 jobs with a total employment income of $27.73 million, a total economic output of $102.11 million, and a sum of 4.3 million recreation visits, with the Wichita Mountains Wildlife Refuge contributing the most in all categories (2018 dollars) (Caudill and Carver 2019). In the Southeastern US, fishing, hunting, and wildlife watching activities collectively contributed $53.9 billion in gross output in 2006 (2006

dollars) (Munn et al. 2010). Wildlife watching alone generated $23.9 billion (in 2006 dollars) in gross output in 2011 in this same region (Poudel, Munn, and Henderson 2017). Since public lands provide a substantial amount of jobs, employment income, and tax revenue at the local, county, state, and federal levels (Bergstrom et al. 1990; Caudill and Carver 2019; Poudyal, Watkins, and Joshi 2020), determining the economic contribution of WMAs can be used to show how they contribute to rural communities and can help justify future ODWC land acquisitions.

My study contributes to existing literature in two unique ways. First, while previous efforts have conducted a statewide or WMA-specific economic contribution analysis, they have not analyzed the difference in economic contribution among WMAs with higher or lower visitation levels. I have categorized WMAs based on the perceived intensity of visitation and conducted separate analyses for representative high, medium, and low visitation WMAs. In addition, I have quantified economic contribution of residents as well as those who can be considered 'tourists', as they make overnight trips for WMA visitation. Second, I have provided a comprehensive economic benefit of WMAs in Oklahoma, which involve individual benefits to WMAs visitors (based on travel-cost model) as well as broader benefits to local economies through employment opportunities, value-added, and taxation. To this end, utilizing a common dataset of WMA trip-related information to estimate the individual and aggregate CS value along with the economic contribution provided by WMA visitation in Oklahoma is a unique characteristic of this study.

## 3. Materials and Methods

### *3.1. Estimating Net Economic Value*

In the TCM, a visitor's willingness to pay (WTP) to visit a recreation site, such as a WMA, reflects demand as they choose a certain site among many available recreational amenities (Haab and McConnell 2002). Since access to WMAs for recreation is characterized by having non-market value, the TCM estimates demand using the cost of travelling to the recreation site as a

price proxy (Haab and McConnell 2002). The TCM is a demand-based model where the number of trips taken to a recreational site is a function of the cost to travel to the site, the availability of substitute sites, and other socio-demographic factors (Parsons 2017):

$$Trips_i = f(Travel\ Cost, Substitutes, Socio - demographics) \quad (2.1)$$

Since the number of trips taken to a WMA is non-zero count data, the demand for WMAs can be appropriately specified by the negative binomial regression model. Specifically, a zero-truncated negative binomial regression model was chosen for this study because respondents who took at least one trip to a WMA were included in the analysis. Based on Equation (2.1) and similar TCM studies (Joshi, Poudyal, and Hodges 2017; Chapagain and Poudyal 2020), the empirical model of demand for trips taken to Oklahoma WMAs in 2020 was specified:

$$Trips_{ik} = f\begin{pmatrix} TC_{ik},\ Sub_{ik}, Age_i,\ Recreate_i, \\ Gender_i, AvgParty_i, Consumptive_i \end{pmatrix} + \mu_{ik} \quad (2.2)$$

Where, $Trips_{ik}$ is the number of trips the $i$th respondent took to k WMAs in 2020, $Sub_{ik}$ is the substitute travel cost, $Age_i$ is the respondent's age, $Recreate_i$ is the number of years the respondent has been recreating in Oklahoma, $Gender_i$ is the respondent's gender, $AvgParty_i$ is the average party size, $Consumptive_i$ is a dummy variable if the respondent was a hunter or angler, or not, and the term $\mu_{ik}$ represents random error. The definitions and descriptive statistics for the variables used in the analyses can be found in Table 2.1.

*3.2. TCM Specification*

Results of zero-truncated negative binomial regression models are sensitive to truncation (Blaine et al. 2015), so much attention was given to removing outliers in the variables for the number of trips, travel distance, and average party size. For the number of trips, any value exceeding 52 was considered an outlier and removed, as 52 trips translates to visiting a WMA once a week (Bowker et al. 2009). Any one-way travel distance exceeding 500 miles was

considered an outlier and removed because the purpose behind a longer distanced trip could include more than just recreating at the WMA (Mingie et al. 2019). Group sizes larger than 10 people were also considered outliers and removed because large group sizes are usually not associated with a typical recreation trip (Chapagain et al. 2018).

The time a visitor spends travelling to and from a WMA could be devoted to other activities or endeavors, thus a time cost of a trip exists (Parsons 2003). Omitting time cost biases the travel cost variable downward, which can cause an underestimation of the benefits provided by a recreation site (Freeman III, Herriges, and Kling 2014). Many studies account for time cost by multiplying a fraction of the visitor's wage rate by their travel time and including the cost within the travel cost variable (Hwang et al. 2021; Joshi, Poudyal, and Hodges 2017; Hussain et al. 2016). Calculation of the opportunity cost of travel time is a debated subject within TCM literature; the fractions of wage rate used in different studies range from 0 to 1, but 1/3 is commonly used (Amoako-Tuffour and Martínez-Espiñeira 2012; Parsons 2003). Two zero-truncated negative binomial regression models were used in this study: a No Wage Rate model that does not include the opportunity cost of time in the travel cost variable and a 33% Wage Rate model that includes the opportunity cost of time using 1/3 of the wage rate.

The travel cost variable for the No Wage Rate model was calculated using the round-trip travel distance (in miles) from an individual's home zip code to the WMAs they visited, the weighted average vehicle operating cost per mile in 2020 ($0.1979) provided by AAA (*Your Driving Costs* 2020), and the "entry fee" of their license cost per trip based on the number of trips taken in 2020. For lifetime license holders, the per trip license cost accounted for the number of years they have recreated in Oklahoma.

$$Travel\ Cost = (Travel\ Distance\ \times Transportation\ Cost) + Entry\ Fee \qquad (2.3)$$

The opportunity cost of time can be calculated by including one-third of the visitor's wage rate multiplied by their travel time (Loomis and McTernan 2014):

$$Total\ Travel\ Cost = Travel\ Cost + 0.33 \times (wage\ rate \times travel\ time) \qquad (2.4)$$

where the wage rate is calculated by:

$$Wage\ Rate = \frac{\frac{Income}{\#\ of\ income\ earners\ in\ the\ household}}{2080}$$

In Equation (2.4), the number of work hours in a year is 2,080, and the sum of the number of adults and seniors reported in each household was used as the number of income earners in the household in the model.

The negative inverse of the travel cost coefficient in Equation (2.2) (i.e., $-1/\beta_{TC}$) was used to calculate group CS values for the two models (Yen and Adamowicz 1993). Through bootstrapping the standard errors of the travel cost coefficients, the upper and lower bounds of the confidence interval were calculated as well (Chapagain and Poudyal 2020). Individual CS values were calculated by dividing the group CS values by the average group size (i.e., 2.78), and the aggregate CS values were calculated by multiplying the individual CS values by the estimated number of WMA visitors in 2020 (i.e., 275,247).

### *3.3. Estimating Economic Impact*

Input-output (IO) analysis is "an economic analysis based on the interdependencies between economic sectors" (IMPLAN 2021) that mathematically links an array of economic transactions among multiple sectors (Joshi, Poudyal, and Hodges 2017). Plainly, it shows how different sectors of the economy are interconnected and how they affect each other. IO modelling provides information in terms of direct, indirect, and induced results; the deliverables provide economic impacts in terms of jobs created, industrial output added, income and labor wage generated, and

tax revenue. Necessary data for an IO model are the monetary values of the transactions (txy) from each sector x to each sector y. Assuming the economy has n sectors, the total output (sx) of sector x and the total final demand (dx) can be written in a simple equation accounting for how sector x distributes its product through sales to other sectors and to final demand (Miller and Blair 2009):

$$s_x = t_{x1} + \cdots + t_{xy} + \cdots + t_{xn} + d_x = \sum_{y=1}^{n} t_{xy} + d_x \quad (2.5)$$

The IO model is a commonly used tool for regional economic impact analysis of recreational activities (Hutt et al. 2013). Tourism is a unique export activity in IO analysis because purchasers travel to a region to buy goods and services instead of having the goods or services being shipped to them (Clouse 2021). Similar to other economic activities, tourism cannot be considered its own industry because it encompasses a wide variety of businesses and activities (Clouse 2021). Since tourists typically spend their money on known commodities like lodging, food, and travel, commodity output events are used to model the economic impacts of tourist spending in IO modelling (Clouse 2021). A model for tourism includes a list of commodity sectors in which tourists spent their money, an average amount spent in each sector, and the scale of the event like the number of days spent in the region. To estimate the economic impacts of WMAs in Oklahoma, an IO analysis was adopted using an IMPLAN (Economic Impact Analysis for Planning) tool that is commonly used in characterizing the economic impact of the outdoor recreation industry such as hunting and fishing (Munn et al. 2010; WRD 2014).

### *3.4. IMPLAN Models and Methods*

There were two statewide IMPLAN models included in this study: a model for all WMA visitation, and a model that only included respondents who typically stayed overnight during their WMA trips. Oklahoma economic data and statewide visitation estimates for 2020 were used in these models. Since the magnitude of economic impacts is largely determined by visitation

(Bergstrom et al. 1990), three additional models were created for WMAs having high, medium, and low visitation levels and serve as a unique feature of this research. This was done by first identifying the respondents who lived within 50 miles of each of the nine representative WMAs. Then, the percentage of those respondents who visited the WMA they lived by was multiplied by the whole license population living within 50 miles of that WMA to estimate the number of local WMA visitors. Based on the estimated number of local visitors and recreation days for each WMA, the nine representative WMAs were categorized as having either high, medium, or low visitation. County-wide economic data for the counties within 50 miles of the nine WMAs were used in these models to capture economic impact at the local level. IMPLAN data contains 546 economic sectors representing all private industries as defined by the North American Industry Classification System (NAICS), and all these information are used to form a database of employment, employee compensation, industry expenditures, commodity demands, and relationships between industries (Nealy 2021).

The WMA Visitor Survey included a list of items and asked respondents to indicate how much they would spend on those items during a typical trip to a WMA. Using the 2020 IMPLAN 546 Industries and Commodities list and the 2017 NAICS to IMPLAN list, the sector in which the items belong to were identified and used in the models (Nealy 2021). The average per-person, per day amount spent on each item during WMA trips was calculated. Table 2.2. includes a list of the sectors included in the models, what items from the survey were included in each one, and the average amount spent per recreation day on each one.

The per person, per recreation day average amounts spent on each item represent consumer expenditures, or the purchaser price of those items. For items belonging to retail, wholesale, and transportation industry sectors, margins were applied to convert the purchaser price to producer price. This allocates expenditures to the industries that produced the goods or services (Clouse 2021).

The Local Purchase Percentage (LPP) provides what portion of the purchaser price affects the local region (Clouse 2021). The LPP was assumed to be 100% for all sectors included in this model, except for sector 3154-Refined petroleum products, which was set to 50%. An LPP of 50% accounted for the gas bought by nonresident visitors who may have bought gas in other regions during their road trip to WMAs (Clouse 2021). The gas bought in other regions does not benefit local economy, so adjusting the LPP for gas ensured the economic benefit provided by purchasing gas was not over-estimated.

Social accounting matrix (SAM) multipliers are used in IO modelling to show the magnitude of the response throughout the economy from the modelled economic activity (Poudel, Munn, and Henderson 2017). For example, a multiplier of 1.5 for total output indicates that an additional $0.50 of total output in the economy is generated for every $1 of direct total output resulting from WMA-related expenditures (Poudel, Munn, and Henderson 2017). The SAM multiplier is the ratio of the total effect to the direct effect (Frakes 2019).

### *3.5. Study Area*

There are 82 WMAs ranging across the state of Oklahoma (Figure 2.2.). Oklahoma is home to a diverse array of ecotypes ranging from the Western High Plains in the panhandle to the cypress swamps and forests in the southeast corner (*Oklahoma's Diverse Ecoregions*). WMAs reflect this diversity as they range in size, shape, habitat types, wildlife, and amenities offered (*Where to Hunt* 2022). To access Oklahoma WMAs, one must have a hunting or fishing license or a conservation passport (*Special Licenses and Permits* 2022). Most WMAs in Oklahoma are open to hunting, fishing, trapping, and non-consumptive recreation activities, but because every WMA is unique, visitors must pay attention to the area-specific regulations that show what hunting seasons the WMA is opened or closed for, seasons or activities where access may be

limited, and acceptable methods of take within the WMA *(Public Hunting Areas: Special Regulations* 2022).

### *3.6. Data Collection*

Nine representative WMAs were sampled for this study: Beaver River, Canton, Cross Timbers, Hackberry Flats, Honobia, Hulah, Lexington, Okmulgee, and Spavinaw. ODWC identified several factors that were considered when choosing these 9 WMAs including the level of use, ecosystem types, acreage, amenities, and recreational opportunities. Because recreationists living close to a recreation site are more likely to take more trips compared to their distant counterparts (Hussain et al. 2016), the following sampling frame was used to determine the sample population of Oklahoma resident and nonresident license holders:

a) 50% of the total sampling population resided within 25 miles of each representative WMA.

b) 30% of the total sampling population resided within 25-50 miles of each representative WMA.

c) 20% of the total sampling population resided beyond 50 miles of each representative WMA.

Once the WMA Visitor Survey was developed and approved by Oklahoma State University's Institutional Review Board (IRB), survey questionnaires were distributed to 2,997 residents and non-residents who held an Oklahoma hunting and fishing license or conservation passport during the 2020-2021 hunting season. The data collection procedure utilized a mixed-mode approach (a combination of mail, online, and phone questionnaires), and a modified Dillman method (Dillman et al., 2014) was followed for each. For the mail questionnaire, we distributed two waves of mail in the summer of 2021. The front cover of the questionnaire included a URL where respondents

could complete the survey online if they preferred. A low response rate was encountered with the mail questionnaire, so it was sent to nonrespondents via email along with subsequent reminder emails from July-September 2021. The Qualtrics platform was used to distribute the online version of the questionnaire. To further ensure a higher response, the questionnaire was administered over the phone to nonrespondents at the same time as the email questionnaire. It is important to note that the online and phone questionnaires did not target users outside of the original sample, but rather supplemented mail correspondence to reach out to as many respondents in the sample population as possible.

## 4. Results

### *4.1. Survey Response*

Of the 2,997 survey questionnaires initially mailed out, 9 were dropped due to the recipient being deceased and 3 were dropped due to address issues, resulting in a final sample size of 2,985. At the end of the survey, 197 responses were received by mail, 180 by email, and 32 by phone contact, resulting in a total of 409 responses and a response rate of 14%. After removing duplicate and invalid questionnaires, 390 valid questionnaires remained.

A mode bias analysis showed that the average age for mail respondents was significantly higher compared to both email ($p = 0.006$) and phone ($p = 0.005$) respondents. This supports the mode bias findings from ODWC's 2019 Angler Survey, as there was also a significantly higher average age for mail respondents compared to internet respondents (York 2019). However, there was a significantly higher proportion of males who responded to the phone survey compared to both the mail ($p = 0.025$) and email ($p = 0.022$) surveys, as only 1 of the 32 completed phone respondents were female. There was no significant difference in race and or residential type among the mail, email, and phone respondents.

Respondents were mostly Caucasian males with an average age of 54 years. Most respondents lived in rural areas, had at least a high school education, worked full-time jobs, and made an average income of $67,370. Of all 390 respondents, 49% (n = 191) indicated they had visited a WMA in Oklahoma between January 1st, 2020, and December 31st, 2020. Based on their primary recreation activity during their last WMA trip, 42% were anglers, 22% were hunters, and the remaining 36% were non-consumptive users that participated in wildlife watching, site seeing, photography, hiking, etc.

The demographic results from this study are like those found in other studies conducted by ODWC. The average age of fishing license holders that responded to the 2019 Angler Survey was 52.3, and the average age of respondents to the 2018 Waterfowl Hunter survey was slightly lower at 44 years old (Richardson, York, and Jager 2018; York 2019). The respondents to this survey, the 2019 Angler Survey, and the 2018 Waterfowl Hunter Survey were mostly male, but the percentages for this survey (77% male) were more similar to the percentages found in the 2019 Angler Survey (63% male, 15% no response) compared to the 2018 Waterfowl Hunter Survey (98% male) (Richardson, York, and Jager 2018; York 2019). The 2020 Game Harvest Survey revealed that 29% of active hunting license holders used public land for any portion of their hunting in 2020, which is slightly lower than the percentage of respondents to this survey who said they visited a WMA (49%) (York 2020). This survey provides demographic data not commonly found in other ODWC surveys, including residential type, education level, work status, and income.

### *4.2. Visitation Estimation*

Table 2.3. shows the estimated number of visitors and recreation days for Oklahoma statewide, overnight visitors, and the nine representative WMAs. Statewide WMA visitation was estimated by multiplying the license population i.e., 777,873 by 35%, or the percentage of

respondents that said they visited a WMA after outliers and invalid surveys were removed. This resulted in an estimated 275,247 WMA visitors in Oklahoma in 2020. The estimated number of visitors was then multiplied by the average number of trips respondents took to WMAs in 2020 (i.e., 10) and the average trip length (i.e., 1.7) to estimate the recreation days (4,648,065) in WMAs in Oklahoma in 2020. The number of estimated overnight visitors and recreation days was calculated the same way, except only those respondents that had an average trip length greater than one day were considered. Based on the estimated number of local visitors and recreation days, the nine representative WMAs were categorized as follows: Beaver River and Honobia made up the Low Visitation category; Canton, Cross Timbers, Hackberry Flats, Hulah, and Spavinaw made up the Medium Visitation category; Lexington and Okmulgee made up the High Visitation category.

### *4.3. Economic Value to Visitors*

Results from the negative binomial regression models are shown in Table 2.4. A test for overdispersion showed significant overdispersion in the number of trips taken to WMAs for both models ($P > |t| = 0.00$), validating the choice to use negative binomial regression models instead of Poisson regression models. Multicollinearity was tested for using variance inflation factors (VIF). All VIF values were less than 2 for both models, showing little to no correlation between the variables.

The coefficients for *TravelCost1* and *TravelCost2* were significant ($p < 0.001$) and negative, as expected. This provides a negative slope for the demand curve, indicating that as the travel cost increases, the number of trips taken to a WMA decrease. The negative and significant ($p < 0.001$ and $p < 0.01$) coefficients for *Age* in both models show that WMA visitors took less trips as their age increased. The positive and significant ($p < 0.01$) coefficients for *Consumptive* in both models show the number of trips taken to WMAs was higher for hunters and anglers. More

specifically, the IRR values show that the number of trips taken to a WMA is 77% to 88% higher for hunters and anglers compared to non-consumptive users, depending on the inclusion of the opportunity cost of time in the model. The other variables were not significant in either model but were retained as they are commonly included variables in recreational demand modeling (Bowker, Bergstrom, and Gill 2007; Pirikiya et al. 2016; Chapagain et al. 2018).

The CS results are shown in Table 2.5. In 2020, WMA visitors received a CS of $15.95 (95% CI: $11.78-$24.68) when the opportunity cost of their travel time is not accounted for and $28.09 (95% CI: $19.05-$53.44) when it is accounted for. This estimates that Oklahoma WMAs provided an average aggregate annual CS between $42.6-75.1 million for visitors in 2020.

*4.4. Economic Impact*

The direct, indirect, induced, and total impacts on employment, labor income, added value, and taxes caused by WMAs are presented in Table 2.6. Statewide, WMA visitation in Oklahoma provided a total of 8,341.4 jobs, including full-time, part-time, and seasonal employment in 2020. Likewise, $332.13 million in labor income was also provided, which includes both employee compensation such as payroll and benefits provided to employees by employers and proprietor income, including current production income of sole proprietorships, partnerships, and tax-exempt cooperatives (Lucas 2021). The WMA visitation in 2020 directly contributed $535.23 million to Gross Domestic Product (GDP), and it provided $48.32 million in state and local taxes and $63.10 million in federal taxes. The multipliers for WMAs with different visitation levels are shown in Table 6. The employment multiplier shows that 0.45 jobs are created in other industries for every job created by WMA visitation. Likewise, the tax multipliers imply that $0.43 in state and local taxes and $0.62 in federal taxes are generated by other industries for every $1 of tax revenue generated from WMA visitation.

The local economic impact of an individual WMA depends on the level of visitation it has in a year (Bergstrom et al. 1990). The WMAs that experienced high visitation levels in 2020, about 289,000 recreation days, provided about 358 jobs, $15.94 million in labor income, $26.04 million to GDP, $1.95 million in state and local taxes, and $3.05 million in federal taxes within the surrounding counties. The WMAs that had medium visitation levels, or about 28,000 recreation days, provided around 67 jobs, $2.36 million in labor income, $3.78 million to GDP, $293,000 in state and local taxes, and $465,000 in federal taxes. The low visitation-level WMAs that experienced about 10,000 recreation days provided around 21 jobs, $541,000 in labor income, $843,000 to GDP, $87,000 in state and local taxes, and $104,000 in federal taxes.

## 5. Discussion

In this study, WMA visitation decreased as respondents' age increased, further supporting the notion that participation among elderly hunters and anglers has been declining in the US (Moore 2021; York 2019). Even though the average age of all respondents (54) in this study is not elderly, the significantly higher average age of mail respondents (55) compared to internet (47) and phone (42) respondents shows that younger respondents tend to respond using more modern technologies. Utilizing modern technology platforms could aid ODWC during their WMA research efforts by helping them reach the younger demographic that is more likely to visit them. The results also showed that hunters and anglers are more likely to visit a WMA in Oklahoma compared to non-consumptive users, which is expected, as there is less public land open for hunting and fishing in general. Non-consumptive users can typically enjoy their primary recreation activity in city and state parks that don't allow hunting or fishing. However, advertising non-consumptive recreation opportunities offered by WMAs during the non-hunting season could increase overall WMA visitation.

The per person per trip CS estimates for the Oklahoma WMA system are similar to those found in other studies estimating the value of recreational access to public land and water systems (Wu et al. 2018; Mingie et al. 2019). The range of individual CS estimates found in this study ($15.95-$28.09) falls within the range of individual big game hunters in Georgia, who received between $15.69-$59.76 (2012 dollars) in CS when they hunted on public lands in 2012 (Mingie et al. 2019). In Oklahoma during the 2018-2019 recreation season, visitors received an estimated $34 (95% CI: $27, $38) in per person per trip CS when they visited Canton Lake, a lake adjacent to the Canton WMA included in this study. However, my estimated per person per trip CS values are slightly lower than the estimated CS value ($55 in 2019 dollars) provided to anglers who visit Oklahoma rivers and streams and the CS value ($80 in 2014 dollars) found for Fort Cobb Lake, another lake located in Oklahoma (Boyer, Melstrom, and Sanders 2017; Joshi et al. 2021). The estimated aggregate annual CS ($42.6-$75.1 million) provided by WMAs in Oklahoma is similar to the aggregate estimate ($68.51 million in 2019 dollars) provided to all stream and river anglers in Oklahoma but smaller than the aggregate estimates found for WMAs in Tennessee ($137.37-$293.62 million in 2018 dollars) (Shattuck 2021). It should be noted that CS estimates differ between studies due to differences in calculating the travel cost variable; some studies include the cost of food and lodging in the travel cost variable, exclude the opportunity cost of travel time, or use a different percentage of wage rate to calculate the value of travel time (Joshi et al. 2021; Boyer, Melstrom, and Sanders 2017).

The 2020 statewide economic impact results from IMPLAN are slightly smaller but comparable to those found for WMAs in Tennessee in 2018 (Poudyal, Watkins, and Joshi 2020). The SAM multipliers are similar also, strengthening the proposition that they can be applied in other states with similar economic realities (Poudyal, Watkins, and Joshi 2020). The multipliers for employment and state and local tax revenue were slightly higher for Oklahoma WMA visitation, meaning that $1 dollar spent while visiting an Oklahoma WMA provides more in these

outputs compared to $1 spent while visiting Tennessee WMAs. The statewide employment multiplier for Oklahoma (1.45) in this study is slightly lower but comparable to the multipliers for employment created by all wildlife-related recreation expenditures in the Southeast US in 2006 and by wildlife-watching expenditures in Oklahoma in 2011 (Munn et al. 2010; Poudel, Munn, and Henderson 2017). The economic impact estimates for individual WMAs based on their visitation level are unique and important features of this study because they provide Oklahomans with an idea of how their specific community is positively impacted by the presence of a WMA in their area. Depending on the visitation level, WMAs can provide between 6-46 jobs in the full-service restaurant sector alone, which was one of the top affected industries by WMA visitation in this study. The multipliers for the three visitation level models increase as the visitation increases. For example, the federal tax multiplier shows that a dollar spent while visiting a WMA with low visitation provides $0.27 in federal tax revenue, compared to WMAs with medium ($0.50) and high ($0.65) visitation.

Compared to 4.65 million estimated recreation days spent in Oklahoma WMAs in 2020, Poudyal, Watkins, and Joshi (2020) reported that visitors spent an estimated 3.44 million recreation days in Tennessee WMAs in 2018, and visitors spent 3.86 million recreation days in Georgia WMAs in 2013 (WRD 2014), which are relatively smaller estimates. The range of estimated recreation days for 10 WMAs in Virginia in 2009 and 2010 fell within the lower end of the range of estimated recreation days for the 9 representative WMAs in this study (Busch et al. 2011). The range of estimated recreation days for the 9 representative WMAs in this study were more similar to the range for the top 10 WMAs in Tennessee (Poudyal, Watkins, and Joshi 2020). The statewide estimated number of visitors was higher for Oklahoma WMAs (275,247) compared to Georgia WMAs (146,086) as well (WRD 2014). The higher estimates in Oklahoma could be the result of less restriction for WMA access. For example, the statewide visitor estimate for Georgia WMAs was not representative of the total visitation to Georgia WMAs because the

population sampled only consisted of hunting license holders with WMA privileges, or Georgia Outdoor Recreation Pass (GORP) holders (WRD 2014). Georgia, Tennessee, Virginia, and many other states require a special WMA pass or permit in addition to required licenses associated with their recreation activity (i.e., hunting or fishing license) for WMA access (Busch et al. 2011; WRD 2014; Poudyal, Watkins, and Joshi 2020; Moscovici, Tredick, and Russell 2020). In Oklahoma, Land Access Permits are only required for two WMAs, including the Honobia WMA, one of the WMAs selected for this study. Similarly, Wildlife Conservation Passports are only required on certain ODWC-managed lands, but individuals who possess a hunting or fishing license are exempt from needing a Passport (*Special Licenses and Permits* 2022). This wider variety of accepted licenses paired with lower access restrictions could have encouraged more WMA visitation in Oklahoma. The wide variety of accepted licenses in Oklahoma provided a larger, more diverse population (N = 777,783) of hunting and fishing license and conservation passport holders to sample from, compared to the sample size of GORP holders that have access to WMAs in Georgia (N = 309,500) (WRD 2014).

The visitation estimation results of this study are applicable at a general, statewide-level overview of the WMAs in Oklahoma, which could cause limitations if one is interested in the estimated number of visitors to a specific WMA. To estimate the number of visitors to a specific WMA, the survey design methods used in this study are not recommended. A significant challenge of this study is that it was conducted during the COVID-19 pandemic. Globally, the overall general demand for parks and outdoor green spaces increased during the COVID-19 pandemic (Geng et al. 2021), but regional and local demand depended on local restrictions. However, in the US, there was an estimated 26% decrease in the number of trips taken per participant to public outdoor recreation sites (Landry et al. 2021). In Oklahoma, 11 million people visited Oklahoma State Parks during the 2020 fiscal year, a 20% increase in visitation from the previous year (Godfrey 2020). Likewise, there was a 27% increase in the sale of all Oklahoma

hunting and fishing licenses in 2020 compared to 2019. More specifically, resident fishing license sales increased by 49%, and resident hunting license sales increased by 15% (York 2021). The increased population of license holders could have contributed to our large estimate of WMA visitors in this study. Therefore, more research needs to be conducted on the impact of COVID-19 on WMA visitation in Oklahoma, where the ODWC encouraged people to get outside during the pandemic.

State agencies like ODWC have tough decisions to make when allocating funds for wildlife management (Jewell 2021). The individual and aggregate CS values found in this study show benefits to visitors in monetary terms, so they can easily be compared to the cost of acquiring and managing WMAs (Hwang et al. 2021). Likewise, the economic impact results show the positive economic impacts that WMAs provide for Oklahoma communities. ODWC can consider both economic measures or estimates when making budget allocation and WMA management decisions. Acquiring more land for the WMA system and improving WMA management would help ODWC improve wildlife conservation and recreation opportunities, strengthening its mission of sustainable wildlife and fish management and growing the community of hunters and anglers (ODWC).

Land acquisition by government agencies can be a highly debatable topic, but the combination of sufficient financial compensation and other requisites can help ensure that landowners view the acquisition as fair or morally right (Holtslag-broekhof et al. 2016; Holtslag-Broekhof et al. 2016). The economic impacts provided for communities by WMAs could be viewed as extra compensation along with the initial compensation fee paid to acquire the land. It is important for government agencies like ODWC to clarify that land acquisition is only the first step in a process to provide public access to lands managed in a way that benefits both wildlife and humans (Frank, Walton, and Rollins 2019). Highlighting both the non-market benefits and economic impacts provided by WMAs could further support a positive landowner perception of

land acquisition by ODWC. This could be exceptionally important in states like Oklahoma that are mostly privately owned.

## 6. Conclusion

This study shows that access to Oklahoma WMAs for outdoor recreation has substantial value to recreationists as well as the state and local economies. ODWC can use both non-market, CS benefits and the economic impacts provided by WMAs as justification for new WMA management practices or land acquisitions to expand the WMA system. In a state that is mostly privately owned, land acquisition by a government agency can be a sensitive topic, unless landowners feel the acquisition is justified by lawfulness, decentness, equality, and sufficient financial compensation. Educating the public on the benefits and economic impacts of WMAs could raise public acceptance and support for increasing public land available for hunting, fishing, trapping, and non-consumptive recreation.

Regarding the economic benefit and impacts of Oklahoma WMAs, future research could focus on their seasonal magnitude. While conducting this study, many WMA managers expressed that WMA visitation is not steady throughout the year, as they typically experience larger visitation volumes during the hunting season in the fall and winter months. Analyzing the effects of seasonality on WMA visitation would provide ODWC with a clearer picture of demand and regional economic impact.

**Table 2.1.** Definitions and descriptive statistics for variables used in the zero-truncated negative binomial regression analyses (n= 130)

| Variable | Definition | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| [1,2]*TotalTrips* | Total number of trips taken to WMAs in 2020 (dependent variable) | 10.01 | 9.46 | 1 | 50 |
| [1]*TravelCost1* | Travel cost per trip including travel time ($) | 54.16 | 59.87 | 1.25 | 342.65 |
| [2]*TravelCost2* | Travel cost per trip excluding travel time ($) | 39.82 | 45.05 | 0.66 | 238.29 |
| [1,2]*Substitute* | Distance from respondents' home zip code to the closest WMA (miles) | 31.54 | 50.00 | 0 | 451.05 |
| [1,2]*Age* | Respondents' age (years) | 50.71 | 16.01 | 19 | 88 |
| [1,2]*Recreate* | How long the respondent has been recreating in the state of Oklahoma (years) | 34.15 | 18.72 | 0 | 82 |
| [1,2]*Gender* | Dummy variable for respondents' gender (Male = 1, Female = 0) | 0.76 | 0.43 | 0 | 1 |
| [1,2]*AvgParty* | Average group size during trips taken to WMAs in 2020 | 2.78 | 1.62 | 1 | 8 |
| [1,2]*Consumptive* | Dummy variable for whether the respondent participated in hunting or fishing, or non-consumptive activities (Consumptive = 1, Non-cons. = 0) | 0.62 | 0.49 | 0 | 1 |

[1]Used in 33% Wage Rate Model
[2]Used in No Wage Rate Model

**Table 2.2.** Items from the survey categorized by IMPLAN Sector and the average spent per recreation day on those items while travelling to WMAs

| IMPLAN Sector | Survey Items | Statewide (All WMAs) | Overnight Visitation (All WMAs) | High Visitation | Medium Visitation | Low Visitation |
|---|---|---|---|---|---|---|
| 3154[1,2] | Gasoline and oil | $51.99 | $31.67 | $23.62 | $21.71 | $12.20 |
| 3512 | Repair/Service for Automobile, Truck, SUV, or Trailer | $2.06 | $3.18 | - | $4.00 | - |
| 3364[1] | Other transportation (bicycle, motorcycle, ATV)<br>Other transportation costs indicated by respondent (horses, jet ski and boats) | $1.17 | $2.60 | - | $1.92 | $8.40 |
| 3509 | Meals at restaurants | $20.67 | $25.84 | $9.02 | $21.86 | $27.14 |
| 3408[1] | Food & drinks purchased at a convenience store/travel plaza | $12.40 | $12.14 | $9.49 | $11.25 | $8.66 |
| 3406[1] | Food & drinks purchased at a grocery store or supermarket | $19.40 | $26.26 | $41.61 | $18.59 | $21.36 |
| 3507 | Hotel or motel | $10.87 | $9.17 | - | $16.53 | $20.00 |
| 3448 | Bed & Breakfast or Cabin Rental House, Airbnb, or VRBO | $5.10 | $6.59 | $2.53 | $8.42 | - |
| 3508 | Public or private campground for RV, tent, and/or camper | $9.46 | $13.73 | $4.94 | $13.72 | $11.54 |
| 3410[1] | Hunting supplies<br>Fishing supplies<br>Camping supplies | $22.68 | $40.32 | $30.89 | $38.16 | $44.86 |
| 3531 | Fishing/Hunting fees or licenses | $19.11 | $15.06 | $28.40 | $27.09 | $20.20 |
| 3451 | Equipment rentals (e.g., kayak/canoe, ATV, etc.) | $2.70 | $0.87 | - | $6.00 | - |
| 3412[1] | Other recreation supplies (e.g., binoculars, hiking poles, etc.) | $5.14 | $6.18 | $1.25 | $6.47 | $5.51 |
| 3501 | Entertainment (museums, amusements) | $4.34 | $4.32 | - | $12.29 | - |
| 3411[1] | Retail goods other than groceries (general merchandise) | $8.49 | $10.90 | $1.30 | $7.79 | $3.01 |
| 3504 | Guide/Outfitter or tour fees | $2.64 | $5.08 | $5.21 | $5.83 | $8.33 |

[1]Includes margins
[2]50% Local Purchasing Power

**Table 2.3.** Estimated number of visitors and recreation days statewide and by representative WMA

| | **Estimated Visitors** | **Estimated Recreation Days** |
|---|---|---|
| Statewide | 275,247 | 4,648,065 |
| Overnight | 129,646 | 3,758,474 |
| | **Estimated Visitors** (by locals living within 50 miles of WMA) | **Estimated Recreation Days** (by locals living within 50 miles of WMA) |
| Beaver River[3] | 713 | 17,561 |
| Canton[2] | 4,685 | 54,315 |
| Cross Timbers[2] | 4,233 | 29,327 |
| Hackberry Flats[2] | 5,368 | 20,075 |
| Honobia[3] | 349 | 2,619 |
| Hulah[2] | 7,181 | 26,988 |
| Lexington[1] | 24,085 | 238,440 |
| Okmulgee[1] | 39,498 | 339,681 |
| Spavinaw[2] | 9,723 | 37,919 |

[1]High Visitation Category
[2]Medium Visitation Category
[3]Low Visitation Category

**Table 2.4.** Results of the Zero-Truncated Negative Binomial Regression Analyses

| Variable | 33% Wage Rate | | No Wage Rate | |
|---|---|---|---|---|
| | Coefficient (SE) | IRR (SE) | Coefficient (SE) | IRR (SE) |
| *TravelCost1* | -0.0128 (0.00)*** | 0.9873 (0.00)*** | - | - |
| *TravelCost2* | - | - | -0.0226 (0.00)*** | 0.9777 (0.00)*** |
| *Substitute* | 0.0000 (0.00) | 1.0000 (0.00) | 0.0019 (0.00) | 1.0019 (0.00) |
| *Age* | -0.0194 (0.01)** | 0.9808 (0.01)** | -0.0179 (0.01)** | 0.9823 (0.01)** |
| *Recreate* | 0.0054 (0.01) | 1.0054 (0.01) | 0.0053 (0.01) | 1.0053 (0.01) |
| *Gender (Male)* | -0.3711 (0.23) | 0.6810 (0.16) | -0.3726 (0.20) | 0.6890 (0.14) |
| *AvgParty* | -0.0037 (0.06) | 0.9963 (0.06) | -0.0013 (0.05) | 0.9987 (0.05) |
| *Consumptive (Yes)* | 0.6303 (0.22)** | 1.8782 (0.41)** | 0.5738 (0.19)** | 1.7749 (0.34)** |
| *Cons* | 3.4260 (0.51)*** | 30.7535 (15.70)*** | 3.4198 (0.45)*** | 30.5618 (13.66)*** |
| *AIC Statistic* | 581.53 | | 645.25 | |
| *BIC Statistic* | 604.32 | | 669.31 | |
| *Log-Likelihood* | -281.76 | | -313.63 | |
| *N* | 93 | | 107 | |
| *Pseudo* $R^2$ | 0.0683 | | 0.0909 | |

**p < 0.01, ***p < 0.001

**Table 2.5.** Individual and aggregated consumer surplus estimates provided by WMAs in Oklahoma

| | Per person, per trip | Statewide |
|---|---|---|
| 33% Wage Rate | $28.09 | $75.08 million |
| No Wage Rate | $15.95 | $42.62 million |

**Table 2.6.** Estimated economic impacts of WMA visitation in Oklahoma, 2020 US dollars

| | Statewide (All WMAs) | Overnight Visitation (All WMAs) | High Visitation | Medium Visitation | Low Visitation |
|---|---|---|---|---|---|
| **Recreation Days:** | 4,648,065 | 3,758,474 | 289,061 | 28,104 | 10,090 |
| *Economic Impact Type* | | | | | |
| **Jobs (Total):** | **8,341.4** | **8,083.9** | **358.3** | **65.6** | **21.3** |
| Direct: | 5,741.1 | 5,767.8 | 233.1 | 48.5 | 17.8 |
| Indirect: | 1,344.3 | 1,191.8 | 64.7 | 9.4 | 2.3 |
| Induced: | 1,256.0 | 1,124.3 | 60.5 | 7.7 | 1.2 |
| Multiplier: | 1.45 | 1.40 | 1.54 | 1.35 | 1.20 |
| **Labor Income (Total):** | **$332,129,725** | **$297,261,722** | **$15,941,552** | **$2,357,611** | **$541,445** |
| Direct: | $200,639,419 | $184,149,039 | $9,406,802 | $1,546,910 | $426,389 |
| Indirect: | $74,990,247 | $62,532,416 | $3,633,809 | $480,224 | $79,041 |
| Induced: | $56,500,059 | $50,580,267 | $2,900,941 | $330,477 | $36,015 |
| Multiplier: | 1.66 | 1.61 | 1.69 | 1.52 | 1.27 |
| **Value Added (Total):** | **$535,225,571** | **$472,700,156** | **$26,043,895** | **$3,783,842** | **$842,972** |
| Direct: | $321,518,009 | $287,031,832 | $15,591,158 | $2,433,617 | $637,145 |
| Indirect: | $113,515,077 | $95,974,011 | $5,459,426 | $741,148 | $124,422 |
| Induced: | $100,192,485 | $89,694,313 | $4,993,311 | $609,077 | $81,405 |
| Multiplier: | 1.66 | 1.65 | 1.67 | 1.55 | 1.32 |
| **State & Local Tax (Total):** | **$48,322,449** | **$39,643,125** | **$1,951,740** | **$293,126** | **$86,509** |
| Direct: | $33,727,695 | $27,986,504 | $1,340,872 | $212,316 | $71,007 |
| Indirect: | $8,094,831 | $5,838,052 | $307,300 | $39,710 | $7,302 |
| Induced: | $6,499,923 | $5,818,569 | $303,568 | $41,100 | $8,200 |
| Multiplier: | 1.43 | 1.42 | 1.46 | 1.38 | 1.22 |
| **Federal Tax (Total):** | **$63,996,084** | **$57,109,114** | **$3,053,099** | **$465,088** | **$103,713** |
| Direct: | $39,447,634 | $35,866,986 | $1,851,780 | $309,438 | $81,522 |
| Indirect: | $13,516,657 | $11,366,255 | $645,270 | $88,727 | $14,697 |
| Induced: | $11,031,793 | $9,875,873 | $556,049 | $66,923 | $7,494 |
| Multiplier: | 1.62 | 1.59 | 1.65 | 1.50 | 1.27 |

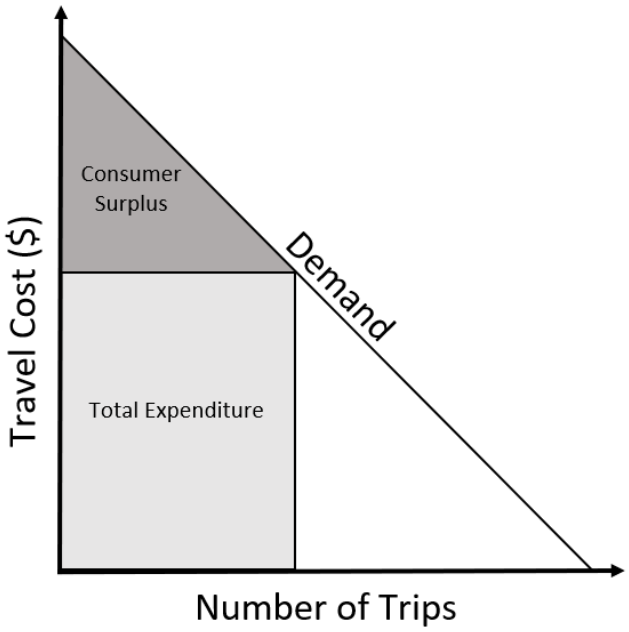


**Figure 2.1.** Illustration of the demand curve for WMA visitation

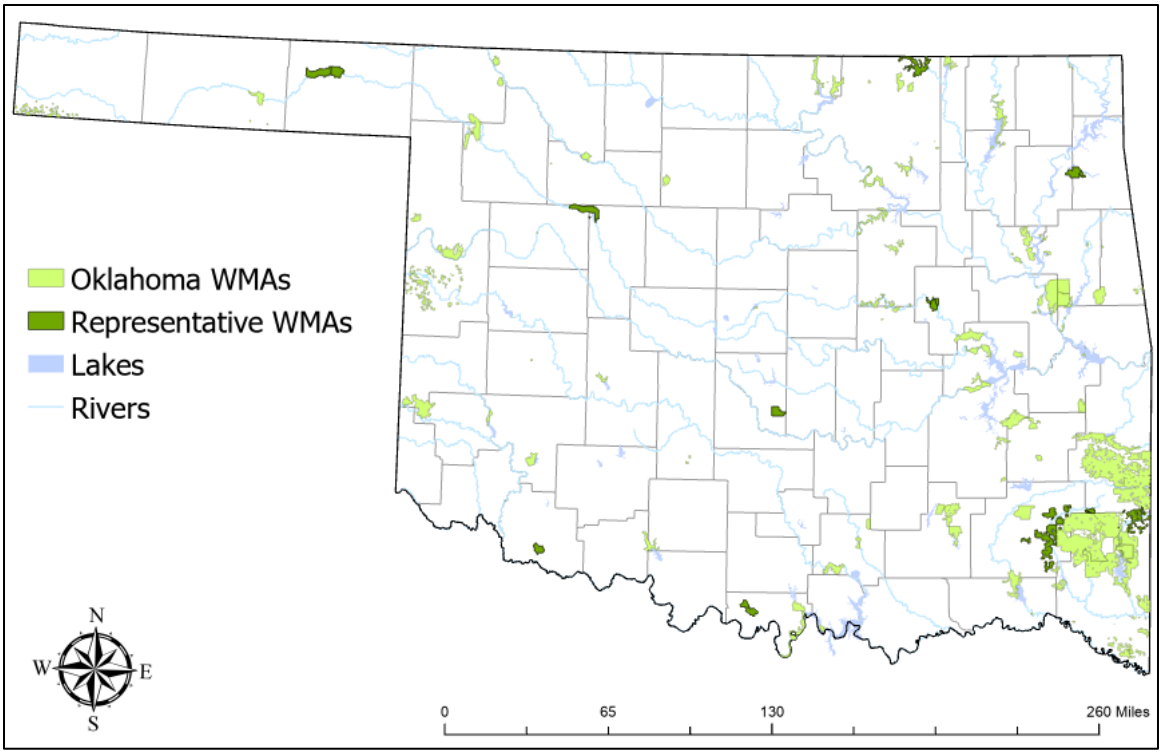


**Figure 2.2.** A map of the WMAs in Oklahoma, highlighting the 9 representative WMAs chosen in this study

# CHAPTER III

## VISITOR SATISFACTION WITH WILDLIFE MANAGEMENT AREAS IN OKLAHOMA

Abstract

Analyzing visitor satisfaction has been an important practice for outdoor recreation managers, as visitor satisfaction influences visitor behavior, choices, and their decision for repeat visitation. This study analyzed visitors' level of satisfaction with their overall recreational experience at the last Oklahoma Wildlife Management Area (WMA) they visited and WMA characteristics like accessibility, the availability and condition of facilities, scenery, abundance of wildlife, and feeling of privacy and safety. To accomplish the study objective, WMA visitor surveys were administered among Oklahoma hunting and fishing license and conservation passport holders during the 2020-2021 hunting season. CUB (Covariates in a Uniform and shifted Binomial mixture) models were used to analyze the effects of visitors' characteristics including primary recreation activity, age, gender, and residential type on their level of satisfaction with WMA characteristics. Major findings from this study include: 1) consumptive WMA visitors have higher feelings of satisfaction compared to non-consumptive visitors, and 2) WMA visitors generally have lower feelings of satisfaction, and higher levels of uncertainty with their privacy from others and their feeling of safety. These issues could be addressed by increasing advertisement of the non-consumptive opportunities available on WMAs during the non-hunting season. This study demonstrates the applicability of a relatively new consumer preference model for analyzing visitor satisfaction within the outdoor recreation field and provides valuable visitor satisfaction results to help ODWC analyze WMA visitation levels and determine best management practices.

Keywords: wildlife management areas, visitor satisfaction, CUB modelling

1. Introduction

Wildlife Management Areas (WMAs) are publicly owned lands that are managed by government agencies across North America for the benefit of wildlife populations. Specifically, in the US, state agencies manage WMAs for many outdoor recreation activities including public hunting, fishing, hiking, camping, wildlife-watching (*Where to Hunt* 2022). The WMAs across Oklahoma differ in size, habitat, land management, wildlife, and vicinity to urban and rural areas, and they offer different amenities, facilities, and recreational opportunities for visitors (*Where to Hunt* 2022). Understanding visitors' level of satisfaction with these WMA characteristics is vital for agencies like Oklahoma Department of Wildlife Conservation (ODWC) because visitor satisfaction influences visitor behavior, choices, and their decision for repeat visitation (Iannario and Piccolo 2016). Positive visitor satisfaction typically leads to more visits and expenditure, thus, understanding visitor satisfaction can also aid ODWC in understanding WMA visitation levels and economic impacts (Disegna and Osti 2016; Loomis 2000). Overall, visitor satisfaction data can help ODWC get an indication of what the agency is doing right and where it can improve; the data will allow the agency to manage, plan, and budget more effectively in agreement with what visitors like (Loomis 2000).

WMA visitor satisfaction has been investigated in states including Mississippi, Tennessee, Minnesota, New Jersey, Virginia, and more (Busch et al. 2011; Munn et al. 2013; Watkins and Poudyal 2021; LaSharr 2017; Moscovici, Tredick, and Russell 2020). Most Mississippi WMA visitors indicated that WMAs provided a similar quality of services compared to private lands when considering game abundance, habitat quality, quality of food plots, internal access, rating of safety, and rating of crowding (Munn et al. 2013). In Minnesota, visitors who felt highly satisfied with their WMA experiences also ranked specific experience preferences as highly important and felt a moderate to high place attachment to WMAs (LaSharr 2017). Eighty-one percent of surveyed New Jersey WMA visitors indicated they were satisfied or very satisfied with WMA

conditions and did not think the WMA they were visiting needed improvements (Moscovici, Tredick, and Russell 2020). Similarly, 82% of survey respondents reported they were satisfied to very satisfied with their WMA visit during a study of Virginia WMA visitors (Busch et al. 2011). Reasons for dissatisfaction among WMA visitors across the US include an unsuccessful hunting or fishing trip, encounters with other recreating individuals or groups, trash in the area, poor road conditions, a lack of maps and signage, low wildlife abundance (Moscovici, Tredick, and Russell 2020; Busch et al. 2011; Watkins and Poudyal 2021).

Analyzing visitor satisfaction has been an important practice for outdoor recreation managers over the years. Often, recreation managers will elicit visitor satisfaction via survey questions equipped with Likert scales asking respondents to rate their level of satisfaction with specific characteristics of the recreational area or their recreational experience (Schroeder et al. 2017; Watkins and Poudyal 2021). Many methods including importance-performance analysis (IPA), importance-satisfaction grid analysis, Pearson correlation, multiple regression, mediation models, gap analysis, and more have previously been used to assess visitor satisfaction with outdoor recreational spaces (Tonge, Moore, and Taplin 2011; Tarrant and Smith 2002; Fletcher and Fletcher 2003; Graefe and Burns 2013). Many of these models, like IPA, were initially developed in the marketing and/or business sectors and later adopted by outdoor recreation managers, following the notion that visitor satisfaction with a recreational area's facilities, amenities, and other characteristics is similar to customer satisfaction with a product or service (Tonge, Moore, and Taplin 2011; Graefe and Burns 2013).

Review of the previous research suggests that ordinal regression models are commonly used to analyze ratings of visitor satisfaction with a recreational area or activity on a Likert scale (Jarvis, Stoeckl, and Liu 2016; Finch and Hernández Finch 2020). Likert scale-based models regroup latent variables into predefined classes with the assumption that their error terms are normally distributed (Gambacorta and Iannario 2013). Although computationally simpler, these

models do not partition the effect of intrinsic factors such as feeling and uncertainty during survey response analysis process. This could be a significant oversight particularly when there is a considerable uncertainty in the judgment during elicitation such as in recreational satisfaction rating (Gambacorta and Iannario 2013).

The CUB (Covariates in a Uniform and shifted Binomial mixture) model used in this study can overcome some of these limitations. It is based on the notion that the rating assigned to a survey item is a product of their feeling towards the item and an inherent uncertainty in the rating process itself (D'Elia 2003). Further, the model can include the respondent's demographics, or covariates, within the feeling and/or uncertainty parameters to investigate how they affect their rating. The ability to include these covariates gives a deeper insight for interpreting visitor behavior, understanding potential drivers behind their level of satisfaction, and characterizing meaningful subsets of the population (Iannario and Piccolo 2010). The approach study has been used to analyze consumer perceptions of olive oil (Chousou, Tsakiridou, and Mattas 2018), perceptions on immigration (Ribecco, D'Uggento, and Labarile 2022), consumer perceptions of organic food (Lamonaca et al. 2022), job satisfaction (Punzo, Castellano, and Buonocore 2018), and customer satisfaction surveys (Iannario and Piccolo 2012), but has not been used to study visitor satisfaction with a natural resource recreation site, to the best of my knowledge.

For this study, CUB models were used to analyze Oklahoma WMA visitors' level of satisfaction with their overall recreational experience at the last WMA they visited and WMA characteristics like accessibility, the availability and condition of facilities, scenery, abundance of wildlife, and feeling of privacy and safety. Covariates including recreation type, age, gender, and residential type were used to investigate their effect on WMA visitor satisfaction.

This study fills a major gap in the literature by demonstrating how the CUB model, a relatively new consumer preference model, is applicable for analyzing visitor satisfaction within

the outdoor recreation field. The following sections discuss the theoretical framework of CUB models without and with covariates, the study area and survey method, the results of the CUB models without and with covariates, and the main findings from the models.

## 2. Methods

### *2.1. Data collection*

The WMA Visitor Survey was designed to solicit data on visitors' trip profile and demographics, including questions related to their preference and satisfaction of WMAs for recreation activities. Respondents were asked to rate their level of satisfaction with their overall recreational experience at the WMA they most recently visited, along with several amenities like accessibility, availability and condition of facilities, scenery, abundance of wildlife, privacy, and safety on a 5-point Likert scale (1 = Dissatisfied, 2 = Somewhat Dissatisfied, 3 = Neither Satisfied nor Dissatisfied, 4 = Somewhat Satisfied, and 5 = Satisfied). Whether respondents were consumptive or non-consumptive recreationalists was determined from their trip profile, and the demographics section asked about respondents' age, gender, and residential type.

The survey questionnaire was approved by Oklahoma State University's Institutional Review Board (IRB), and it was distributed to 2,997 residents and non-residents who held an Oklahoma hunting and fishing license or conservation passport during the 2020-2021 hunting season. The data collection procedure utilized a mixed-mode approach (a combination of mail, online, and phone surveys), and a modified Dillman method (Dillman et al., 2014) was followed for each mode. For the mail questionnaire, we distributed two waves of mail in the summer of 2021. The front cover of the questionnaire included a URL where respondents could complete the survey online if they preferred. A low response rate was encountered with the mail questionnaire, so email questionnaires and subsequent reminders were sent to nonrespondents from July-September 2021 using the Qualtrics platform. To ensure a higher response, the survey was administered over

the phone to nonrespondents at the same time as the email questionnaires were being distributed. It is important to note that the online and phone questionnaires did not target users outside of the original sample, but rather supplemented mail correspondence to reach out to as many respondents in the sample population as possible.

### *2.2. CUB Model Without Covariates*

D'Elia and Piccolo (2005) introduced a mixture of a uniform and a shifted binomial (MUB) model for analyzing preference data that accounts for the composite nature of the decision mechanism during the rating process. When a respondent makes a discrete choice from a limited ordinal list of *m* alternatives, their decision combinedly represent their feelings and uncertainty towards the subject (Iannario and Piccolo 2010). Based on these theoretical underpinnings, we postulated that one person's level of feeling and uncertainty affects their choice when rating their level of satisfaction with WMA characteristics. Human feelings are intrinsic and explain how the respondent feels about the subject; they are the result of factors related to the respondent's life including gender, age, education, job, experiences, and personal relationships (Iannario and Piccolo 2012). Likewise, respondent's inherent uncertainty is generated by several factors related to their knowledge, personal interest, engagement, and laziness of the subject.

Of note, the MUB model is the base for a CUB model, as its also called a CUB model without covariates. In an MUB model, feeling is the result of a continuous random variable that becomes a discrete one when the respondent is compelled to express their level of satisfaction (rating, *r*) in the prefixed options within the Likert scale (*m*), so it is expressed by a shifted Binomial random variable. It is characterized by the ξ parameter with a probability mass of (Iannario and Piccolo 2012):

$$b_r(\xi) = \binom{m-1}{r-1}\xi^{m-r}(1-\xi)^{r-1}, \qquad r = 1, 2, \ldots, m \tag{3.1}$$

Likewise, *uncertainty* is expressed by a discrete Uniform random variable because the probability of the item receiving any rate is the same even if respondents show complete indifference towards a certain item (Iannario and Piccolo 2012; Piccolo 2006):

$$U_r(m) = \frac{1}{m}, \qquad r = 1, 2, \ldots, m \tag{3.2}$$

The feeling and uncertainty components are linearly combined in a mixture model to express the composite nature of the elicitation process. Therefore, it is assumed that the rate *r* is the realization of a random variable *R*, which is a mixture of a shifted Binomial variable (feeling, ξ) and a discrete Uniform random variable (uncertainty, π) (Iannario and Piccolo 2012; Piccolo 2006). Further, each respondent has a proportion (π) of *feeling* and a proportion (1 - π) of *uncertainty* while making a rating decision (Iannario and Piccolo 2012). For a known integer $m > 3$, the random variable *R* with parameters π and ξ is defined on the finite support and denoted by $R \sim MUB(\pi, \xi)$ , if its probability distribution:

$$\Pr(R = r) = \pi \underbrace{\left[\binom{m-1}{r-1}(1-\xi)^{r-1}\xi^{m-r}\right]}_{Feeling} + (1-\pi)\underbrace{\left[\frac{1}{m}\right]}_{Uncertainty} \tag{3.3}$$

In above equation, *R* behaves like a uniform distribution when the value of π is closer to 0 but behaves like a shifted binomial distribution when the value of π is closer to 1 (D'Elia and Piccolo 2005). This means that when π is low, or closer to 0, the measure of uncertainty (1 - π) is high, so the rate assigned to the item highly depends on the number of categories *m*. However, when π is high, or closer to 1, the measure of uncertainty (1 – π) is low, so the rate assigned to the item highly depends on the feeling parameter (ξ) (D'Elia and Piccolo 2005). The feeling parameter (ξ) is strongly determined by skewness of the expressed ratings, so $\xi < 0.5$ shows positively skewed responses whereas $\xi > 0.5$ reveals their negative skewness (Iannario and Piccolo 2012). Therefore, (1 - ξ) is the measure of feeling, which increases as respondents choose high ratings

for the item (Iannario and Piccolo 2012). Since $\pi \in (0,1]$ and $\xi \in [0,1]$, the parametric space of R is the unit square $(0,1]\times[0,1]$ (Iannario and Piccolo 2010). A simple visual of the output of CUB models with no covariates can be graphed within this parametric space with the measure of uncertainty $(1 - \pi)$ along the horizontal axis and the measure of feeling $(1 - \xi)$ along the vertical axis (Figure 3.1.).

Calculating the expected value of *R* can be useful for comparative purposes because it is related to the mean value of the feeling parameter. For a fixed value of $\pi$, the expectation of *R* increases as $(1 - \xi)$ increases. The expected value of R is calculated by:

$$E(R) = \pi(m-1)\left(\frac{1}{2} - \xi\right) + \frac{m+1}{2} \tag{3.4}$$

The Expectation-Maximization (E-M) algorithm is used for obtaining the maximum likelihood (ML) estimates of both the feeling ($\xi$) and uncertainty ($\pi$) parameters, which is typical for mixture models (Laird, Lange, and Stram 1987; Piccolo 2006). Although ML estimators have an asymptotically unbiased nature, the inherent bias in CUB models decreases as the ratio of *k* increases (d'Elia 2003):

$$k = n/m \tag{3.5}$$

where n is the sample size and *m* is the fixed number of values on the Likert scale. The acceptable bound for k is 30 (d'Elia 2003).

*2.3 CUB Model With Covariates*

When respondents decide on their answer to a satisfaction question in a survey, it is reasonable to assume that their feelings and uncertainty are affected by their demographic covariates, which can be quantitative (age, income, etc.) or qualitative (dichotomous covariates like gender, residence, profession, etc.) (Iannario and Piccolo 2012, 2016). The CUB models are MUB random variables where the feeling and uncertainty parameters become functions of the

subjects' covariates when explaining the rating ri of the ith subject. The uncertainty parameter ($\pi$) is a function of $p$ subjects' covariates ($y_{i1}, y_{i2}, \ldots, y_{ip}$), and the feeling parameter ($\xi$) is a function of $q$ subjects' covariates ($w_{i1}, w_{i2}, \ldots, w_{ip}$) (Iannario and Piccolo 2010):

$$\pi_i = \frac{1}{1+e^{-y_{i\beta}}}, \qquad \xi_i = \frac{1}{1+e^{-w_i\gamma}}, \qquad i = 1, 2, \ldots, n, \tag{3.6}$$

where $\gamma = (\gamma_0, \gamma_1, \ldots, \gamma_q)$ and $\beta = (\beta_0, \beta_1, \ldots, \beta_p)$ are parameter vectors. Therefore, a CUB model including subjects' covariates has the probability distribution (Iannario and Piccolo 2010):

$$\Pr(R_i = r|y_i; w_i) = \frac{1}{1+e^{-y_{i\beta}}}\left[\binom{m-1}{r_i-1}\frac{(e^{-w_i\gamma})^{r_i-1}}{(1+e^{-w_i\gamma})^{m-1}} - \frac{1}{m}\right] + \frac{1}{m} \tag{3.7}$$

The CUB models are flexible in the fact that covariates do not have to be added [MUB model or CUB(0,0)], can be added for the uncertainty parameter only [CUB(0,p)], can be added for the feeling parameter only [CUB(0,q)], or can be added for both the uncertainty and feeling parameters [CUB(p,q)] (Iannario and Piccolo 2010). To test for the significance and relevance of adding a dummy covariate in the feeling parameter, the log-likelihood ($L_{M1}$) for a CUB model including the covariate ($M_1$) is compared to the log-likelihood ($L_{M0}$) for a CUB without covariates ($M_0$) (Iannario and Piccolo 2012; Iannario 2008). This is done by comparing the deviance difference statistic with the asymptotic critical region of nominal size $\alpha = 0.05$ defined by (Iannario 2008):

$$Test\ (M_1\ vs. M_0)\colon 2(L_{M1} - L_{M0}) > \chi^2_{(0.05,1)} = 3.841 \tag{3.8}$$

This study includes both CUB(0,0) and CUB(0,q) models to investigate WMA visitors' level of satisfaction with certain WMA characteristics. Table 3.1. provides information on the covariates included in the CUB(0,q) models.

## 3. Results

### *3.1. Survey Response*

Of the 2,997 survey questionnaires initially mailed out, 9 were dropped due to the recipient being deceased and 3 were dropped due to address issues, resulting in a final sample size of 2,985. At the end of the survey, 197 responses were received by mail, 180 by email, and 32 by phone contact, resulting in a total of 409 responses and a response rate of 14%. After removing duplicate and invalid questionnaires, 390 valid questionnaires remained.

A mode bias analysis showed that the average age for mail respondents was significantly higher compared to both email ($p = 0.006$) and phone ($p = 0.005$) respondents. This supports the mode bias findings from ODWC's 2019 Angler Survey, as there was also a significantly higher average age for mail respondents compared to internet respondents (York 2019). However, there was a significantly higher proportion of males who responded to the phone survey compared to both the mail ($p = 0.025$) and email ($p = 0.022$) surveys, as only 1 of the 32 completed phone respondents were female. There was no significant difference in race and or residential type among the mail, email, and phone respondents.

Respondents were mostly males (77%) with an average age of 54 years. Most respondents were Caucasian, lived in rural areas, had at least a high school education, worked full-time jobs, and made an average income of $67,370. Of all respondents, 49% indicated they had visited a WMA in Oklahoma between January 1st, 2020, and December 31st, 2020. Based on their primary recreation activity during their last WMA trip, 42% were anglers, 22% were hunters, and the remaining 36% were non-consumptive users that participated in wildlife watching, site seeing, photography, hiking, etc.

The demographic results from this study are like those found in other studies conducted by ODWC. The average age of fishing license holders that responded to the 2019 Angler Survey was 52.3, and the average age of respondents to the 2018 Waterfowl Hunter survey was slightly lower at 44 years old (Richardson, York, and Jager 2018; York 2019). The respondents to this survey,

the 2019 Angler Survey, and the 2018 Waterfowl Hunter Survey were mostly male, but the percentages for this survey (77% male) were more similar to the percentages found in the 2019 Angler Survey (63% male, 15% no response) compared to the 2018 Waterfowl Hunter Survey (98% male) (Richardson, York, and Jager 2018; York 2019). The 2020 Game Harvest Survey revealed that 29% of active hunting license holders used public land for any portion of their hunting in 2020, which is slightly lower than the percentage of respondents to this survey who said they visited a WMA (49%) (York 2020). This survey provides demographic data not commonly found in other ODWC surveys, including residential type, education level, work status, and income.

Table 3.1. shows the descriptive statistics for the variables of interest in this study. Respondents had high average ratings of satisfaction with their overall recreation experience (4.64), WMA accessibility (4.58), availability of WMA facilities (4.15), condition of WMA facilities (4.03), scenery (4.42), abundance of wildlife (4.15), privacy from others (3.94), and feeling of safety (4.45).

### *3.2. CUB Model Without Covariates*

Table 3.2. includes the results of the CUB (0,0) models. The measures of feeling ($1 - \xi$) all have values greater than 0.7, meaning that visitors are highly satisfied with their overall recreational experience and WMA characteristics (Chousou, Tsakiridou, and Mattas 2018). Specifically, visitors are most satisfied with WMA accessibility and least satisfied with the condition of WMA facilities. The measures of uncertainty ($1 - \pi$) for WMA accessibility, their overall recreational experience, scenery, abundance of wildlife, and the availability and conditions of facilities have values less than 0.2, meaning visitors rated their level of satisfaction with a low measure of uncertainty ($1 - \pi$) (Chousou, Tsakiridou, and Mattas 2018). However,

they experienced more uncertainty when rating their level of satisfaction with their feeling of safety and privacy while visiting a WMA.

### *3.3. CUB Models with Covariates*

#### *3.3.1. Recreation Type*

The recreation type (*RecType)* as a covariate for the feeling parameter significantly affected visitor satisfaction with all the variables of interest. Table 3 shows that the difference of the deviances between the CUB models with and without covariates are higher than the asymptotic critical region ($\chi^2 = 3.841$). The negative values of $\gamma_1$ for all variables indicate that hunters and anglers have a higher level of satisfaction with all the variables of interest compared to non-consumptive visitors. Likewise, the values of feeling for the consumptive visitors ($1 - \xi_1$) are higher than the values for non-consumptive visitors ($1 - \xi_0$). Respondents were most uncertain about their rating of satisfaction with *Safety* [$(1 - \pi) = 0.24$] when *RecType* is included as a covariate.

When examining the populations separately, hunters and anglers have the highest feeling of satisfaction with *Safety* and lowest feeling of satisfaction with *Co-Facilities,* and non-consumptive visitors have the highest feeling of satisfaction with *Access* and lowest feeling of satisfaction with *Privacy*.

#### *3.3.2. Hunters*

*Hunter* as a covariate for the feeling parameter significantly affected visitor satisfaction with all the variables of interest. Table 4 shows that the difference of the deviances between the CUB models with and without covariates are higher than the asymptotic critical region $\chi^2 = 3.841$. The positive values of $\gamma_1$ suggest that hunters have a lower feeling of satisfaction with *Overall* and *Access* compared to other visitors. The negative values of $\gamma_1$ for *AvFacilities*, *CoFacilities*, *Scene*, *Wildlife*, *Privacy*, and *Safety* indicate that hunters have a higher level of

satisfaction with these variables compared to other visitors. The feeling parameters, $1 - \xi_1$ and $1 - \xi_0$, reflect these trends as well. Respondents were most uncertain about their rating of satisfaction with *Privacy* [$(1 - \pi) = 0.17$] when *Hunter* is included as a covariate.

When considering only the population of hunters, they have the highest feeling of satisfaction with *Access* and *Safety* and lowest feeling of satisfaction with *Privacy*.

### *3.3.3. Anglers*

*Angler* as a covariate for the feeling parameter significantly affected visitor satisfaction with all the variables of interest. Table 5 shows that the difference of the deviances between the CUB models with and without covariates are higher than the asymptotic critical region $\chi^2 = 3.841$. The positive value of $\gamma_1$ suggests that other visitors have a higher feeling of satisfaction with *CoFacilities* compared to anglers. The negative values of $\gamma_1$ suggest that anglers have a higher feeling of satisfaction with *Overall*, *Access*, *AvFacilities*, *Scene*, *Wildlife*, *Privacy*, and *Safety* compared to other visitors. Likewise, these trends are reflected in the feeling parameters, $1 - \xi_1$ and $1 - \xi_0$. Respondents were most uncertain about their rating of satisfaction with *Safety* [$(1 - \pi) = 0.24$] when *Angler* is included as a covariate.

When examining the population of anglers only, they have the highest feeling of satisfaction with *Safety* and the lowest feeling of satisfaction with *CoFacilities*.

### *3.3.4. Age*

*Age* as a covariate for the feeling parameter significantly affected visitor satisfaction with all the variables of interest, except for *Access*. Table 6 shows that the difference of the deviances between the CUB models with and without covariates are higher than the asymptotic critical region $\chi^2 = 3.841$ for all variables but *Access.* The positive values of $\gamma_1$ suggests that elderly visitors (≥ 65 years old) have a lower feeling of satisfaction with *Safety* compared to younger visitors (18 – 64 years old). The negative values of $\gamma_1$ suggest that elderly visitors have a higher feeling of satisfaction with *Overall*, *AvFacilities*, *CoFacilities*, *Scene*, *Wildlife*, and *Privacy*

compared to younger visitors. The feeling parameters, $1 - \xi_1$ and $1 - \xi_0$, reflect these trends, but the feeling parameters for *Safety* are equal due to rounding. Respondents were most uncertain about their rating of satisfaction with *Safety* [$(1 - \pi) = 0.28$] when *Age* is included as a covariate.

When examining the populations separately, elderly visitors have the highest feeling of satisfaction with *Overall* and *Safety* and lowest feeling of satisfaction with *Privacy*, and younger visitors have the highest feeling of satisfaction with *Safety* and lowest feeling of satisfaction with *CoFacilities*.

### *3.3.5. Gender*

*Gender* as a covariate for the feeling parameter significantly affected visitor satisfaction with all the variables of interest. Table 7 shows that the difference of the deviances between the CUB models with and without covariates are higher than the asymptotic critical region $\chi^2 = 3.841$. The positive value of $\gamma_1$ suggests that female visitors have a higher feeling of satisfaction with *Overall* and *Scene* compared to male visitors. The negative values of $\gamma_1$ suggest that male visitors have a higher feeling of satisfaction with *Access, AvFacilities, CoFacilities, Wildlife, Privacy,* and *Safety* compared to female visitors. Likewise, these trends are reflected in the feeling parameters, $1 - \xi_1$) and $1 - \xi_0$. Respondents were most uncertain about their rating of satisfaction with *Privacy* [$(1 - \pi) = 0.25$] when *Age* is included as a covariate.

Considering the populations separately, male visitors have the highest feeling of satisfaction with *Access* and *Safety* and lowest feeling of satisfaction with *CoFacilities*. Female visitors have the highest feeling of satisfaction with *Scenery* and lowest feeling of satisfaction with *Privacy*.

### *3.3.6. Residential Type*

Residential type *(ResType)* as a covariate for the feeling parameter significantly affected visitor satisfaction with all the variables of interest. Table 7 shows that the difference of the deviances between the CUB models with and without covariates are higher than the asymptotic

critical region $\chi^2 = 3.841$. The positive values of $\gamma_1$ suggest that urban visitors have a higher feeling of satisfaction with all the variables of interest compared to rural visitors. The feeling parameters, $1 - \xi_1$ and $1 - \xi_0$, reflect these trends as well. Respondents were most uncertain about their rating of satisfaction with *Privacy* $[(1 - \pi) = 0.22]$ when *ResType* is included as a covariate.

When examining the populations separately, rural visitors have the highest feeling of satisfaction with *Access* and lowest feeling of satisfaction with *Privacy*, and urban visitors have the highest feeling of satisfaction with *Access* and *Safety* and lowest feeling of satisfaction with *CoFacilities.*

## 4. Discussion

Consumptive visitors were more satisfied than non-consumptive visitors with their overall recreational experience and WMA amenities. On the surface, the results contrast the work done by Vaske and Roemer (2013) who found that consumptive recreationalists reported significantly lower overall satisfaction levels compared to non-consumptive recreationalists when they conducted a comparative analysis on recreation satisfaction surveys administered within North America over three decades. However, inferences based on overall satisfaction alone does not provide a complete picture, and our results provided more detail on the likes and dislikes of each group. Non consumptive visitors had the highest feeling of satisfaction with WMA accessibility but were least satisfied with their privacy from other recreationalists. They had the highest feeling of uncertainty when rating their level of satisfaction with their feeling of safety. Further, my results provided a deeper insight within the consumptive visitor group. Anglers had higher feelings of satisfaction with their overall recreation experience compared to hunters, which is similar to the findings for hunters and anglers who visited Tennessee WMAs in 2018 (Watkins and Poudyal 2021). They also had higher feelings of satisfaction for all the other variables of interest excluding the condition of facilities. In the US, hunters tend to prefer hunting on private lands and anglers tend to prefer fishing on public lands (Ghimire et al. 2016). This is also true for

hunters and anglers in Oklahoma; only 29% of active Oklahoma hunting license holders used public land for any portion of their hunting in 2020, and the estimated number of anglers in Oklahoma who fished public waters was more than double the number that chose private waters in 2019 (York 2019, 2020). Hunters were least satisfied but most uncertain about their privacy from other recreationalists, and they also had lower feelings of satisfaction for the availability and condition of facilities. Crowding can affect one's feeling of safety and privacy and has become a limiting barrier for many hunters in the US (Hinrichs 2019; Montgomery and Blalock 2010).

Elderly WMA visitors had higher feelings of satisfaction with most of the variables of interest in this study, including their overall recreational experience. Recreation satisfaction can be a significant predictor of quality of life among the elderly, but recreation participation typically decreases as age increases (Russell 1990). When considering long-term future management practices, it is important to consider how satisfied the younger age group is with these variables. The WMA visitors between 18-64 years of age were significantly most satisfied but most uncertain about their feeling of safety while visiting WMAs. They were least satisfied with the condition of facilities. Regarding gender, my results support the findings that females are more likely to be constrained from outdoor recreation by concern for their personal safety and inadequate facilities (Ghimire et al. 2014). The trends found for rural and urban WMA visitors in this study are comparable to urban and rural anglers in Arkansas, as urban anglers placed greater importance on site amenities and safety and rural anglers placed more importance on the ability to escape the urban environment (Hutt and Neal 2010).

A limitation to this study is the low sample size provided by the survey responses. The sample size provides *k* values with a range of 23.6-28.6, which are lower than the acceptable bound of 30. However, the value for k can be lowered if the survey item possesses a high degree of feeling, which is the case for all the WMA amenities included in this study (d'Elia 2003).

The results of this study have some important implications for future Oklahoma WMA management. An overarching issue emphasized by the results of this study is that WMA visitors are either most uncertain or least satisfied with their feeling of safety and privacy while visiting WMAs. This is similar to the findings of (Busch et al. 2011) in Virginia, where some respondents expressed concerns about safety, problems with crowding, and conflict with other WMA users. Although incidents are virtually inevitable, especially in respect to large areas of lands, management agencies can take preventative actions to protect visitors from harm and protect the agency from financial and other burdens associated with preventable or unwarranted claims (Mills 1987). To address the lack of privacy, ODWC must understand perceived levels of crowding on WMAs. Perceived levels of crowding vary by use conditions and management actions (Shelby and Vaske 2007) and are driven by visitors' preferences and expectations (Kyle, Landon, and Schuett 2022). Future research could investigate the relationship between levels of perceived crowding at specific WMAs and their associated use conditions and management activities to locate areas with high perceived crowding. Although agencies cannot directly control encounters, they can shape visitors' expectations through communications and messaging, which can have downstream effects on perceived crowding and level of enjoyment (Kyle, Landon, and Schuett 2022). Specifically, to increase WMA satisfaction among non-consumptive visitors, ODWC could advertise the accessibility of WMAs for non-consumptive use during the non-hunting season, which could maintain their satisfaction with WMA accessibility and increase their satisfaction with feelings of privacy and safety. Encouraging non-consumptive visitors to visit WMAs during the non-hunting season, paired with the practice of ethical hunting practices of individual hunters themselves could increase hunter satisfaction with feelings of privacy and safety (Montgomery and Blalock 2010).

## 5. Conclusion

Part of ODWC's mission is to aid in growing the community of hunters and anglers, and understanding visitor satisfaction with WMAs serves as an important piece for achieving their mission. Ensuring WMA management practices agree with the greater good of visitors' expectations and preferences is important for increasing visitation and use of these lands in the future. Overall, the visitor satisfaction data found in this study can help ODWC get an indication of management practices that are working and ones that need improvement, which can be considered when planning, determining best management practices, and allocating funds in their budget.

The ability to include visitors' covariates for the feeling parameter within the CUB (0,1) models provided deeper insights into visitor satisfaction with Oklahoma WMAs. My study results suggest that consumptive WMA visitors have higher feelings of satisfaction compared to non-consumptive visitors. Likewise, study results further suggest that WMA visitors generally have lower feelings of satisfaction and higher levels of uncertainty with their privacy from others and their feeling of safety. These issues could be addressed by increasing advertisement of the non-consumptive opportunities available on WMAs during the non-hunting season.

**Table 3.1.** WMA visitors' characteristics and their level of satisfaction with different aspects of the WMA they most recently visited

| **Variables** | *Definition* | Mean | SD |
|---|---|---|---|
| *Overall* | Overall recreation experience | 4.64 | 0.72 |
| *Access* | Accessibility (parking, entrances) | 4.58 | 0.90 |
| *AvFacilities* | Availability of bathroom facilities, camping areas, shooting ranges, & boat ramps | 4.15 | 0.95 |
| *CoFacilities* | Condition of bathroom facilities, camping areas, shooting ranges, & boat ramps | 4.03 | 1.02 |
| *Scene* | Scenery/condition of the natural environment | 4.42 | 0.91 |
| *Wildlife* | Abundance of wildlife | 4.15 | 1.00 |
| *Privacy* | Privacy from other recreating individuals/parties | 3.94 | 1.13 |
| *Safety* | Feeling of safety | 4.45 | 0.92 |
| | | | |
| **Covariates** | | Mean | SD |
| *RecType* | 1 if the primary recreation activity is consumptive use, 0 otherwise | 0.64 | 0.48 |
| *Hunter* | 1 if the primary recreation activity is hunting, 0 otherwise | 0.22 | 0.42 |
| *Angler* | 1 if the primary recreation activity is fishing, 0 otherwise | 0.42 | 0.49 |
| *Age* | 1 if respondent is 65 or older, 0 otherwise | 0.30 | 0.46 |
| *Gender* | 1 if respondent's gender is male, 0 otherwise | 0.77 | 0.42 |
| *ResType* | 1 if respondent's residential type is rural, 0 otherwise | 0.76 | 0.43 |

**Table 3.2.** CUB model with no covariates, CUB(0,0) (n = 191)

| Variable | Uncertainty (1 - $\pi$) | Feeling (1 - $\xi$) | Log-Likelihood | $k$ = n/$m$ |
|---|---|---|---|---|
| *Overall* | 0.12 | 0.95 | -120.10 | 29.8 |
| *Access* | 0.17 | 0.97 | -122.87 | 29.8 |
| *AvFacilities* | 0.05 | 0.80 | -174.50 | 27.8 |
| *CoFacilities* | 0.11 | 0.79 | -176.15 | 26.6 |
| *Scene* | 0.19 | 0.92 | -153.88 | 28.8 |
| *Wildlife* | 0.15 | 0.83 | -175.89 | 27.4 |
| *Privacy* | 0.23 | 0.79 | -194.08 | 27.6 |
| *Safety* | 0.24 | 0.95 | -152.25 | 29.2 |

**Table 3.3.** Estimated CUB (0,1) models with Recreation type (*RecType)* as covariate for feeling parameter

| Variables | $\gamma_0$ (SE) | $\gamma_1$ (SE) | CUB (0,1) Log-Likelihood ($LL_{01}$) | Significance Test $2(LL_{00} - LL_{01}) > \chi^2 = 3.841$ | Uncertainty $(1 - \pi)$ | Feeling $(1 - \xi_0)$ | Feeling $(1 - \xi_1)$ | n | *k* (n/*m*) |
|---|---|---|---|---|---|---|---|---|---|
| *Overall* | -2.71 (0.57) | -0.36 (0.58) | -107.42 | 25.38* | 0.11 | 0.94 | 0.96 | 133 | 26.6 |
| *Access* | -3.02 (0.53) | -0.42 (0.65) | -110.32 | 25.10* | 0.16 | 0.95 | 0.97 | 133 | 26.6 |
| *AvFacilities* | -1.13 (0.20) | -0.38 (0.24) | -156.12 | 36.77* | 0.04 | 0.75 | 0.82 | 124 | 24.8 |
| *CoFacilities* | -1.29 (0.22) | -0.11 (0.28) | -155.40 | 41.50* | 0.12 | 0.78 | 0.80 | 118 | 23.6 |
| *Scene* | -1.60 (0.27) | -1.19 (0.47) | -135.18 | 37.40* | 0.15 | 0.83 | 0.94 | 128 | 25.6 |
| *Wildlife* | -1.03 (0.19) | -0.92 (0.35) | -149.88 | 52.02* | 0.14 | 0.74 | 0.88 | 121 | 24.2 |
| *Privacy* | -1.00 (0.21) | -0.45 (0.29) | -169.15 | 49.85* | 0.18 | 0.73 | 0.81 | 122 | 24.4 |
| *Safety* | -1.80 (0.29) | -2.59 (1.21) | -132.58 | 39.35* | 0.24 | 0.86 | 0.99 | 130 | 26 |

*Significant

**Table 3.4.** Estimated CUB (0,1) models with *Hunter* as covariate for feeling parameter

| Variables | $\gamma_0$ (SE) | $\gamma_1$ (SE) | CUB (0,1) Log-Likelihood ($LL_{01}$) | Significance Test $2(LL_{00} - LL_{01}) > \chi^2 = 3.841$ | Uncertainty $(1 - \pi)$ | Feeling $(1 - \xi_0)$ | Feeling $(1 - \xi_1)$ | n | *k* (n/*m*) |
|---|---|---|---|---|---|---|---|---|---|
| *Overall* | -3.42 (0.60) | 0.71 (0.71) | -107.05 | 26.11* | 0.14 | 0.97 | 0.94 | 133 | 26.6 |
| *Access* | -3.36 (0.41) | 0.17 (0.70) | -110.49 | 24.76* | 0.16 | 0.97 | 0.96 | 133 | 26.6 |
| *AvFacilities* | -1.34 (0.15) | -0.12 (0.30) | -157.24 | 34.51* | 0.05 | 0.79 | 0.81 | 124 | 24.8 |
| *CoFacilities* | -1.26 (0.15) | -0.51 (0.38) | -154.46 | 43.38* | 0.11 | 0.78 | 0.85 | 118 | 23.6 |
| *Scene* | -2.14 (0.29) | -0.64 (0.61) | -138.51 | 30.73* | 0.16 | 0.89 | 0.94 | 128 | 25.6 |
| *Wildlife* | -1.37 (0.19) | -0.12 (0.35) | -154.19 | 43.40* | 0.07 | 0.80 | 0.82 | 121 | 24.2 |
| *Privacy* | -1.22 (0.17) | -0.10 (0.34) | -170.34 | 47.48* | 0.17 | 0.77 | 0.79 | 122 | 24.4 |
| *Safety* | -2.06 (0.31) | -1.18 (1.07) | -136.81 | 30.88* | 0.14 | 0.89 | 0.96 | 130 | 26 |

*Significant

**Table 3.5.** Estimated CUB (0,1) models with *Angler* as covariate for feeling parameter

| Variables | $\gamma_0$ (SE) | $\gamma_1$ (SE) | CUB (0,1) Log-Likelihood ($LL_{01}$) | Significance Test $2(LL_{00} - LL_{01}) > \chi^2 = 3.841$ | Uncertainty $(1 - \pi)$ | Feeling $(1 - \xi_0)$ | Feeling $(1 - \xi_1)$ | n | *k* (n/*m*) |
|---|---|---|---|---|---|---|---|---|---|
| *Overall* | -2.76 (0.37) | -1.13 (0.87) | -106.43 | 27.34* | 0.13 | 0.94 | 0.98 | 133 | 26.6 |
| *Access* | -3.09 (0.40) | -0.54 (0.69) | -110.19 | 25.36* | 0.16 | 0.96 | 0.97 | 133 | 26.6 |
| *AvFacilities* | -1.26 (0.16) | -0.30 (0.26) | -156.62 | 35.76* | 0.05 | 0.78 | 0.83 | 124 | 24.8 |
| *CoFacilities* | -1.44 (0.19) | 0.21 (0.27) | -155.18 | 41.93* | 0.11 | 0.81 | 0.77 | 118 | 23.6 |
| *Scene* | -1.99 (0.28) | -0.90 (0.57) | -137.49 | 32.77* | 0.16 | 0.88 | 0.95 | 128 | 25.6 |
| *Wildlife* | -1.19 (0.16) | -0.90 (0.38) | -150.57 | 50.65* | 0.10 | 0.77 | 0.90 | 121 | 24.2 |
| *Privacy* | -1.11 (0.18) | -0.41 (0.32) | -169.46 | 49.24* | 0.18 | 0.75 | 0.82 | 122 | 24.4 |
| *Safety* | -2.25 (0.34) | -2.67 (2.21) | -135.83 | 32.84* | 0.24 | 0.91 | 0.99 | 130 | 26 |

*Significant

**Table 3.6.** Estimated CUB (0,1) models with *Age* as covariate for feeling parameter

| Variables | $\gamma_0$ (SE) | $\gamma_1$ (SE) | CUB (0,1) Log-Likelihood ($LL_{01}$) | Significance Test $2(LL_{00} - LL_{01}) > \chi^2 = 3.841$ | Uncertainty $(1 - \pi)$ | Feeling $(1 - \xi_0)$ | Feeling $(1 - \xi_1)$ | n | $k$ (n/$m$) |
|---|---|---|---|---|---|---|---|---|---|
| *Overall* | -2.68 (0.39) | -0.51 (0.62) | -118.01 | 4.19* | 0.10 | 0.94 | 0.96 | 143 | 28.6 |
| *Access* | -3.38 (0.41) | 0.03 (0.71) | -121.22 | 3.30 | 0.18 | 0.97 | 0.97 | 143 | 28.6 |
| *AvFacilities* | -1.28 (0.14) | -0.32 (0.29) | -167.39 | 14.21* | 0.04 | 0.78 | 0.83 | 133 | 26.6 |
| *CoFacilities* | -1.16 (0.14) | -0.49 (0.33) | -168.16 | 15.98* | 0.10 | 0.76 | 0.84 | 127 | 25.4 |
| *Scene* | -2.11 (0.28) | -0.83 (0.55) | -146.63 | 14.50* | 0.14 | 0.89 | 0.95 | 138 | 27.6 |
| *Wildlife* | -1.60 (0.22) | -0.07 (0.42) | -168.28 | 15.22* | 0.17 | 0.83 | 0.84 | 131 | 26.2 |
| *Privacy* | -1.25 (0.19) | -0.23 (0.39) | -187.64 | 12.88* | 0.23 | 0.78 | 0.81 | 132 | 26.4 |
| *Safety* | -3.25 (0.74) | 0.16 (0.93) | -147.45 | 9.60* | 0.28 | 0.96 | 0.96 | 141 | 28.2 |

*Significant

**Table 3.7.** Estimated CUB (0,1) models with *Gender* as covariate for feeling parameter

| Variables | $\gamma_0$ (SE) | $\gamma_1$ (SE) | CUB (0,1) Log-Likelihood ($LL_{01}$) | Significance Test $2(LL_{00} - LL_{01}) > \chi^2 = 3.841$ | Uncertainty $(1 - \pi)$ | Feeling $(1 - \xi_0)$ | Feeling $(1 - \xi_1)$ | n | *k* (n/*m*) |
|---|---|---|---|---|---|---|---|---|---|
| *Overall* | -3.52 (2.07) | 0.47 (1.97) | -116.54 | 7.12* | 0.14 | 0.97 | 0.95 | 142 | 28.4 |
| *Access* | -3.23 (0.72) | -0.16 (0.79) | -120.92 | 3.90* | 0.18 | 0.96 | 0.97 | 142 | 28.4 |
| *AvFacilities* | -1.15 (0.24) | -0.26 (0.27) | -166.65 | 15.69* | 0.05 | 0.76 | 0.80 | 132 | 26.4 |
| *CoFacilities* | -1.14 (0.31) | -0.15 (0.33) | -168.32 | 15.66* | 0.11 | 0.76 | 0.78 | 126 | 25.2 |
| *Scene* | -4.33 (1.76) | 1.91 (1.73) | -144.90 | 17.97* | 0.22 | 0.99 | 0.92 | 137 | 27.4 |
| *Wildlife* | -1.07 (0.27) | -0.86 (0.37) | -164.41 | 22.96* | 0.20 | 0.74 | 0.87 | 130 | 26 |
| *Privacy* | -0.80 (0.28) | -0.69 (0.35) | -184.79 | 18.57* | 0.25 | 0.69 | 0.82 | 131 | 26.2 |
| *Safety* | -1.69 (0.35) | -1.80 (0.67) | -143.30 | 17.90* | 0.24 | 0.84 | 0.97 | 140 | 28 |

*Significant

**Table 3.8.** Estimated CUB (0,1) models with residential type *(ResType)* as covariate for feeling parameter

| Variables | $\gamma_0$ (SE) | $\gamma_1$ (SE) | CUB (0,1) Log-Likelihood ($LL_{01}$) | Significance Test $2(LL_{00} - LL_{01}) > \chi^2 = 3.841$ | Uncertainty $(1 - \pi)$ | Feeling $(1 - \xi_0)$ | Feeling $(1 - \xi_1)$ | n | *k* (n/*m*) |
|---|---|---|---|---|---|---|---|---|---|
| *Overall* | -3.15 (0.50) | 0.50 | -117.67 | 4.86* | 0.10 | 0.96 | 0.93 | 142 | 28.4 |
| *Access* | -3.80 (0.76) | 0.61 | -117.53 | 10.69* | 0.16 | 0.98 | 0.96 | 142 | 28.4 |
| *AvFacilities* | -1.51 (0.24) | 0.19 | -165.93 | 17.13* | 0.05 | 0.82 | 0.79 | 132 | 26.4 |
| *CoFacilities* | -1.32 (0.25) | 0.07 | -169.33 | 13.64* | 0.11 | 0.79 | 0.78 | 127 | 25.4 |
| *Scene* | -3.02 (0.56) | 0.86 | -146.51 | 14.75* | 0.17 | 0.95 | 0.90 | 138 | 27.6 |
| *Wildlife* | -1.98 (0.33) | 0.58 | -166.90 | 18.00* | 0.13 | 0.88 | 0.80 | 131 | 26.2 |
| *Privacy* | -1.89 (0.40) | 0.84 | -184.80 | 18.55* | 0.22 | 0.87 | 0.74 | 132 | 26.4 |
| *Safety* | -3.70 (0.79) | 1.59 | -145.21 | 14.09* | 0.16 | 0.98 | 0.89 | 141 | 28.2 |

*Significant

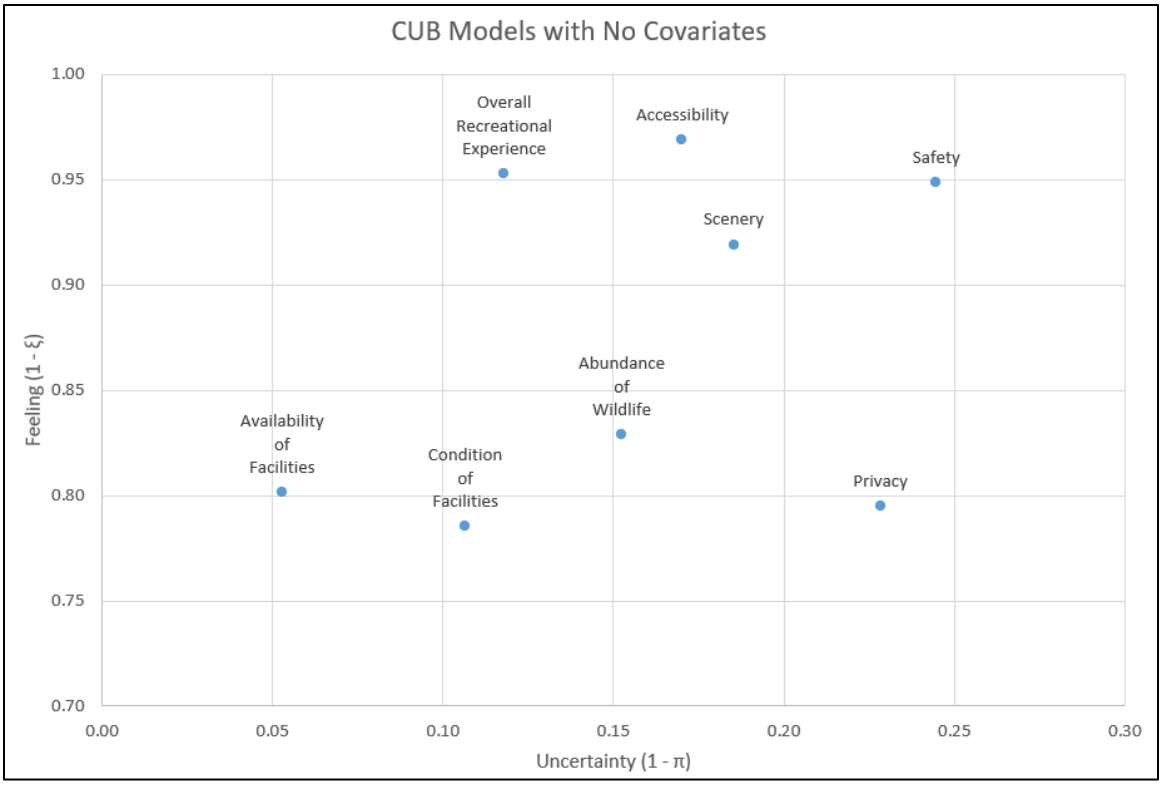


**Figure 3.1.** Estimated CUB models for WMA characteristics used when analyzing WMA visitor satisfaction

# CHAPTER IV

## CONCLUSION

The results presented from this research demonstrate how important WMAs are to visitors and the state and local economies. They also provide insight on WMA visitation and satisfaction. ODWC can use these results to improve and/or expand the WMA system, so they can maintain their status as valuable assets to Oklahoma hunters, anglers, and other recreationalists.

Chapter II revealed that WMA visitors received an individual CS value of $15.95-$28.09 and annual aggregate CS value between $42.62-75.08 million in 2020. WMA-related spending, directly and indirectly, created a total of 8,341.4 jobs that provided a labor income of $297.3 million and contributed a total of $39.6 million in state and local taxes and $57.1 million in federal taxes in Oklahoma in 2020. These estimates are helpful in demonstrating the public value of WMAs and comparing the cost of WMA management against the benefit to the user community.

Chapter III revealed that WMA visitors are generally satisfied with WMAs in Oklahoma, but the use of a CUB model provided a deeper insight into visitor satisfaction. Consumptive users had higher feelings of satisfaction with WMA characteristics compared to non-consumptive users, and visitors were either most uncertain or least satisfied with their feeling of safety and privacy while visiting WMAs.

Combining the economic importance of WMAs with the human dimensions aspect of WMA visitation was a unique feature of this research. Ultimately, by understanding and meeting visitor satisfaction and preferences, ODWC can aid in the increase in demand for WMAs, which could lead to an increase in positive economic impacts in the state and local communities. Keeping these public lands open for access will continue to play an important role in growing the community of hunters, anglers, and other recreationalists who enjoy Oklahoma's outdoors and natural resources.

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# APPENDICES

## APPENDIX A: IRB Approval Sheet

**Oklahoma State University Institutional Review Board**

| | |
|---|---|
| Application Number: | IRB-21-156 |
| Proposal Title: | Visitors' Characteristics and Economic Contribution of WMAs in Oklahoma (Oklahoma Wildlife Management Area (WMA) Visitor Survey) |
| Principal Investigator: | Madison Gore |
| Co-Investigator(s): | |
| Faculty Adviser: | Omkar Joshi |
| Project Coordinator: | |
| Research Assistant(s): | |

**Status Recommended by Reviewer(s): Approved**

| | |
|---|---|
| Study Review Level: | Exempt |
| Modification Approval Date: | 08/25/2021 |

The modification of the IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46. The original expiration date of the protocol has not changed.

Modifications Approved:
Modifications Approved: conduct surveys via phone

The final versions of any recruitment, consent and assent documents bearing the IRB approval stamp are available for download from IRBManager. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved.
2. Submit a status report to the IRB when requested
3. Promptly report to the IRB any harm experienced by a participant that is both unanticipated and related per IRB policy.
4. Maintain accurate and complete study records for evaluation by the OSU IRB and, if applicable, inspection by regulatory agencies and/or the study sponsor.
5. Notify the IRB office when your research project is complete or when you are no longer affiliated with Oklahoma State University.

Sincerely,

Oklahoma State University IRB
223 Scott Hall, Stillwater, OK 74078
Website: https://irb.okstate.edu/
Ph: 405-744-3377 | Fax: 405-744-4335| irb@okstate.edu

APPENDIX B: Participation Information Sheet

## Oklahoma Wildlife Management Area (WMA) Visitor Survey 2021




**Survey Instructions:** Oklahoma State University and the Oklahoma Department of Wildlife Conservation (ODWC) are conducting a survey to learn more about the economic impacts of Wildlife Management Areas (WMAs) in Oklahoma, WMA visitor satisfaction and preference, and the effects of COVID-19 on WMA use.

You are one of a small number of people chosen for this study, so your opinions are important to us. You must be 18 years or older to participate in this study. Please take approximately 15 minutes to complete this questionnaire. There are no right or wrong answers, we are simply interested in seeking your opinions and perspectives. There are no financial compensation or direct benefits to you for your participation. However, study results will provide insights on if and how ODWC should alter their management practices on Oklahoma WMAs, to benefit WMA users. If you wish, you can complete this survey online using the URL at the bottom of the page. We work to ensure confidentiality to the degree permitted by technology. It is possible, although unlikely, that unauthorized individuals could gain access to your responses if you decide to respond online. However, your participation in the online version of the survey involves risks similar to a person's everyday use of the internet. If you have concerns, you can consult the survey provider privacy policy at https://www.qualtrics.com/privacy-statement/.

Your individual responses and information will be kept confidential and will not be shared with anyone. The aggregate data will be used in any related reports/publications/presentations, and respondents' names will never be used in any reports. Your response is voluntary, and no action may be taken against you based on your responses or for refusing to supply the information requested. You are free to withdraw your consent and participation in this project at any time. You may contact the Principal Investigator, Madison Gore, at (580)-922-0372 or madison.archer@okstate.edu if you desire to discuss your participation in the study and/or request information about the results of the study. If you have questions about your rights as a research participant, contact the OSU Office of Institutional Review Board (IRB) at (405)-744-3377 or irb@okstate.edu. Please read each question carefully and save any additional comments for the final page. When finished, please place the completed survey into the addressed postage-paid return envelope and mail it back to us.

**https://tinyurl.com/WMAVisitorSurvey**

DEPARTMENT OF NATURAL RESOURCE ECOLOGY AND MANAGEMENT

Approved: 03/31/2021
Protocol #: IRB-21-156

APPENDIX C: Oklahoma Wildlife Management Area Visitor Survey

## Section A: Recreation Experience at WMAs in Oklahoma

This section includes questions on your WMA trip details and expenditures.

**WMAs are public areas across the state managed by ODWC for hunting, fishing, and outdoor recreation purposes. They do not include State Parks, National Wildlife Refuges, National Grasslands, National Forests, or National Recreation Areas.**

1. **Did you visit any WMAs in Oklahoma from January 1, 2019-December 31, 2020?** (*Check one*)
   - ☐ Yes (*Continue to Question 3*)
   - ☐ No (*Continue to Question 2*)

2. **Which of the following describes the reason you did not visit a WMA in 2019 or 2020?** (*Check one. Then Answer Question 2A below and complete Section C on page 9*)
   - ☐ I typically visit WMAs in Oklahoma, but I did not visit one in 2019 or 2020.
   - ☐ I typically visit WMAs in Oklahoma, but I did not visit one in 2019 or 2020 due to the COVID-19 pandemic.
   - ☐ I have never visited a WMA in Oklahoma.
   - ☐ I no longer visit WMAs in Oklahoma.

**2. A) Please indicate whether the following constraints keep you from visiting WMAs in Oklahoma.** (*Check all that apply.*)

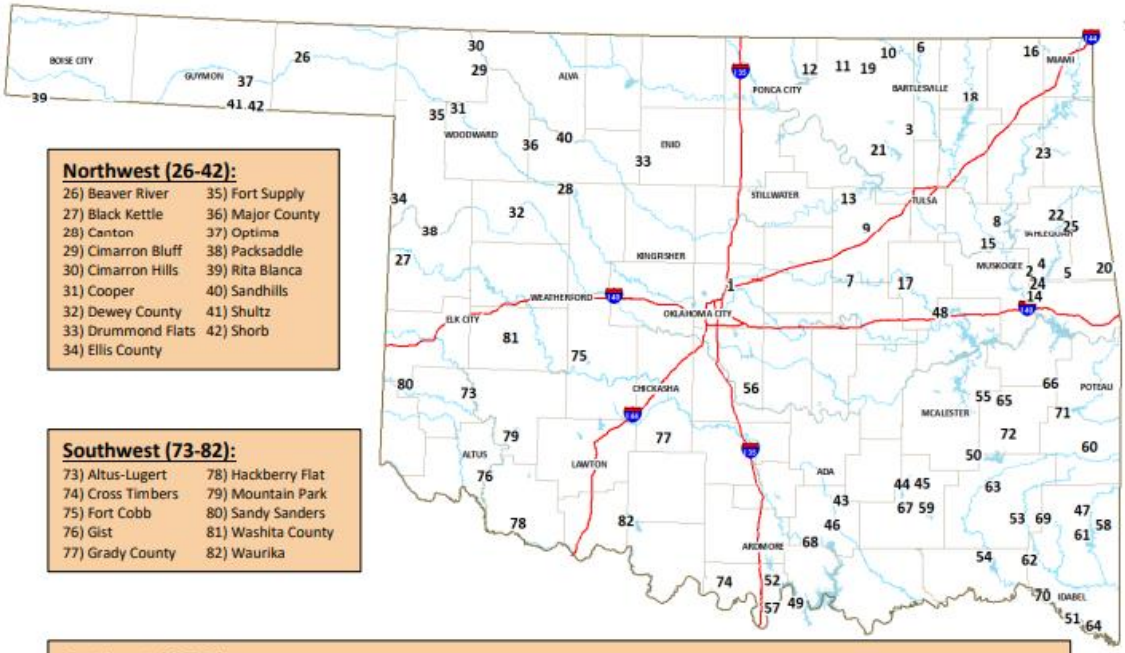
| | |
|---|---|
| ☐ Not enough time | ☐ Litter or trash problems at WMAs |
| ☐ Not enough money | ☐ Personal health issues |
| ☐ No means of transportation | ☐ No one to visit WMAs with |
| ☐ Lack of safety at WMAs | ☐ You have access to private property for recreation |
| ☐ Lack of maintenance at WMAs | ☐ You lease private property for recreation |
| ☐ Too many people at WMAs | ☐ You are unaware of opportunities available on WMAs |
| ☐ Inadequate facilities at WMAs | ☐ No WMAs close to your home |
| ☐ WMA regulations are confusing | ☐ WMA regulations are overly restrictive |

3. **How important were the following factors in determining your decision to visit a WMA in Oklahoma** (*Check one box in each row.*)

| | Not at all important | Low importance | Neutral | Important | Very important |
|---|---|---|---|---|---|
| Accessibility (i.e., parking, entrances) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Condition of roads & trails | ☐ | ☐ | ☐ | ☐ | ☐ |
| Adequacy of signage | ☐ | ☐ | ☐ | ☐ | ☐ |
| Availability of bathrooms | ☐ | ☐ | ☐ | ☐ | ☐ |
| Availability of shooting ranges | ☐ | ☐ | ☐ | ☐ | ☐ |
| Availability of boat ramps | ☐ | ☐ | ☐ | ☐ | ☐ |
| Availability of camping areas | ☐ | ☐ | ☐ | ☐ | ☐ |
| Land Management (food plots, brush control) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Scenery/condition of natural environment | ☐ | ☐ | ☐ | ☐ | ☐ |
| Abundance of wildlife | ☐ | ☐ | ☐ | ☐ | ☐ |
| Presence of ponds and/or rivers | ☐ | ☐ | ☐ | ☐ | ☐ |
| Presence of prairie habitat | ☐ | ☐ | ☐ | ☐ | ☐ |
| Presence of forest habitat | ☐ | ☐ | ☐ | ☐ | ☐ |
| Privacy from other recreating individuals | ☐ | ☐ | ☐ | ☐ | ☐ |
| Feeling of safety | ☐ | ☐ | ☐ | ☐ | ☐ |
| Cleanliness (amount of litter, trash, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Availability of WMAs near my home | ☐ | ☐ | ☐ | ☐ | ☐ |
| Helpfulness of ODWC employees | ☐ | ☐ | ☐ | ☐ | ☐ |

**Northeast (1-25):**

| | | | | | |
|---|---|---|---|---|---|
| 1) Arcadia CEA | 5) Cookson | 9) Heyburn | 13) Keystone | 17) Okmulgee | 21) Skiatook |
| 2) Camp Gruber | 6) Copan | 10) Hulah | 14) Lower Illinois River | 18) Oologah | 22) Sparrow Hawk |
| 3) Candy Creek | 7) Deep Fork | 11) John Dahl | 15) McClellan-Kerr | 19) Osage | 23) Spavinaw |
| 4) Cherokee | 8) Fort Gibson | 12) Kaw | 16) Neosho | 20) Ozark Plateau | 24) Tenkiller |
| | | | | | 25) Thomas Bamberger |




**Northwest (26-42):**

| | |
|---|---|
| 26) Beaver River | 35) Fort Supply |
| 27) Black Kettle | 36) Major County |
| 28) Canton | 37) Optima |
| 29) Cimarron Bluff | 38) Packsaddle |
| 30) Cimarron Hills | 39) Rita Blanca |
| 31) Cooper | 40) Sandhills |
| 32) Dewey County | 41) Shultz |
| 33) Drummond Flats | 42) Shorb |
| 34) Ellis County | |

**Southwest (73-82):**

| | |
|---|---|
| 73) Altus-Lugert | 78) Hackberry Flat |
| 74) Cross Timbers | 79) Mountain Park |
| 75) Fort Cobb | 80) Sandy Sanders |
| 76) Gist | 81) Washita County |
| 77) Grady County | 82) Waurika |

**Southeast (43-72):**

| | | | | | |
|---|---|---|---|---|---|
| 43) Arbuckle Springs | 48) Eufaula | 53) Honobia Creek | 58) McCurtain County WA | 63) Pushmataha | 68) Texoma Washita Arm |
| 44) Atoka | 49) Fobb Bottom | 54) Hugo | 59) McGee Creek | 64) Red Slough | 69) Three Rivers |
| 45) Atoka PHA | 50) Gary Sherrer | 55) James Collins | 60) Ouachita Leflore Unit | 65) Robbers Cave | 70) Whitegrass Flats |
| 46) Blue River | 51) Grassy Slough | 56) Lexington | 61) Ouachita McCurtain Unit | 66) Sans Bois | 71) Wister |
| 47) Broken Bow | 52) Hickory Creek | 57) Love Valley | 62) Pine Creek | 67) Stringtown | 72) Yourman |

**4. Using the map of Oklahoma WMAs and their corresponding numbers, please identify all of the WMAs you visited in 2020. Also, fill in the details of the trips you took to each WMA.**

| WMA # or Name | Number of trips taken in 2020 | Average length of trip (*in days*) | Average Party Size (*including yourself*) | Primary recreation activity (*i.e., hunting, fishing, hiking, wildlife photography, other*) | Secondary recreation activity (*write "X" if you did not participate in a secondary activity*) |
|---|---|---|---|---|---|
| *Example: 28 or Canton* | *6* | *2* | *2* | *Hunting* | *Wildlife Photography* |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

5. **Using the map of Oklahoma WMAs and their corresponding numbers on page 2, please identify the WMA you last visited and your primary recreation activity for that trip.**

   **A) WMA Name or #:** _____

   **B) Primary recreation activity:** _____

   **C) Time spent doing your primary activity:** _____ hours

   **D) Including your most recent trip, about how many times have you come to this WMA for recreation in the past 12 months?**

   _____ # total trips

   **E) About how many planned trips to this WMA have you cancelled in the past 12 months due to the COVID-19 pandemic?**

   _____ # total trips

   **F) How many of those cancelled trips were to participate in the primary activity you mentioned above?**

   _____ # total trips

   **G) How many trips do you intend on taking to this WMA for your primary recreation activity in the next 12 months?**

   _____ # total trip

   **H) Suppose management efforts resulted in the improvement of accessibility, facilities, amenities, land management, wildlife abundance, safety, and privacy at this WMA. How many trips for your primary recreation activity would you take during the next 12 months if these improvements were made?**

| **Intended number of trips during the next 12 months if…** | **# of trips in next 12 months** |
|---|---|
| Accessibility was improved (parking, entrances, roads, trails, & adequacy of signage) | _____ trips |
| Condition of camping areas, boat ramps, shootings ranges, etc. were improved | _____ trips |
| Land management activities (food plots, brush control) were improved | _____ trips |
| Abundance of wildlife was improved | _____ trips |
| Safety and privacy from other recreating individuals were improved | _____ trips |

   **I) Please rate your perception of the level of crowding at the recreation site in this WMA during your last visit.** (*Check one*)

**Not at all crowded** ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 **Very crowded**

   **J) As far as you remember, how many individuals were also participating in the same recreation activity as your primary activity at the recreation site during your last visit?**

   _____ # of individuals

   **K) As far as you remember, how many individuals were participating in other recreation activities at the recreation site during your last visit?**

   _____ # of individuals

   **L) How acceptable was the number of individuals recreating at the recreation site in this WMA during your last visit?** (*Check one box in each row.*)

| | **Very Unacceptable** | **Unacceptable** | **About right** | **Acceptable** | **Very Acceptable** |
|---|---|---|---|---|---|
| Number of individuals participating in the **same** recreation activity as your primary activity | ☐ | ☐ | ☐ | ☐ | ☐ |
| Number of individuals participating in **other** recreation activities | ☐ | ☐ | ☐ | ☐ | ☐ |

**M) WMAs are used by a variety of users, so encounters with others may hinder your recreation experience. How many trips for your primary recreation activity would you take to this WMA during the next 12 months if your encounter with other groups were altered?**

| Intended number of trips during the next 12 months if your encounter with… | # of trips in next 12 months |
|---|---|
| People participating in the same activity as your primary activity were to **double** | _____ trips |
| People participating in the same activity as your primary activity were to **be cut in half** | _____ trips |
| People participating in different activities as your primary activity were to **double** | _____ trips |
| People participating in different activities as your primary activity were to **be cut in half** | _____ trips |

**N) How did the encounter with other users of the following groups add or take away from your recreation satisfaction during your last visit to this WMA?** (*Check one box in each row*)

| Visitor Group | Take away from my satisfaction | No Effect | Add to my satisfaction |
|---|---|---|---|
| Hunters | ☐ | ☐ | ☐ |
| Anglers | ☐ | ☐ | ☐ |
| Trappers | ☐ | ☐ | ☐ |
| Hikers | ☐ | ☐ | ☐ |
| Mountain bikers | ☐ | ☐ | ☐ |
| Wildlife watchers | ☐ | ☐ | ☐ |
| Horseback riders | ☐ | ☐ | ☐ |
| Campers | ☐ | ☐ | ☐ |
| Target Shooters | ☐ | ☐ | ☐ |
| Boaters | ☐ | ☐ | ☐ |
| Foragers | ☐ | ☐ | ☐ |
| Other: _____ | ☐ | ☐ | ☐ |

**O) Please indicate your level of agreement with each statement describing your feelings towards the WMA you visited most recently.** (*Check one box in each row*)

| | Strongly disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Strongly agree |
|---|---|---|---|---|---|
| I am very attached to this WMA | ☐ | ☐ | ☐ | ☐ | ☐ |
| I identify strongly with this WMA | ☐ | ☐ | ☐ | ☐ | ☐ |
| This WMA means a lot to me | ☐ | ☐ | ☐ | ☐ | ☐ |
| This WMA reflects the type of person I am | ☐ | ☐ | ☐ | ☐ | ☐ |
| This WMA is the best place for what I like to do | ☐ | ☐ | ☐ | ☐ | ☐ |
| No other WMA can compare to this one | ☐ | ☐ | ☐ | ☐ | ☐ |
| This WMA is my favorite place to be | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would not substitute this WMA for another | ☐ | ☐ | ☐ | ☐ | ☐ |

**P) If you had been unable to go to this WMA, which of the following best describes your potential reaction?** (*Check all that apply.*)

- ☐ I would have travelled up to _____ miles to go to a different WMA in Oklahoma.
- ☐ I would have found a different, non-WMA location for the same activity.
- ☐ I would have participated in a different activity in Oklahoma during that time.
- ☐ I would have travelled outside of Oklahoma for the same activity.
- ☐ I would have stayed home or found a different non-outdoor activity to participate in.

**Q) How long have you been recreating in Oklahoma?** _____ years

6. **Did you visit a WMA for the first time during the COVID-19 pandemic?** (*Check one*)
   ☐ Yes ☐ No

7. **When you visit WMAs in Oklahoma, how do you handle expenses?** (*Check one*)
   ☐ Pay only for your expenses ☐ Share expenses with others in your party ☐ Pay for all people in your party

8. **During a typical trip to an Oklahoma WMA, how much do you spend on each item below?** [Please indicate the amount spent for all people you were financially responsible for (e.g., children, spouse). If you did not spend money on an item, write "0".]

| ITEM | SPENDING/DAY |
|---|---|
| **Transportation to and from WMA:** | |
| Gasoline & Oil | $_____ |
| Repair/Service for Automobile, Truck, SUV, or Trailer | $_____ |
| Other Transportation (Bicycle, Motorcycle, ATV) | $_____ |
| Other Transportation Costs (Please specify): _____ | $_____ |
| **Food & Beverages:** | |
| Meals (food & drinks) at Restaurants (including tips) | $_____ |
| Food & Drinks purchased at a Convenience Store/Travel Plaza | $_____ |
| Food & Drinks purchased at a Grocery Store or Supermarket | $_____ |
| **Lodging:** | |
| Hotel or Motel | $_____ |
| Bed & Breakfast or Cabin | $_____ |
| Public or Private Campground for RV, Tent, and/or Camper | $_____ |
| Rental House, Airbnb, or VRBO | $_____ |
| **Activity Expenses:** | |
| Hunting Supplies | $_____ |
| Fishing Supplies | $_____ |
| Fishing/Hunting Fees or Licenses | $_____ |
| Equipment Rentals (e.g., kayak/canoe, ATV, etc.) | $_____ |
| Other Recreation Supplies (e.g., binoculars, hiking poles, etc.) | $_____ |
| **Other Expenses:** | |
| Entertainment (Museums, Amusements) | $_____ |
| Retail Goods Other than Groceries (General Merchandise) | $_____ |
| Camping Supplies | $_____ |
| Guide/Outfitter or Tour Fees | $_____ |
| Other Expenses (Please specify): _____ | $_____ |

9. **What percentage (%) of your expenses are spent in the same county as the WMA during a typical trip?**
   ☐ Almost all ☐ Approximately _____ %

## Section B: Recreation Satisfaction and Preference

This section includes questions on your level of satisfaction with and preference for WMAs, which will be used to inform ODWC of how well they are serving WMA users and what improvements need to be made.

**10. How satisfied were you with the following aspects of the WMA you most recently visited?** (*Check one box in each row*)

| | Dissatisfied | Somewhat Dissatisfied | Neither Satisfied nor Dissatisfied | Somewhat Satisfied | Satisfied | Did not Use/Not applicable |
|---|---|---|---|---|---|---|
| Overall recreational experience | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Accessibility (parking, entrances) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Condition of roads & trails | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Adequacy of signage | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Availability of bathroom facilities | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Availability of camping areas | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Availability of shooting ranges | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Availability of boat ramps | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Condition of bathroom facilities | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Condition of camping areas | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Condition of shooting ranges | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Condition of boat ramps | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Land management practices (food plots, brush control) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Scenery/condition of the natural environment | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Abundance of wildlife | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Special Area Regulations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Privacy from other recreating individuals/parties | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Feeling of safety | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Cleanliness (amount of litter, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Helpfulness of ODWC employees (Game Wardens, Wildlife Biologists) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**11. How important are each of the following reasons for why you visit WMAs in Oklahoma?** (*Check one box in each row*)

| | Not at all Important | Less Important | Neutral | Important | Very Important |
|---|---|---|---|---|---|
| Enjoying nature and the outdoors | ☐ | ☐ | ☐ | ☐ | ☐ |
| Getting physical exercise | ☐ | ☐ | ☐ | ☐ | ☐ |
| Improving my skills (hunting, fishing, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Experiencing challenges (the hunt, hiking, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Seeing the beauty of nature | ☐ | ☐ | ☐ | ☐ | ☐ |
| Giving my mind a rest | ☐ | ☐ | ☐ | ☐ | ☐ |
| Being with friends and/or family | ☐ | ☐ | ☐ | ☐ | ☐ |
| Teaching others to recreate (to hunt, fish, hike, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Knowing friends and family are recreating | ☐ | ☐ | ☐ | ☐ | ☐ |
| Harvesting an animal | ☐ | ☐ | ☐ | ☐ | ☐ |
| Helping manage wild game populations | ☐ | ☐ | ☐ | ☐ | ☐ |
| Catching fish | ☐ | ☐ | ☐ | ☐ | ☐ |
| Taking an animal/fish home for food | ☐ | ☐ | ☐ | ☐ | ☐ |

**12. In 2020, how satisfied were you with the quality of experience of the recreation activities you participated in while visiting Oklahoma WMAs?** (*Check one box in each row*)

| | Dissatisfied | Somewhat Dissatisfied | Neither Satisfied nor Dissatisfied | Somewhat Satisfied | Satisfied | Did not Do/Not applicable |
|---|---|---|---|---|---|---|
| Hunting | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Fishing | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Trapping | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Hiking | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Mountain biking | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Wildlife watching | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Horseback riding | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Camping | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Target Shooting | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Boating | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Foraging | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other: _____ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**13. We would like to know how COVID-19 impacted your participation in recreational activities. Please check the recreational activities you participated in on Oklahoma WMAs in 2020 and 2019. Then, provide the number of trips and distance travelled to those activities in the last 2 years.** (*Only answer for activities you participated in*)

| Activity | Number of trips taken in a year | | Average one-way travel distance from home to recreation site |
|---|---|---|---|
| | In 2020 | In 2019 | |
| ✓ *Example:* Hiking | *6* trips | *10* trips | *45* miles |
| ☐ Hunting | _____ trips | _____ trips | _____ miles |
| ☐ Fishing | _____ trips | _____ trips | _____ miles |
| ☐ Trapping | _____ trips | _____ trips | _____ miles |
| ☐ Hiking | _____ trips | _____ trips | _____ miles |
| ☐ Mountain biking | _____ trips | _____ trips | _____ miles |
| ☐ Wildlife watching | _____ trips | _____ trips | _____ miles |
| ☐ Horseback riding | _____ trips | _____ trips | _____ miles |
| ☐ Camping | _____ trips | _____ trips | _____ miles |
| ☐ Target shooting | _____ trips | _____ trips | _____ miles |
| ☐ Boating | _____ trips | _____ trips | _____ miles |
| ☐ Foraging | _____ trips | _____ trips | _____ miles |
| ☐ Other: _____ | _____ trips | _____ trips | _____ miles |

**14. Please indicate your level of agreement with each statement regarding your perception of the risk of COVID-19 while visiting WMAs.** (*Check one box in each row*)

| | Strongly disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Strongly agree |
|---|---|---|---|---|---|
| I am worried that I will contract COVID-19 | ☐ | ☐ | ☐ | ☐ | ☐ |
| I am worried about my family contracting COVID-19 | ☐ | ☐ | ☐ | ☐ | ☐ |
| I am worried about COVID-19 occurring in my region | ☐ | ☐ | ☐ | ☐ | ☐ |
| I think there is a risk of spread of COVID-19 in WMAs | ☐ | ☐ | ☐ | ☐ | ☐ |
| I think there is a high probability of meeting a person infected with COVID-19 when visiting WMAs | ☐ | ☐ | ☐ | ☐ | ☐ |

**15. Please indicate, in general, how willing you are to take risks in the following domains of your everyday life.** (*Check one box in each row*)

| | Strongly unwilling | Somewhat unwilling | Neutral/Neither willing nor unwilling | Somewhat willing | Strongly willing |
|---|---|---|---|---|---|
| Personal health | ☐ | ☐ | ☐ | ☐ | ☐ |
| Family health | ☐ | ☐ | ☐ | ☐ | ☐ |
| Financial matters | ☐ | ☐ | ☐ | ☐ | ☐ |
| Driving | ☐ | ☐ | ☐ | ☐ | ☐ |
| Sports/Leisure | ☐ | ☐ | ☐ | ☐ | ☐ |
| Job/Career | ☐ | ☐ | ☐ | ☐ | ☐ |

## Section C: Demographics

This section ensures that respondents are representative of the population of WMA users in Oklahoma. Your answers will be used for statistical purposes only; they will strictly be kept confidential and not be shared with anyone.

**16. What is your age?** _____ years

**17. What is your gender?** (*Check one*) ☐ Male ☐ Female

**18. What is your race?** (*Check all that apply*)
☐ African American ☐ Caucasian ☐ Asian or Pacific Islander
☐ American Indian ☐ Hispanic/Latino/Spanish ☐ Other: _____

**19. What is your home zip code?** _____

**20. What is your residency type?** (*Check one*) ☐ Urban ☐ Semi-urban ☐ Rural

**21. Including yourself, how many people live in your household?** (*Check one*)
_____ Children (0-17) _____ Adults (18-64) _____ Seniors (65+)

**22. In 2020, was there anyone living in your household with pre-existing conditions putting them at risk for contracting COVID-19?** (*Check one*) ☐ Yes ☐ No

**23. In 2020, did anyone in your household contract COVID-19?** (*Check one*) ☐ Yes ☐ No

**24. What is the highest level of education you have completed?** (*Check one*)
☐ Less than High School ☐ Some College ☐ Bachelor's Degree
☐ High School or GED ☐ Associates Degree ☐ Post-graduate Degree

**25. What is your current employment status?** (*Check one*)
☐ Full-Time Job ☐ Student ☐ Retired ☐ Part-Time ☐ Unemployed ☐ Military

**26. Are you a member of any of the following groups?** (*Check all that apply*)
☐ Ducks Unlimited ☐ The Audubon Society ☐ Oklahoma Fur Bearer Alliance
☐ Trout Unlimited ☐ National Rifle Association ☐ Rocky Mountain Elk Foundation
☐ The Sierra Club ☐ The Nature Conservancy ☐ The National Wild Turkey Federation
☐ The Wildlife Society ☐ American Fisheries Society ☐ Backcountry Hunters and Anglers
☐ B.A.S.S. ☐ Pheasants/Quail Forever ☐ Local hunting/fishing club
☐ Other: _____

**27. What was your total gross household income in 2020 before taxes?** (*Check one*)
☐ Less than $20,000 ☐ $20,001-$40,000 ☐ $40,001-$60,000 ☐ $60,001-$80,000
☐ $80,001-$100,000 ☐ More than $100,000 ☐ Prefer not to answer

**Thank you for taking the time to complete this survey! If you have any questions or comments about your recreational experiences at Oklahoma WMAs, please write them below.**

**If you have additional questions or comments, please contact:**

Madison Gore
580-922-0372
madison.archer@okstate.edu

**Using the postage-paid, self-addressed envelope provided, please return this completed survey to:**

Attn: Madison Gore
Natural Resource Ecology and Management
008C Agriculture Hall
Oklahoma State University
Stillwater, OK 74078

VITA

Madison Gore

Candidate for the Degree of

Master of Science

Thesis: WILDLIFE MANAGEMENT AREAS IN OKLAHOMA: A STUDY OF ECONOMIC IMPORTANCE AND VISITOR SATISFACTION

Major Field: Natural Resource Ecology and Management

Biographical:

Education:

Completed the requirements for the Master of Science in Natural Resource Ecology and Management at Oklahoma State University, Stillwater, Oklahoma in July, 2022.

Completed the requirements for the Bachelor of Science in Natural Resource Ecology and Management at Oklahoma State University, Stillwater, Oklahoma in 2020.

Experience:

Graduate Research Assistant at Oklahoma State University, 2020-2022

Professional Memberships:

Society of American Foresters
Xi Sigma Pi