ESTIMATING THE ECONOMIC VALUE OF BIG GAME HUNTING IN GEORGIA:

A NONMARKET APPROACH

by

JAMES CORY MINGIE

(Under the direction Michael T. Mengak and Neelam C. Poudyal)

ABSTRACT

Big game hunting is an important outdoor recreation activity that generates billions of dollars in expenditures each year nationwide. In recent decades, lease hunting on private farm and forestland has become popular in Georgia and other southeastern states. The objectives of this study were to model big game hunting trip demand for public and private land access types, identify hunter preferences for lease attributes, and identify factors correlated with individual hunting club dues. To accomplish these objectives, a mail survey was sent to 3,000 licensed big game hunters in Georgia in 2012 and achieved an adjusted response rate of 24.4%.

The travel cost method was used to model big game hunting trip demand for different land access types. Consumer surplus estimates associated with trips to leased land were largest, while those associated with trips to public land were smallest. Factors affecting trip demand included travel costs, age, retirement status, and hunting experience; while factors affecting demand to lease sites specifically included lease size and membership.

A choice experiment was used to identify hunter preferences for lease attributes. Lease alternatives contained varying levels of the following attributes: price, lease size, membership, buck harvesting regulations, and forest management activity. An analysis of choice responses revealed that big game hunters preferred leases with greater acreages and leases with fewer members. Hunters also preferred leases with more restrictive buck harvesting regulations and sites that had not been recently clearcut.

Hedonic valuation was used to explain variation in hunters' self-reported big game hunting club dues. Lease size, presence of food plots, and game quality had a positive effect on individual club dues while membership had a negative effect.

Results from this research provide a greater understanding of aspects related to the economic value of big game hunting. Findings can be used to educate landowners on big game hunter preferences. For lessors specifically, results indicate that management decisions can be made to increase lease revenue. In addition, policymakers can use the results to better understand the value of big game hunting in Georgia and how hunters respond to price changes based on access type.

INDEX WORDS: hunting, nonmarket valuation, travel cost method, choice experiment, hedonic

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B.S., University of Tennessee, 2009

M.S., Mississippi State University, 2011

A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

DOCTOR OF PHILOSOPHY

ATHENS, GEORGIA

2015

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December 2015

ACKNOWLEDGEMENTS

I am indebted to a number of individuals who helped me during my time at UGA. I had the privilege of working with many brilliant faculty members, research scientists, and fellow students. I cannot list them all here, but I would be remiss if I did not acknowledge at least a few of them.

First, I would like to thank the faculty members I served as a teaching assistant for. I came to UGA with no teaching experience at all, but serving as a TA quickly became one of my favorite parts of the graduate student experience.

I also would like to thank fellow students I was able to work with or alongside. These individuals provided assistance, support, and friendship during my time at UGA. A special acknowledgement goes to Zachary Walton and Unmesh Koirala for their help in implementing the Georgia big game hunting survey.

I also would like to thank the members of my committee for their direction, expertise, and patience. Dr. Lynne Seymour and Dr. Jacek Siry were very helpful and approachable both as teachers and committee members. Dr. Mike Bowker provided a tremendous amount of guidance in crafting this dissertation. I cannot thank him enough for his expertise, candor, and willingness to help. I also thank Dr. Mike Mengak for serving as my co-advisor and taking on a role neither of us anticipated. I thank Dr. Mengak for his guidance and support during my time at UGA. I would also like to express my sincere gratitude to Dr. Neelam Poudyal. Dr. Poudyal gave me the opportunity to come to UGA and is possibly the hardest working and kindest person I have ever met. It was truly a privilege to be his first Ph.D. student. Dr. Poudyal continues to be very supportive and patient, and I cannot thank him enough.

I never would have completed this endeavor without the support of my family. I am extremely blessed for all they have done and continue to do for me.

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CHAPTER 1

INTRODUCTION

Overview of Big Game Hunting

Hunting is a popular outdoor recreation activity with a significant economic contribution. The most recent national survey on wildlife related recreation estimated that 13.7 million hunting participants generated $33.7 billion in expenditures in 2011 (USFWS 2011). In the state of Georgia, there were an estimated 392,000 resident and nonresident hunters in 2011 that generated $965 million in total expenditures (USFWS 2011). Nearly 90% of hunters in Georgia hunted big game in 2011, and roughly 60% of all hunting expenditures in Georgia that year were related to big game hunting (USFWS 2011).

Hunters have various access options such as public land, private leased land, and private non-leased land. Most hunters in Georgia (87%) hunted on some form of private land while a small percentage (22%) hunted on public land in 2011 (USFWS 2011). However, factors such as urban sprawl and land use conversion have decreased the overall acreage of private forestland in the United States (Best and Wayburn 2013). In addition, the amount of private land open to the public for recreation has decreased in recent decades (Kilgore et al. 2008).

As private hunting land access becomes more restrictive and hunters seek an alternative to hunting on public hunting land, lease hunting has become a viable solution for many hunters (Mozumder et al. 2007). The importance of lease hunting indicates that hunters are willing to pay a premium for a higher quality hunting experience (Hussain et al. 2004). For landowners, revenue from leases can be critical considering forest landowner property taxes (Arano et al. 2002) and the number of years it may take for timber sale revenues to materialize (Yarrow and Yarrow 1999). Lessors receive additional nonmonetary benefits such as access control and reduced property damage due to trespassing (Marsinko et al. 1992).

Nonmarket Valuation of Natural Resources

Natural resources provide a number of services to society. In addition to direct uses such as fossil fuels and ecosystem services such as breathable air, natural resources provide amenities such as scenic views and recreational opportunities (Freeman 2003). Though the services provided by natural resources possess intrinsic value for many, intrinsic value alone does not provide a basis for making informed environmental management decisions. Instead, economic values are needed to understand how services and amenities provided by nature affect human well-being (Freeman 2003).

Since environmental services such as recreation do not possess market prices or comprise of a bundle of attributes possessing nonmarket elements, alternative valuation approaches are needed. Categorized into two broad categories, stated preference methods rely on eliciting preferences from respondents based on proposed or hypothetical situations (Brown 2003). Using carefully worded survey questions, stated preference techniques derive estimates of value from choices, ratings, or other indications of preference (Brown 2003). Examples of stated preference techniques include contingent valuation and attribute-based methods. Though contingent valuation is the oldest and most established stated preference method, attribute-based approaches can also be used to elicit preferences for services provided by the environment. Instead of focusing on a single valuation scenario, attribute-based approaches estimate the economic value of a divisible set of attributes related to an environmental good (Holmes and Adamowicz 2003). By allowing the good's attributes to possess varying levels, a better understanding of preferences for multiple states of the environment is achieved (Holmes and Adamowicz 2003).

Revealed preference approaches rely on soliciting preferences from the actual choices people make within markets (Boyle 2003). Examples of revealed preference methods include the travel cost method and hedonic price analysis. The travel cost method is used to model recreation trip demand and estimate the economic benefit of access to a site (Boyle 2003). This method assumes that travel costs can act as a proxy for a good's price and that an individual takes a number of trip that maximizes his or her utility (Parsons 2003). Hedonic models can be used to determine the economic value of characteristics related to a good. By observing market transactions for a heterogeneous good possessing a number of attributes, implicit prices for characteristics related to the good can be estimated (Taylor 2003).

Previous Nonmarket Hunting Studies

Revealed and stated preference approaches have been used to analyze economic aspects of hunting. Travel cost studies have analyzed trip demand to hunting sites (Balkan and Kahn 1988; Creel and Loomis 1990; Bergstrom and Cordell 1991; Creel and Loomis 1992; Luzar et al. 1992; Offenbach and Goodwin 1994; Sarker and Surry 1998). However, many of these studies focused solely on trip demand to public sites (Creel and Loomis 1990; Bergstrom and Cordell 1991; Creel and Loomis 1992; Luzar et al. 1992; Sarker and Surry 1998). Hedonic studies have examined factors affecting hunting lease price. For instance, many studies have examined factors affecting lease rates (Standiford and Howitt 1993; Shrestha and Alavalapati 2004; Zhang et al. 2006; Hussain et al. 2007; Rhyne et al. 2009; Munn and Hussain 2010) while few have examined factors affecting hunting club dues (Livengood 1983; Pope and Stoll 1985; Messonier and Luzar 1990).

Stated preference approaches have been used to analyze hunter preferences. For instance, studies using attribute-based methods have analyzed preferences for site characteristics (Mackenzie 1990; Gan and Luzar 1993; Boxall et al. 1996; Boxall and Macnab 2000). Recent studies have used contingent valuation and attribute-based approaches to examine factors affecting lease choice and hunter willingness to pay for a lease (Hussain et al. 2003; Hussain et al. 2010; Munn et al. 2011).

Research Gaps

Even though studies have examined hunting from a nonmarket perspective, gaps in the literature exist. For instance, the focus of the majority of hunting trip demand studies has been hunting on public land. Since the majority of hunters choose to hunt on private land (USFWS 2011), a better understanding of hunting trip demand with respect to various land access options is needed. Economic values associated with different access options (i.e. leased private land, non-leased private land, public land) may differ. In addition, the response of hunters to changes in costs may vary across different access options. A better understanding of the structure of hunting trip demand could be especially useful considering potential policy changes such as Georgia's proposed increase in hunting license fees.

Though previous studies have examined lease hunting from an attribute-based approach (Hussain et al. 2003; Hussain et al. 2010), studies have not focused on management factors affecting lease preferences. Specifically, preferences for lease attributes pertaining to buck harvesting regulations or timber management activities have not been analyzed. By examining additional potentially important lease attributes, a greater understanding of lease site management preferences can be achieved.

A number of hedonic studies have examined factors affecting per acre lease rates. However, few studies have examined factors affecting hunting club dues (Livengood 1983; Pope and Stoll 1985; Messonier and Luzar 1990). From the demand perspective, a better understanding of hunter preferences for lease characteristics can be achieved by examining factors affecting individual club dues rather than per acre lease rates.

Objectives

The objectives of this study were to:

1. evaluate big game hunting trip demand to various land access types in Georgia (i.e. leased land, non-leased private land, land owned outright by the hunter, and public land) and to identify factors affecting trip demand to lease sites,
2. determine Georgia big game hunter preferences for lease related attributes and to estimate willingness to pay associated with each attribute
3. estimate the economic value of factors that affect individual big game hunting club membership dues in Georgia.

The objectives were achieved by carrying out individual research studies specific to each of the three objectives. The studies were organized into three essays and represent three chapters of this dissertation. For each chapter, relevant background information and literature are presented. Each study's methodological framework is described in detail, and results are presented and discussed along with research implications.

Essay Overview

The first essay (Chapter 2) examined big game hunting trip demand using a travel cost approach. The objective of this study was to model big game hunting demand to different land access types in Georgia and to derive measures of economic benefit associated with this demand. Travel cost models were used to model individual big game hunting trip demand to different hunting sites based on factors such as trip costs, hunting substitutes, income, demographics, and site-specific variables. Factors specifically affecting trip demand to lease sites were also identified. Results from this research should be useful to landowners and stakeholders interested in better understanding the structure of big game hunting trip demand in Georgia.

The second essay (Chapter 3) examined big game hunter preferences for lease attributes. The objective of this study was to identify hunter preferences for attributes related to big game leases and to derive measures of economic value for these attributes. To accomplish this objective, a choice experiment was conducted involving licensed big game hunters in Georgia. Specific lease attributes examined included price, lease size, membership, buck harvesting regulations, and recent forest management activity. Choice responses were analyzed using conditional logit and multinomial probit regression models. Results from this study should provide landowners with useful information regarding lease hunter preferences.

The third essay (Chapter 4) analyzed individual hunting club dues using a hedonic approach. The objective of this study was to identify factors that affect individual big game hunting club membership dues in Georgia. To achieve this objective, a multivariate regression analysis was applied to explain variation in hunters' self-reported big game hunting club dues in 2012. From the estimated hedonic model, implicit price was computed for each significant characteristic. Results from this research should be of interest to landowners interested in increasing hunting club revenue.

The final chapter of the dissertation summarizes key results from each of the three research chapters. In addition, the overall contribution of the essays is discussed along with implications and limitations.

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CHAPTER 2

TOWARD A VALUE FOR BIG GAME HUNTING: A TRAVEL COST APPROACH

Abstract

Big game hunting is an important outdoor recreation activity that generates billions of dollars in expenditures each year nationwide. Leasing is a significant access alternative for hunters who do not have free private access options or do not prefer hunting on public land. The objective of this study was to model big game hunting trip demand to different land access types in Georgia and to derive measures of economic benefit associated with this demand. To understand big game hunter trip behavior, a mail survey was sent to 3,000 big game hunters in Georgia, and a response rate of 24.4% was achieved. Travel cost models were estimated to analyze individual big game hunting trip demand to different access types based on factors such as trip costs, hunter income, demographics, and site-specific variables. To identify factors specific to lease hunting demand, a separate travel cost model was estimated focusing on trip demand to lease sites only. Results indicate that hunting trips to lease sites were valued more than trips to other access types such as public land. Assuming a 0.25 wage rate specification for the cost of time, per trip per person consumer surplus estimates for leased land and public land were $93.79 and $41.98 respectively. Factors that negatively affected big game hunting trip demand included travel costs, age, and household income while factors that had a positive effect on trip demand included retirement status, hunting experience, and the presence of food plots. For lease sites specifically, lease price and size had a positive effect on trip demand while membership had a negative effect. Results from this research are useful for policymakers interested in knowing the value of a big game hunting trip and how this value differs based on access type. In addition, private landowners and managers of public hunting are benefited by better understanding hunter preferences.

Introduction

In the United States, hunting is a popular outdoor recreation activity with a significant economic contribution. The U.S. Fish and Wildlife Service's most recent national survey (2011) on wildlife related recreation estimated that 13.7 million Americans participated in some form of hunting in 2011. In terms of economic importance, hunting expenditures totaled $33.7 billion in 2011 and composed of trip-related expenditures ($10.4 billion), equipment expenditures ($14.0 billion), and other expenditures ($9.3 billion) such as licenses, permits, and lease fees (USFWS 2011). In 2011, big game hunting had the most participants (11.6 million) of any form of hunting in the United States and generated the most expenditures ($16.9 billion) (USFWS 2011).

In the state of Georgia, there were an estimated 392,000 resident and nonresident hunters in 2011 that generated $965 million in total expenditures (USFWS 2011). In 2011, 89% of Georgia hunters hunted big game, and roughly 60% of all hunting expenditures in Georgia were related to big game hunting (USFWS 2011). Georgia hunters have various access options such as public land, private leased land, and private non-leased land. Most hunters in Georgia (87%) hunted on some form of private land while a small percentage (22%) hunted on public land in 2011 (USFWS 2011).

Despite big game hunting's popularity, participants may be constrained by available access options. For instance, a limited supply of public hunting land exists (Mozumder et al. 2007). Hunters also often perceive public land as being of lesser quality due to factors such as congestion and seek access to private land for hunting opportunities (Hussain et al. 2004). In 2011, an estimated 84% of big game hunters nationwide hunted at least partly on private land such as leases while 33% of big game hunters hunted on public land (USFWS 2011). From 1991 to 2011, the percentage of big game hunters who hunted on private land remained stable at or just above 80%. However, during the same period, the percentage of big game hunters who hunted on public land dropped from a high of 47% in 1996 to a low of 33% in 2011 (USFWS 1991, 1996, 2001, 2006, 2011).

Despite the popularity of hunting on private land, factors such as urban sprawl and land use conversion have decreased the overall acreage of private forestland in the United States (Best and

Wayburn 2013). In addition, the amount of private land open to the public for recreation has also decreased in recent decades (Kilgore et al. 2008). Between 1986 and 2006, the percentage of private forest landowners who opened their property to hunting declined from 25% to 14.6% respectively (USDA 2010). Landowners are often hesitant to provide public access without adequate economic incentives or liability protection (Mozumder et al. 2007). Additional reasons for landowner resistance to supplying public access include safety concerns, economic conditions, taxation issues, and legal restrictions (Zhang et al. 2006; Cordell et al. 1999). Examining hunting in the state of Texas, Wright et al. (1988) developed a framework to describe landowner willingness to provide hunting access. Grouping access into two broad categories (fee access and free access), free access to private hunting lands can be broken down into additional categories based on access restricted to the landowners only (exclusive access), access restricted to family and friends of the landowner (restrictive access), and access to the general public (open access) (Wright et al. 1988). As private hunting land access becomes more restrictive and hunters seek an alternative to hunting on public hunting land, fee or lease hunting has become a viable solution for many hunters (Mozumder et al. 2007). The percentage of forest industry land in the southeast leased to hunting clubs and individuals increased to 76.6% in 1999 from 64.5% in 1994 (Marsinko et al. 1998; Morrison et al. 2001). In Georgia, the estimated farm gate value of hunting leases for white-tailed deer was approximately $108 million in 2006 (Boatwright and McKissick 2006). In 1999, this value was approximately $50 million.

The significance of lease hunting indicates that hunters are willing to pay a premium for a higher quality hunting experience (Hussain et al. 2004). For rural landowners, leasing land for hunting can provide a much needed additional source of income (Hussain et al. 2007). Additional nonmonetary benefits of leasing include access control and reduced property damage due to trespassing (Marsinko et al. 1992). Lease agreements can protect landowners by stipulating where the hunting boundaries are, what activities are permitted, and how facilities should be maintained. Lease agreements can also protect landowners by including liability clauses (Wright et al. 2002).

Previous Studies

Studies have examined hunting using various approaches such as contingent valuation (CV), hedonic regression, and the travel cost method (TCM). However, no TCM study has explicitly examined the effect of different access types on hunting site trip demand. For instance, Balkan and Kahn (1988) used nationwide USFWS data to model hunting trip demand for the entire United States. Hunting trip demand to public land has been examined often (Creel and Loomis 1990; Bergstrom and Cordell 1991; Creel and Loomis 1992; Luzar et al. 1992; Sarker and Surry 1998). Specifically, Sarker and Surry (1998) examined moose hunting demand in Canada and Luzar et al. (1992) studied deer hunting trip demand on Louisiana public land. Bergstrom and Cordell (1991) examined nationwide hunting trip demand on public land while both Creel and Loomis (1990) and Creel and Loomis (1992) examined deer hunting on public land in California. Offenbach and Goodwin (1994) modeled Kansans' trips to their favorite hunting sites, but did not make a distinction between different access types in their analysis.

Factors affecting hunting trip demand have been analyzed. Household income has increased (Balkan and Kahn 1988; Creel and Loomis 1990) or decreased trip demand (Bergstrom and Cordell 1991; Creel and Loomis 1992). In addition, increasing hunter age has negatively affected trip demand (Offenbach and Goodwin 1994; Bergstrom and Cordell 1991) while education and hunting experience have been insignificant factors (Offenbach and Goodwin 1994; Balkan and Kahn 1988). Bergstrom and Cordell (1991) developed an outdoor recreation index and found that other forms of outdoor recreation can serve as hunting substitutes. However, a number of hunting TCM studies (Balkan and Kahn 1988; Luzar et al. 1992; Sarker and Surry 1998) were unsuccessful at identifying hunting substitutes. TCM studies have also examined the effect of site specific characteristics on wildlife recreation trip demand. Specifically, site beauty (Offenbach and Goodwin 1994) and number of deer seen (Creel and Loomis 1990) were found to positively affect trip demand.

Contingent valuation and hedonic approaches have analyzed hunter preferences for lease attributes such as size. For instance, Munn et al. (2011) used contingent valuation and a sample selection approach and found that lease size did not significantly influence hunter WTP for a lease. Hussain et al.

(2010) used a choice experiment and found that only lease tracts smaller than 1,000 acres positively influenced WTP for a lease in Mississippi. A number of hedonic studies (Shrestha and Alavalapati 2004; Zhang et al. 2006; Rhyne et al. 2009; Munn and Hussain 2010) have found that lease size has a negative effect on per acre lease rates. The effect of crowding has also been analyzed. For instance, crowded conditions were not preferred by Louisiana waterfowl hunters (Gan and Luzar 1993) and increased the likelihood of Mississippi hunters choosing to lease (Munn et al. 2011).

Forest management activities can affect wildlife habitat and food availability for game species such as deer. A few studies have examined the effect of forest management activities on hunter and general recreationist utility. For instance, Boyle et al. (2001) found that Maine residents did not prefer forest management activities that included clearcutting. Boxall and Macnab (2000) found that moose hunters and wildlife viewers in Saskatchewan actually favored small-scale forest management activities that helped to create wildlife openings. One study (Stribling et al. 1992) examined hunter WTP for hunting harvest regulations and found that hunter WTP for a lease did not increase with the opportunity to harvest more than two deer on a tract.

As population growth continues, the number of hunting participants is expected to increase despite decreasing hunting participation rates (White et al. 2014). Due to hunting's popularity, a greater understanding of hunter management preferences and the structure of hunting trip demand is needed. Though previous studies have examined hunting trip demand primarily on public land, a gap in the literature exists regarding hunting trip demand specifically on private land. If the structure of hunting trip demand is affected by public and private land access options, the economic value of a hunting trip could vary significantly by access type. In addition, the effect of increasing trip costs or access fees on trip demand could vary significantly by user group. A greater understanding of the price response of different hunters groups could be especially useful considering the recent Georgia DNR proposal to increase license fees (Kirby 2015). A greater understanding of Georgia lease hunter trip demand is also needed. Lease hunting is a popular and economically important form of hunting and no previous study has examined lease site trip demand. By examining lease hunting demand and incorporating lease specific characteristics into the trip demand models, a better understanding of lease hunter preferences can be achieved. Landowners who provide lease hunting opportunities could use this knowledge to make management decisions that coincide with lease hunter preferences.

Objectives

The objective of this study was to evaluate big game hunting trip demand to different land access types in Georgia. Access types of specific interest included leased land, public land, own land (exclusive free access), and non-leased private land (restricted free access). An additional objective was to identify factors specifically affecting hunting trip demand to lease sites.

Methodology

Theoretical Basis of the Travel Cost Method

Market clearing prices are often unavailable for recreational activities such as hunting. The travel cost method is an alternative valuation approach used to model recreation demand and derive economic values for recreation resources (Loomis et al. 2000). This approach models trip demand to a site and associated measures of net economic benefit, or consumer surplus can be estimated from the demand curve. Consumer surplus is an accepted measure of economic value and is the difference between an individual's willingness to pay for a good and the actual amount the individual must pay for the good. In contrast to stated preference approaches, which rely on value directly elicited from respondents with a survey, the travel cost method is a revealed preference technique based on the actual consumption behavior of respondents (Zawacki et al. 2000). The theoretical basis of the travel cost method centers on the economic concepts of utility maximization and weak complementarity (Freeman 2003), which can be expressed with the following equation:

$$U_i = f(X)$$

where U_i is an individual's utility that is a function of a set of variables (X). The travel cost method assumes that increasing trip costs decrease the number of trips a recreationist takes all else being equal (Pearse and Holmes 1993). As a result, trip takers maximize utility by choosing a number of trips that reflect their budgetary limits, which may include time, and personal tastes and preferences. Since the trip costs incurred while visiting a site can be thought as a proxy for the price of the services offered by the site, individual trip behavior is affected by a change in travel cost in a manner similar to a change in admission costs (Freeman 2003). From this relationship between travel costs and trips taken, an ordinary demand curve can be derived.

Empirically, the travel cost method has been frequently applied using two conceptual frameworks: the individual travel cost method (ITCM) and the zonal travel cost method (ZTCM). The ITCM approach models individual trip demand as a function of individual travel costs and demographics while the ZTCM approach models visitation rates as a function of each zone's travel costs and aggregate characteristics (Haab and McConnell 2002). In the hunting literature, several studies have used the ITCM approach (Balkan and Kahn 1988; Creel and Loomis 1990; Creel and Loomis 1992; Luzar et al. 1992; Sarker and Surry 1998). One study (Bergstrom and Cordell 1991) has used a ZTCM approach.

With the ITCM approach, individual trip demand is modeled as a function of trip costs, the presence of hunting substitutes or complements, site-specific characteristics, and individual demographics. Empirically, trip demand can be expressed using the following specification (Zawacki et al. 2000):

$$Y_{ij} = f\ (C_{ij}\ , S_{ij}, R_j, D_i)$$

where Y_{ij} is the number of trips taken by individual i to site j, C_{ij} are trip costs associated with individual i's trip to site j, S_i are individual i's substitutes to site j, R_j are resource related variables associated with site j, and D_i are individual demographics. Economic benefits are derived by integrating the trip demand curve between two price levels: the current price and a choke price (Loomis et al. 2000).

Study Area

The study was conducted in the state of Georgia, USA. In Georgia, hunters have the opportunity to hunt a variety of big game species such as white-tailed deer, eastern wild turkey, and American black bear. However, deer is the most popular game species as 89% of hunters in Georgia pursued deer in 2011

(USFWS 2011). A large proportion (87%) of hunting in Georgia occurs on some form of private land such as land associated with leases (USFWS 2011), and no research has been done on lease hunter preferences and the hunting lease market in Georgia. Georgia hunters also have the opportunity to hunt on approximately one million acres of public land on state managed Wildlife Management Areas (Georgia Department of Natural Resources 2015).

Survey and Sampling Design

A mail questionnaire was designed for the general purpose of better understanding big game hunting in Georgia. A preliminary survey was revised with feedback from individuals (i.e. hunters, landowners, wildlife biologists, private wildlife professionals) knowledgeable of big game hunting in Georgia. Specific reviewers of the survey instrument included Quality Deer Management Association (QDMA) CEO Brian Murphy and North American Timberlands owner Forest Kellogg. After several revisions based on comments received from approximately 10 reviewers, a final version of the survey was developed. The survey contained six sections. The first section consisted of a screener question asking respondents to indicate whether or not they hunted big game in Georgia. Additional questions in the general hunting experience section elicited information on big game hunting experience, which species they hunted, and what weapons they used. In the second section, respondents provided details about their big game hunting trips in Georgia in 2012. Specifically, respondents were asked to provide information on up to three of their most visited hunting sites. The sites described could be land leased directly by them, leased land associated with a hunting club, their own land, a friend's or relative's land, or public land. In the third section, non-lease hunters were asked questions regarding potential barriers to leasing in Georgia. The fourth section of the survey consisted of the hunting lease choice experiment. The fifth section contained questions related to awareness of and views on recent captive deer breeding legislation in Georgia. Socio-demographic questions comprised the final section of the survey. The final mail questionnaire (Appendix A) was administered to a sample of licensed hunters who had big game privileges in Georgia in 2012.

The sampling frame for this study included all licensed hunters (resident and nonresident) who had big game hunting privileges in Georgia in 2012. A database of 422,663 big game license holders was obtained from the Georgia Department of Natural Resource's Wildlife Resource Division to create this sample. A stratified random sampling approach was developed to ensure that the sample was representative of the Georgia big game hunter population. The sampling procedure first involved determining the percentages of each of 16 big game license types in the total population. Next, individuals from each license type were randomly selected into the sample based on their respective license type's share of the total population. Generally, the allocation of hunters into the sample was very similar to the percentages based on license type (Appendix B). However, one significant modification involved the number of hunters who obtained Senior (65 and older) Lifetime Licenses at no cost. The proportion of individuals with this license type was very high as these licenses cover all hunting and fishing and are automatically renewed, whether the individual is a current big game hunter or not. As a result, the percentage allocated from this license type was reduced and slight allocation adjustments involving the other license types were made to account for this reduction. The final sample consisted of 3,000 licensed Georgia hunters with big game privileges in 2012.

The survey instrument was administered following a modified version of Dillman's Tailored Design Method (Dillman 2007). Studies following a similar survey implementation procedure include Luzar et al. (1992) and Loomis and McTernan (2014). An initial mailing consisted of a survey packet containing a personalized cover letter, the written questionnaire, and a business-reply prepaid return envelope. The initial mailing was then followed with a postcard reminder approximately three weeks later. A final mail-out to non-respondents including a packet with a follow-up cover letter and a copy of the questionnaire was sent two weeks after the mailing of the postcard reminder. No additional survey mailings or reminders were sent because of budget constraints.

Pooled Hunting Site Model Specification

Since the objective of this study was to model big game hunting trip demand in Georgia in 2012, the dependent variable was defined as the number of reported trips taken in 2012 for the primary purpose of big game hunting in Georgia to a given site. This is consistent with the dependent variable used by various hunting ITCM studies (Balkan and Kahn 1988; Creel and Loomis 1990; Creel and Loomis 1992; Luzar et al. 1992; Sarker and Surry 1998).

Trip data was pooled across multiple hunting site types to derive a big game hunting demand curve (Siderelis and Moore 1995; Bowker and Leeworthy 1998; Englin and Moeltner 2004; Hesseln et al. 2004). In pooled or multi-site models, variables differentiating quality across sites or users are included (Bowker and Leeworthy 1998; Englin and Moeltner 2004; Hesseln et al. 2004). For this study, variables differentiating between big game hunting access types were created. Specific binary demand shifters included *Public land*, *Own land*, *Non-leased private land*, and *Leased land*. Each binary variable was also interacted with travel costs to determine access type price effects. *Leased land* was specified as the site type reference category. Though a pooled specification forces additional covariates to be constant across different site types, additional covariates considered were not specific to one type of hunting site. In the rare instances when site type specific characteristics were included (i.e. *Lease price*), interaction terms were used (i.e. *Lease price*leased land).* The pooled specification created a larger sample size. For access types such as public land that possessed a small number of observations, sample size concerns associated with modeling trip demand separately by site type were alleviated through the use of a pooled model.

The individual is the most common unit of consumption used by ITCM studies (Benson et al. 2013; Hynes and Greene 2013; Hill et al. 2014). However, the group or traveling unit specification has been used often as well (Bowker et al. 2007; Edwards et al. 2011). With a group specification, individual characteristics or preferences are assumed to be representative of the group. Travel costs are defined at the group level and individual measures of consumer surplus can be recovered post-estimation by scaling estimates by group size. Though hunting trip behavior is often analyzed at the individual level, 68.6%

percent of the sample traveled to their respective hunting sites with at least one other person. Therefore, trip demand was analyzed at both the individual level and at the group level.

Specification of the travel cost variable remains a source of debate. According to Freeman (2003), a full specification of travel cost includes admission or specific access fees, out of pocket roundtrip transportation costs to the site, and time costs associated with traveling to and from the site. Since hunters in Georgia typically do not face per specific trip admission costs, travel costs for this study were defined as roundtrip transportation costs plus roundtrip time costs. Following Rosato and Defrancesco (2002), fixed costs associated with hunting trip access (i.e. *Lease price*, *WMA stamp price*, *License price*) were treated as separate covariates to avoid biased consumer surplus estimates. Fixed costs such as lease price are paid upfront and cannot be considered part of the variable costs paid to take a hunting trip.

To estimate transportation costs, the 2012 edition of AAA's *Your Driving Costs* (AAA Association Communication 2012) was used to estimate per mile vehicle operating costs for each trip. Since the survey instrument did not ask respondents to specify their vehicle type, the AAA vehicle category specified for all respondents in the sample was a four-wheel drive sport utility vehicle (SUV). Though a potential limitation, additional AAA vehicle categories included small sedan, medium sedan, large sedan, and minivan. Of these vehicle categories, The SUV category likely best represented the sample since many hunters need the ability to transport hunting equipment to and from a hunting site. Total per mile operating costs from this vehicle category were \$0.248. Scaled to 2012 American dollars, examples of per mile vehicle operating costs used by similar studies include \$0.160 (Bowker et al. 2007), \$0.210 (Edwards et al. 2011), \$0.250 (Englin et al. 1998), and \$0.540 (Donovan and Champ 2009). To calculate roundtrip transportation costs at the group level, the operating cost of \$0.248 per mile was multiplied by the roundtrip travel distance (in miles) for each observation (Bowker et al. 2007; Edwards et al. 2011). At the individual level, group roundtrip transportation costs were divided by the size of each observation's hunting party (Taylor et al. 2004; Hynes and Greene 2013).

To account for opportunity costs associated with taking a trip, TCM studies have included time costs as an added component to travel costs. To specify time costs at the group level, roundtrip travel time for each observation was multiplied by a fraction of the observation's household wage rate (Englin et al. 1998; Bowker et al. 2007; Edwards et al. 2011). At the individual level, group time costs were specified by dividing group costs by the number of individuals of working age in the household (Loomis and McTernan 2014). Following Bowker et al. (1996) and Zawacki et al. (2000), three wage rate multipliers (0, ¼, and ½) were used. The use of three wage rate multipliers created the opportunity to conduct a sensitivity analysis based on fraction used. Similar to previous studies (Taylor et al. 2004; Loomis and McTernan 2014), wage rate estimates were obtained by dividing household income by a full time 2,080-hour work year. To calculate roundtrip travel time for each observation, roundtrip travel distance (in miles) was divided by a rate of travel of 50 miles per hour. Similar rates of travel include 45 miles per hour (Rockel and Kealy 1991), 50 miles per hour (Zawacki et al. 2000; Taylor et al. 2004), and 60 miles per hour (Layman et al. 1996).

In summation, travel costs were specified using group and individual unit assumptions. *Group travel costs* was calculated using the following formula:

$$TC_{gj} = \left(RTmiles_{gj} * \ OC\right) + (RTtime_{gj} * WR_i * MP)$$

where TC_{gj} is the travel cost for group *i* to site *j*, $RTmiles_{ij}$ is the roundtrip distance (in miles) for group *g* to site *j*, OC is the vehicle operating costs, $RTtime_{gj}$ is the roundtrip travel time for group *g* to site *j*, WR_i is the hourly household wage rate for individual *i*, and MP is a wage rate multiplier (0, ¼, and ½). Conversely, *Individual travel costs* was specified using the following formula:

$$TC_{ij} = \frac{\left(RTmiles_{ij} * \ OC\right)}{GR_{ij}} + \frac{(RTtime_{ij} * WR_i * MP)}{WA_i}$$

where GR_i is the hunting party group size for individual *i* to site *j* and WA_i is the number of individuals of working age in individual *i'*s household.

Additional variables considered for the pooled hunting site models were *Party size*, *Years hunted big game*, and *Food plots* (Table 2.1). *Party size* represented the size of the hunting trip traveling unit and was specified only for the group unit of consumption models (Bowker et al. 2007). *Years hunted big game* was used to account for big game hunting experience. *Food plots* was used as a general measure of site quality. Similar measures of site quality used by previous wildlife TCM studies include number of deer seen (Creel and Loomis 1990) and amount of available forestland (Rockel and Kealy 1991).

Substitute variables are needed for most properly specified demand models. When the price of an ordinary commodity increases, consumer theory suggests that consumption of related commodities will increase. Consumer surplus estimates from models lacking substitute variables are likely biased upwards (Liston-Heyes and Heyes 1999; Ovaskainen et al. 2001). The specification of substitute variables in the travel cost literature is highly varied. One common specification involves estimating each observation's travel costs to a potential substitute site (Loomis et al. 2000; Zawacki et al. 2000; Hynes and Greene 2013). However, price or distance information for potential substitute sites is not always available. As an alternative to specifying the price of substitutes, binary variables have been used to account for substitution behavior (Bowker and Leeworthy 1998; Bowker et al. 2009). Due to survey instrument and data limitations, no substitutes beyond hunting associated with different site types were specified for the pooled model. Though a clear limitation, a number of hunting TCM studies have failed to account for potential substitutes (Balkan and Kahn 1988; Luzar et al. 1992; Sarker and Surry 1998).

Socio-economic variables were considered for the pooled model also (Table 2.1). Specific variables included *Age*, *Retired*, *Population density*, and *Household income*. *Retired* has not been previously used in hunting TCM studies and was considered to take into account Georgia's growing population of aging hunters. *Population density* was considered to account for rural vs urban differences between hunters (Tobias and Mendelsohn 1991). Respondents were asked to specify their household income by checking one of seven categories containing different income ranges. For analysis, household income was treated as a continuous variable by using the midpoint for each income category found in the survey (Sun et al. 2015).

Table 2.1. Travel cost method variable definitions derived for data collected from a mail questionnaire targeting licensed big game hunters who hunted big game in Georgia in 2012

Variable	Definition
Pooled model	
Trips	Trips taken in 2012 for primary purpose of big game hunting
Group travel cost	Group travel costs ($)
Individual travel cost	Individual travel costs ($)
Own land	1=hunting site was on individual's property, 0=otherwise
Leased land	1=hunting site was on leased land, 0=otherwise
Non-leased private land	1=hunting site was on family or friend's land, 0=otherwise
Public land	1=hunting site was on public land, 0=otherwise
Lease price	Individual lease price paid by lease hunter in 2012 ($)
WMA stamp price	WMA stamp price paid by public land hunter ($)
License price	License price paid for big game privileges ($)
Food plots	1=site contained food plots, 0=otherwise
Party size	Typical hunting party size
Years hunted big game	Years hunted big game in Georgia
Age	Respondent's age (years)
Retired	1=respondent is retired, 0=otherwise
Population density	Respondent's zip code pop. density (1000 people/sq. mi)
Household income	Respondent's household income ($1000s)
Lease site specific model	
Size	Lease size (acres)
Size squared	Lease size squared (acres)
Membership	Total number of members on lease
Membership squared	Total number of members on lease squared
QDM practiced	1=QDM practiced at site, 0=otherwise
Recent timber harvest	1=site's timber harvested in last 10 years, 0=otherwise
Hunted on another lease	1=hunted on multiple leases in 2012, 0=otherwise
Hunted on own land	1=hunted on own land in 2012, 0=otherwise
Hunted on non-lease private land	1=hunted on non-leased private land in 2012, 0=otherwise
Hunted on public land	1=hunted on public land in 2012, 0=otherwise

Lease Site Only Model Specification

To identify factors specifically influencing lease site big game hunting trip demand, a separate TCM model for lease sites only was developed. Similar to the pooled model, group and individual unit assumptions were used. Formulas used to specify travel costs in the pooled model were applied to travel cost variables in the lease site only model. Lease specific variables considered for the lease site only model included *Size*, *Membership*, *Recent timber harvest*, *QDM practiced*, and *Lease price* (Table 2.1). Additional variables from the pooled model (i.e *Party size*, *Years hunted big game*, *Age*, *Retired*, *Population density*, and *Household income*) were also considered. In contrast to the pooled model, substitute variables were specified for the lease site only model. Specific hunting related substitutes included *Hunted on another lease*, *Hunted on public land*, *Hunted on non-leased private*, and *Hunted on own land*. Each potential substitute was specified as a binary variable (Bowker et al. 2007).

Data Cleaning Procedures and Assumptions

Following previous studies (Zawacki et al. 2000; Marsinko et al. 2002; Englin and Moeltner 2004; Sun et al. 2015), multiple individual hunting site entries were treated as additional observations. Though this practice greatly increased the number of hunting site observations, the observations could no longer be considered strictly independent. Following Haab et al. (2000) and Kim et al. (2007), missing household income values were imputed using a log-linear ordinary least squares regression of household income on age, education, rural origin, and employment.[1] Missing values associated with respondent's age were replaced using age information found in the Georgia DNR licensed hunter database.

Additional data cleaning procedures such as the elimination of a limited number of observations due to missing or extreme values were used as well. Observations that contained missing trip number or distance information were eliminated. In addition, a number of observations contained excessively high travel costs. Preliminary analysis indicated that these high travel costs had a large influence on the results. Excessive travel costs are often the result of multipurpose trips or coding errors (Mendelsohn et al. 1992). Following procedures used by previous studies (Hellerstein et al. 1991; Bowker et al. 1996; Zawacki et al. 2000; Marsinko et al. 2002; Sun et al. 2015), the top one percent of distance observations were removed from the present study's sample. This procedure, in effect, removed observations containing round-trip distances greater than 1,000 miles. Six observations that contained a very large number of trips taken (greater than 150) were removed from the sample. Even though 150 hunting trips to a site cannot be considered implausible, these observations were determined to be outliers and thus were removed from the sample. Since big game hunting trip takers were the focus of the pooled TCM model, 19 observations

[1] Regression results: ln(Household income) = 10.37 + 0.01(Age) + 0.45(College degree) – 0.15(Rural origin) + 0.53(Full time employment); $R^2 = 0.26$

which took zero trips were excluded. Finally, for individuals who hunted on land associated with their residence, a one-way travel distance of 0.1 miles was added to each of these observations.

Estimation Techniques

Due to the discrete, nonnegative nature of the dependent variable (i.e. number of trips), count data models have become standard practice for TCM studies (Hellerstein 1991; Zawacki et al. 2000; Hynes and Greene 2013). With count data models, a discrete probability distribution rather than a continuous probability distribution is assumed for the dependent variable (Betz et al. 2003). Examples of count data models include Poisson and negative binomial regression. A key assumption associated with Poisson regression is that the mean and variance of the dependent variable are equal. If this assumption is violated, the use of a negative binomial model is advised. Typically, when examining trip behavior, most respondents take fewer trips while a small number of respondents take many trips. As a result, overdispersion is common when examining recreation trip behavior necessitating the use of negative binomial regression.

Specifically, the negative binomial probability distribution can be described as (Cameron and Trivedi 2013):

$$P(Y_i = y_i; y_i = 0,1,2 \ldots) = \frac{\Gamma\left(y_i + \frac{1}{\alpha}\right)}{\Gamma(y_i + 1)\Gamma\left(\frac{1}{\alpha}\right)} (\alpha\lambda_i)^{y}i(1 + \alpha\lambda_i)^{-(yi+\frac{1}{\alpha})}$$

where λ_i = exp(β, *Ci, Si, Ri, Di*), β is a vector of coefficients, Γ is the gamma function, α is the overdispersion parameter, the expected value is λ_i, and the variance is λ_i $(1 + \alpha\lambda_i)$. When the overdispersion parameter (α) is significant, the use of a negative binomial model is appropriate. However, when overdispersion is zero, the conditional mean and variance are equal indicating the appropriate use of a Poisson model.

Two concerns often arise when examining recreation trip data: endogenous stratification and truncation. Endogenous stratification occurs when individuals who more frequently visit a site are more likely to be included in the sample. Since a mail questionnaire was used to gather data for the present study and all individuals in any given license stratum had an equal chance of being included in the sample, endogenous stratification was not a concern. Truncated data occur when information on non-participants is unknown and the probability distribution only applies to values above zero (Zawacki et al. 2000). If an untruncated estimator is used to model truncated data, parameter estimates will be "biased and inconsistent" (Creel and Loomis 1990). For the present study, since limited information was collected on respondents who did not take trips to hunting sites, values of zero for the dependent variable were uncommon. As a result, only truncated estimators were used to model big game hunting trip demand. A zero-truncated negative binomial distribution can be described as (Cameron and Trivedi 2013):

$$P(Y_i = y_i; y_i = 0,1,2,3 \ldots) = \frac{\Gamma\left(y_i + \frac{1}{\alpha}\right)(\alpha\lambda_i)^{y_i}(1+\alpha\lambda_i)^{-(yi+\frac{1}{\alpha})}}{\Gamma(y_i+1)\Gamma\left(\frac{1}{\alpha}\right)P(Y_i > 0)}$$

where

$$P(Y_i = 0) = (1+\alpha\lambda_i)^{-(\frac{1}{\alpha})}$$
$$P(Y_i > 0) = 1 - (1+\alpha\lambda_i)^{-(\frac{1}{\alpha})}$$
$$E(Y_i) = \frac{\lambda}{1-(1+\alpha\lambda_i)^{-(\frac{1}{\alpha})}}$$
$$var(yi) = \frac{E(y_i)[1-(1+\alpha\lambda_i)^{-\left(\frac{1}{\alpha}\right)}]^{1+\alpha}\ E(y_i)}{[(1+\alpha\lambda_i)^{-\left(\frac{1}{\alpha}\right)}]^{\alpha}}.$$

Economic Values

From the count data demand models, measures of economic value associated with big game hunting can be estimated. Consumer surplus (CS), a measure of net social benefit, is the difference between an individual's willingness to pay (WTP) and his or her actual expenditures. With count data models, a point estimate of per trip CS is estimated using the following formula (Hellerstein and Mendelsohn 1993; Zawacki et al. 2000; Edwards et al. 2011).

$$CS = \frac{1}{-\beta_{TC}}$$

where β_{TC} is the coefficient associated with the trip cost variable. When a group travel cost specification is used, per person CS estimates can be recovered by dividing per group CS by the average size of the group (Bowker et al. 2007; Edwards et al. 2011). When travel cost interaction terms are used, per trip CS associated with the interaction term can be estimated using the following formula:

$$CS_{INT} = \frac{1}{-(\beta_{TC} + \beta_{INT})}$$

where β_{TC} is the coefficient associated with the trip cost variable and β_{INT} is the coefficient associated with the travel cost interaction term.

Per trip per person CS estimates were aggregated to obtain estimates of the 2012 net economic value of big game hunting for different site users (Bergstrom and Cordell 1991). Since a hunting license is not required for hunters who hunt on their own land or hunt on the land of immediate family members, aggregate estimates of net benefit for hunting on one's own land and hunting on non-leased private land could not be calculated. Aggregate estimates for leased land hunting and public land hunting were calculated using three approaches. The first approach did not incorporate lease price or WMA stamp price. The second approach accounted for fixed costs by specifying *Lease price* and *WMA stamp price* as additional independent variables in the TCM models. Leased land aggregate estimates for the first two approaches were calculated by first multiplying the number of lease hunters by the average number trips taken to a lease site. This product was then multiplied by per trip per person CS estimates for leased land hunting. A similar formula was used to estimate aggregate values for public land hunting. In contrast to the second aggregation approach, the third approach incorporated lease price and WMA stamp price post estimation. For this approach, per person CS was first multiplied by each observation's number of trips taken. Each observation's respective lease price or WMA stamp price was then subtracted from each observation's per year CS estimate. The average of this difference was then multiplied by the estimated number of lease land hunters or public land hunters.

Estimates of price elasticity can be derived as well. Price elasticity is a unitless measure of demand response to a change in price. Price elasticity can be defined as a percentage change in quantity demanded resulting from a one percent change in price. From count data models, price elasticity can be estimated using the following formula (Gill et al. 2004):

$$\varepsilon_p = \beta_{TC} * \overline{TC}$$

where ε_p is the price elasticity, β_{TC} is the travel cost coefficient, and $\overline{TC}$ is average travel costs. To calculate price elasticity associated with a travel cost interaction term, the following formula can be used (Bowker and Leeworthy 1998):

$$\varepsilon_{INT} = (\beta_{TC} + \beta_{INT}) * \overline{TC_{INT}}$$

where ε_{INT} is the price elasticity for the site type, β_{TC} is the travel cost coefficient, β_{INT} is the travel cost interaction coefficient, and $\overline{TC_{INT}}$ is average travel costs associated with the interaction term. An elasticity between 0 and -1 indicates inelastic demand, an elasticity of -1 indicates unitary demand, and an elasticity below -1 indicates elastic demand. Unlike average consumer surplus per trip, price elasticity can be estimated at the sample average travel cost, or any other cost. This allows the measure to be used to gauge changes in demand associated with price changes like travel costs and access fees.

For the lease site TCM model, elasticities of demand associated with *Size* and *Membership* can also be calculated. Following Englin and Moeltner (2004), "lease size elasticity of demand" and "lease membership size elasticity of demand" can be calculated using the following formulas:

$$\varepsilon_s = (\beta_S + 2\beta_{S2} * q_s) * q_s ,$$

$$\varepsilon_m = (\beta_m + 2\beta_{m2} * q_m) * q_m$$

where ε_s is the "lease size elasticity of demand" and ε_m is the "lease membership size elasticity of demand", β_S and β_m are the estimated coefficients for *Size* and *Membership* respectively, $2\beta_{S2}$ and $2\beta_{m2}$ are the estimated coefficients for *Size squared* and *Membership squared* respectively, and q_s and q_m are average values for lease size and membership respectively.

Results

Survey Responses

From the 3,000 surveys mailed out, 663 were completed and returned while 280 were returned as undeliverable. This resulted in an adjusted response rate of 24.4%. Similar studies surveying hunters in the South have achieved comparable but often higher response rates. For example, Hussain et al. (2010)

achieved a 32% response rate surveying Mississippi hunters and Hussain et al. (2004) achieved a 56% response rate surveying Alabama hunters. Survey returns from the Georgia hunting survey were as follows: 486 surveys from the first mailing were completed and returned with 210 returned as undeliverable; 177 surveys were completed and returned from the second mailing with 70 returned as undeliverable. Because the population of interest was specifically individuals who hunted big game in Georgia in 2012, 100 respondents who indicated they did not hunt big game in Georgia in 2012 were removed from the sample. It should be noted that Senior (65 and older) Lifetime Licenses are automatically renewed and thus it is common for holders of such licenses to no longer hunt. As a result, the remaining 563 responses were used to model big game hunting trip behavior in Georgia in 2012.

General Sample Characteristics

Respondents were overwhelmingly male (94.4%), white (98.4%), and non-Hispanic (99.4%) (Table 2.2). Most respondents came from a rural background (64.8%) while nearly a third (32.4%) possessed at least a Bachelor's degree. The average age of a respondent was 50.9 years while nearly a quarter of the sample (23.1%) indicated they were retired. The average household income of respondents was $79.7 thousand. On average, hunters had 26.9 years of experience hunting big game. Nearly all respondents (99.3%) indicated they hunt deer, 64.8% indicated they hunt turkey, and 10.5% indicated they hunt bear. The majority of hunters (55.2%) indicated they hunt deer and turkey while 33.7% indicated they hunt deer exclusively. Over 9% of hunters indicated they hunt deer, bear, and turkey while a small percentage hunted turkey exclusively (0.5%) or bear exclusively (0.2%). Regarding access type, 38.4% hunted on their own land, 47.3% hunted on leased land, and 54.4% hunted on non-leased private land such as family or friend's land. Over 95% of hunters hunted on some form of private land while 33.9% hunted on public land. Over 66% of hunters hunted exclusively on some form of private land while only 5.0% hunted exclusively on public land. The average number of big game hunting trips taken by a Georgia hunter in 2012 was 28.4.

Table 2.2. General sample characteristics collected from a mail questionnaire that targeted licensed big game hunters who hunted big game in Georgia in 2012 (n=563)

Variable	Min	Max	Mean	Missing
Demographics				
Age	20	83	50.9	0
Male (%)	-	-	94.4	14
Hispanic (%)	-	-	0.6	29
White (%)	-	-	98.4	15
Bachelor's degree (%)	-	-	32.4	16
Rural background (%)	-	-	64.8	18
Retired (%)	-	-	23.1	14
NRA member (%)	-	-	36.9	13
QDMA member (%)	-	-	6.9	14
Household income ($1000s)	12.5	162.0	79.7	48
General hunting experience				
Years hunted big game	1	65	26.9	5
Hunt deer (%)	-	-	99.3	0
Hunt turkey (%)	-	-	64.8	0
Hunt bear (%)	-	-	10.5	0
Hunt deer only (%)	-	-	33.7	0
Hunt turkey only (%)	-	-	0.5	0
Hunt bear only (%)	-	-	0.2	0
Hunt deer and turkey (%)	-	-	55.2	0
Hunt deer and bear (%)	-	-	1.2	0
Hunt turkey and bear (%)	-	-	0.0	0
Hunt deer, turkey, and bear (%)	-	-	9.1	0
Hunting site selection in 2012				
Hunted on own land (%)	-	-	38.4	0
Hunted on non-leased private land (%)	-	-	54.4	0
Hunted on leased land (%)	-	-	47.3	3
Hunted on public land (%)	-	-	33.9	0
Hunted on private land (%)	-	-	95.1	3
Hunted on own land only (%)	-	-	8.2	0
Hunted on non-leased private land only (%)	-	-	14.0	0
Hunted on leased land only (%)	-	-	18.4	3
Hunted on public land only (%)	-	-	5.0	0
Hunted on private land only (%)	-	-	66.4	3
Total hunting trips	0	600	28.4	42

Dataset for Hunting Site Pooled Model

A final dataset containing 807 observations was constructed to model big game hunting trip demand in Georgia in 2012. The average number of hunting trips an individual took to a site was 16.32

with a standard deviation of 17.81 trips (Table 2.3). The lowest number of trips taken an individual took was one and the highest number of trips an individual took was 104. Based on wage rate assumptions, average group travel costs ranged from $25.76 to $68.18. Similarly, average individual travel costs ranged from $15.94 to $34.85. The average household wage rate was $38.43 per hour with a standard deviation of $20.34 per hour. The average round-trip distance to a hunting site was 103.90 miles with a standard deviation of 153.63 miles. Leased land accounted for 32.84% of the observations, and 41.81% of total trips; 18.34% of observations and 21.94% of total trips occurred on the respondent's own land, 34.70% of observations and 26.77% of total trips were on non-leased private land, and 14.13% of observations and 9.47% of total trips in the sample were on public land. Food plots were present on 73.87% of the observations. For leased land sites, the average per person lease price paid was $830.25 with a standard deviation of $704.75. For public land sites, the average price paid for WMA privileges was $8.75 with a

Table 2.3. General characteristics of a pooled hunting site trip dataset created from a sample of licensed big game hunters who hunted big game in Georgia in 2012 (n=807)

Variable	Min	Max	Mean	SD	Missing
Trips	1	104	16.32	17.81	0
Group TC ($) - no wage rate	0.05	248.00	25.76	38.10	0
Group TC ($) - 25% of wage rate	0.06	510.90	46.97	71.09	0
Group TC ($) - 50% of wage rate	0.06	823.40	68.18	68.18	0
Individual TC ($) - no wage rate	0.01	248.00	14.94	24.25	0
Individual TC ($) - 25% of wage rate	0.01	421.49	24.89	40.49	0
Individual TC ($) - 50% of wage rate	0.02	679.31	34.85	58.66	0
Household wage rate ($/hour)	6.01	78.13	38.43	20.34	0
Round trip distance to residence (mi)	0.20	1000.00	103.86	153.63	0
Own land (%)	-	-	18.34	38.72	0
Leased land (%)	-	-	32.84	46.99	0
Non-leased private land (%)	-	-	34.70	47.63	0
Public land (%)	-	-	14.13	34.85	0
Food plots (%)	-	-	73.78	44.01	29
Lease price ($)	75	6000	830.25	704.75	542
WMA stamp price ($)	0	73	8.75	13.97	693
License price ($)	0	500	84.05	129.44	0
Party size	1	7	2.04	0.93	0
Hunting experience (years)	1	60	28.05	13.36	11
Age	20	83	49.99	13.33	0
Retired (%)	-	-	20.63	40.49	12
Population density (1000 people/sq. mi)	0.01	8.88	0.51	0.84	0
Household income ($1000s)	12.50	162.50	79.93	42.30	0

Note: TC indicates travel costs.

standard deviation of $13.97. The average price paid for a hunting license (resident and nonresident) with big game privileges was $84.05 with a standard deviation of $129.44. Average typical hunting party size was 2.04 hunters and average big game hunting experience was 28.05 years. Average age was 49.99 years with a standard deviation of 13.33 years. Over 20% of the individuals in the sample were retired. Average population density for the respondent's zip code was 0.51 thousand individuals per square mile with a standard deviation of 0.84 thousand individuals per square mile. Average household income was $79.93 thousand with a standard deviation of $42.30 thousand.

Variable and Model Selection for Pooled Hunting Site TCM Model

The travel cost method (TCM) was used to model big game hunting trip demand in Georgia and derive associated measures of net benefit. To avoid potential concerns with multicollinearity, variables with Pearson correlations of 0.70 or higher were omitted (McCarigal et al. 2013). Ultimately, demographics related to race, education, and rural origin were omitted from the final model due to insignificance or possible multicollinearity concerns. Tests for overdispersion rejected the null hypothesis that the mean and variance of the dependent variable (trips) were equal. As a result, the use of negative binomial regression was deemed appropriate. Since the dependent variable was truncated at zero, trip demand was estimated using truncated negative binomial models. Robust standard errors were used to account for possible model misspecification (Englin and Moeltner 2004).

Hunting Site Pooled TCM Model Results

Travel costs had a negative and significant effect on the number of trips taken by a hunting party indicating that trip demand for big game hunting decreased as travel costs increased (Table 2.4). The reference category related to hunting site type was *Leased land*. Parameter estimates for the access type variables indicate that big game hunting trip demand decreased on non-leased private land and public land compared to trip demand on leased land. In contrast, *Own land* was insignificant. The *Travel costs*own land* interaction term was significant for two wage rate specifications indicating that the slopes of the own

Table 2.4. Results from zero-truncated negative binomial regression of big game hunting trip demand based on a group unit of consumption and alternative wage rate assumptions (n=755)

Variable	No wage rate	25% wage rate	50% wage rate
Travel costs	-0.0102***	-0.0052***	-0.0034***
	(0.0014)	(0.0007)	(0.0005)
Travel costs*own land	0.0033	0.0020*	0.0013*
	(0.0022)	(0.0011)	(0.0007)
Travel costs*non-leased private land	-0.0017	-0.0016	-0.0013
	(0.0037)	(0.0016)	(0.0010)
Travel costs*public land	-0.0106*	-0.0064*	-0.0044*
	(0.0055)	(0.0036)	(0.0026)
Own land	-0.1034	-0.0880	-0.0802
	(0.1239)	(0.1271)	(0.1280)
Non-leased private land	-0.4362***	-0.3881***	-0.3749***
	(0.1258)	(0.1247)	(0.1250)
Public land	-0.5485***	-0.5030**	-0.4971**
	(0.1980)	(0.2039)	(0.2069)
Lease price*leased land	0.0003***	0.0003***	0.0003***
	(0.0001)	(0.0001)	(0.0001)
WMA stamp price*public land	0.0187**	0.0180*	0.0177*
	(0.0095)	(0.0099)	(0.0102)
License price	0.0008***	0.0007***	0.0007***
	(0.0003)	(0.0003)	(0.0003)
Party size	0.0083	0.0003	-0.0039
	(0.0406)	(0.0406)	(0.0406)
Years hunted big game	0.0121***	0.0133***	0.0138***
	(0.0036)	(0.0036)	(0.0036)
Food plots present	0.2538***	0.2581***	0.2598***
	(0.0926)	(0.0921)	(0.0921)
Age	-0.0177***	-0.0186***	-0.0190***
	(0.0042)	(0.0042)	(0.0042)
Retired	0.4281***	0.4430***	0.4490***
	(0.1212)	(0.1211)	(0.1216)
Population density (1000 people/sq. mi)	-0.0417	-0.0529	-0.0609
	(0.0638)	(0.0598)	(0.0581)
Household income ($1000s)	-0.0027***	-0.0013	-0.0008
	(0.0009)	(0.0010)	(0.0010)
Intercept	3.4742***	3.3594***	3.3262***
	(0.2271)	(0.2274)	(0.2281)
Overdispersion	0.8429	0.8468	0.8525
McFadden R^2	0.0370	0.0370	0.0364
Log-likelihood	-2737.69	-2737.80	-2739.37

***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.
Note: Robust standard errors are reported. Fifty-two observations were dropped due to missing data. Leased land was the base hunting site type.

land and leased land trip demand curves were significantly different. Similarly, the *Travel costs*public land* interaction term was significant for all three wage rate specifications.

The *Lease price*leased land* interaction term was positive and significant indicating that the number of trips taken to a lease site increased as lease price increased. This result suggests that lease hunters who paid more for a lease took a greater number of trips to their lease site. Similarly, the *WMA stamp price*public land* interaction term was positive and significant indicating that the number of trips taken to a public hunting site increased as the amount paid for WMA privileges increased. *License price* was positive and significant indicating that big game hunters who paid more for big game hunting privileges took more big game hunting trips.

Party size was insignificant indicating that the size of the hunting party did not significantly affect trip demand. *Food plots* was positive and significant indicating that hunting parties took more trips to sites with existing food plots. *Years hunted big game* was positive and significant suggesting that trip demand increased with greater hunter experience. *Age* was negative and significant indicating that big game hunting trip demand decreased with age. However, *Retired* was positive and significant indicating that retirement status had a positive effect on trip demand. *Population density* was insignificant indicating that urban or rural residence did not significantly influence trip demand. *Household income* was negative and significant in the no wage assumed model and negative and insignificant in the wage-based models. This result indicates that trip demand decreased or was not affected by increasing income.

Overall, parameter estimates obtained from the individual models are very similar to results obtained from the group models (Table 2.5). However, a few differences exist. For the individual models, the *Travel costs*own land* interaction term was insignificant across all wage rate specifications while the *Travel costs*non-lease private land* interaction term was negative and significant across all wage rate specifications. These results are dissimilar to those obtained from the group unit of consumption models and suggest that big game hunting trip demand was considerably affected by the unit of consumption specified for the demand analyses. At the individual unit of consumption, the slopes of the public land and non-leased private land trip demand curves were significantly different from the slope of the leased land trip demand curve. Even though the discrepancies between the group and individual models are not easily explained, the slopes of the leased land and public land demand curves were found to be

Table 2.5. Results from zero-truncated negative binomial regression of big game hunting trip demand based on an individual unit of consumption and alternative wage rate assumptions (n=755)

Variable	No wage rate	25% wage rate	50% wage rate
Travel costs	-0.0136***	-0.0075***	-0.0049***
	(0.0021)	(0.0013)	(0.0009)
Travel costs*own land	0.0042	0.0021	0.0012
	(0.0036)	(0.0020)	(0.0014)
Travel costs*non-leased private land	-0.0090**	-0.0076***	-0.0057***
	(0.0044)	(0.0026)	(0.0019)
Travel costs*public land	-0.0214*	-0.0178**	-0.0138**
	(0.0116)	(0.0077)	(0.0057)
Own land	-0.0867	-0.0508	-0.0405
	(0.1251)	(0.1284)	(0.1288)
Non-leased private land	-0.3578***	-0.2931**	-0.2853**
	(0.1242)	(0.1271)	(0.1275)
Public land	-0.5714***	-0.4502**	-0.4116**
	(0.1902)	(0.1983)	(0.2028)
Lease price*leased land	0.0002***	0.0003***	0.0003**
	(0.0001)	(0.0001)	(0.0001)
WMA stamp price*public land	0.0242***	0.0208**	0.0186**
	(0.0090)	(0.0088)	(0.0089)
License price	0.0006**	0.0006**	0.0005**
	(0.0003)	(0.0003)	(0.0003)
Years hunted big game	0.0129***	0.0135***	0.0141***
	(0.0037)	(0.0036)	(0.0036)
Food plots present	0.2404***	0.2344**	0.2333**
	(0.0913)	(0.0919)	(0.0925)
Age	-0.0160***	-0.0171***	-0.0180***
	(0.0043)	(0.0042)	(0.0043)
Retired	0.4309***	0.4478***	0.4569***
	(0.1221)	(0.1212)	(0.1212)
Population density (1000 people/sq. mi)	-0.0847*	-0.0885*	-0.0946**
	(0.0490)	(0.0478)	(0.0470)
Household income ($1000s)	-0.0019*	-0.0009	-0.0006
	(0.0010)	(0.0010)	(0.0010)
Intercept	3.3172***	3.2412***	3.2289***
	(0.2082)	(0.2091)	(0.2098)
Overdispersion	0.8628	0.8538	0.8579
McFadden R^2	0.0354	0.0366	0.0362
Log-likelihood	-2742.18	-2738.84	-2730.76

***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.
Note: Robust standard errors are reported. Fifty-two observations were dropped due to missing data. Leased land was the base hunting site type.

significantly different regardless of unit of consumption used. The remaining parameter estimates for the individual models are very similar to those obtained from the group models. The only other difference involves *Population density*. For the group models, *Population density* was insignificant while the variable was negative and mostly marginally significant for the individual models.

Pooled Hunting Site TCM Consumer Surplus and Elasticities

Per trip consumer surplus (CS) estimates were obtained from the pooled hunting site demand models using a group unit of consumption. Since the travel cost interaction terms associated with *Own land* and *Public land* were significant, separate CS point estimates were estimated for these site types. CS estimates associated with insignificant travel cost interaction terms were statistically equal to those associated with lease hunting. To scale per group CS estimates down to per person estimates, per group CS estimates were divided by average group size (Bowker et al. 2007; Edwards et al. 2011). 95% confidence intervals around the CS point estimates were calculated using the Delta method (Englin and Shonkwiler 1995; Englin and Moeltner 2004).

CS estimates increased when a larger percentage of the wage rate was assumed. Overall, the highest per trip per person CS estimates obtained from the group models were associated with hunting on one's own land (Table 2.6). Based on wage rate assumptions, own land per trip per person CS point estimates ranged from $47.98 to $236.69. These results indicate that big game hunters, on average, would be willing to pay $47.98 to $236.69 more than their average per trip travel cost expenditures to take a big game hunting trip to their own land. For hunting on leased land, per trip per person CS estimates ranged from $47.98 to $135.49. Public land CS estimates were found to be the lowest. Based on wage rate assumptions, per trip per person CS point estimates for hunting on public land ranged from $23.46 to

Table 2.6. Per trip per person consumer surplus point estimates from hunting site pooled model using a group unit of consumption and alternative wage rate specifications (95% confidence intervals)

Wage rate	Leased land	NLP land	Public land	Own land
None	$47.98	$47.98	$23.46	$47.98
	($36.65, $59.30)	($36.65, $59.30)	($12.71, $34.21)	($36.65, $59.30)
25%	$93.79	$93.79	$41.98	$152.12
	($67.56, $120.01)	($67.56, $120.01)	($14.68, $69.28)	($44.11, $260.12)
50%	$145.39	$145.39	$63.13	$236.69
	($103.40, $187.38)	($103.40, $187.38)	($16.66, $109.60)	($61.74, $411.64)

Note: Average hunting party size was 2.05. NLP land indicates non-leased private land.

$63.13. CS estimates for hunting on non-leased land private land were insignificantly different than estimates associated with hunting on leased land.

Per trip per person CS estimates were also obtained from the pooled hunting site demand models using an individual unit of consumption. CS estimates obtained from the two unit of consumption approaches were similar in that leased land CS was greater than public land CS. However, for the individual models, own land CS was equal to leased land CS while leased land CS was greater than non-leased private land CS (Table 2.7). Specifically, leased land CS estimates ranged from $73.65 to $205.69 while non-leased private land CS ranged from $44.20 to $94.93. Public land CS estimates ranged from $28.57 to $53.62.

Table 2.7. Per trip per person consumer surplus point estimates from hunting site pooled model using an individual unit of consumption and alternative wage rate specifications (95% confidence intervals)

Wage rate	Leased land	NLP land	Public land	Own land
None	$73.65	$44.20	$28.57	$73.65
	($54.62, $92.68)	($31.07, $57.33)	($11.53, $45.60)	($54.62, $92.68)
25%	$132.67	$66.14	$39.43	$132.67
	($86.02, $179.32)	($45.22, $87.05)	($13.91, $87.05)	($86.02, $179.32)
50%	$205.69	$94.93	$53.62	$205.69
	($126.36, $285.02)	($64.32, $125.55)	($18.90, $88.34)	($126.36, $285.02)

Note: NLP land indicates non-leased private land.

Group elasticities associated with big game hunting trip demand to different access types were estimated. Previous price elasticity estimates for hunting in general range from -1.76 to -2.40 (Herriges and Phaneuf 2002). For big game hunting specifically, a price elasticity of -1.03 was estimated (Phaneuf and Smith 2005). All price elasticities estimated were between zero and one indicating inelastic hunting trip demand to all access types (Table 2.8). Price elasticities associated with hunting on leased land were fairly similar to but consistently higher than elasticities associated with hunting on public land. Specifically, lease hunting trip demand elasticities ranged from -0.392 to -0.343. As a result, a 10 percent increase in travel costs for a group would result in a 3.43 to 3.92 percent decrease in hunting trip demand. Similarly, a 10 percent increase in travel costs to a public site would result in a 3.87 to 4.21 percent decrease in hunting trip demand. These results demonstrate that demand for big game hunting trips was

Table 2.8. Travel cost price elasticities obtained from the hunting site pooled model using a group unit of consumption and alternative wage rate specifications (mean travel cost)

Specification	Leased land	NLP land	Public land	Own land
None	-0.392 ($38.58)	NS ($22.18)	-0.421 ($20.18)	NS ($12.92)
25%	-0.366 ($70.51)	NS ($40.24)	-0.409 ($35.22)	-0.084 ($26.28)
50%	-0.343 ($102.44)	NS ($58.30)	-0.387 ($50.16)	-0.082 ($39.64)

Note: NLP land indicates non-leased private land. NS indicates insignificance.

slightly more elastic for groups on public land compared to groups on leased land. Demand for big game hunting was found to be more elastic for hunting on one's own land compared to hunting on lease sites. Price elasticities for own land hunting trip demand were approximately -0.08.

Individual price elasticities associated with big game hunting trip demand to different access types were also estimated (Table 2.9). Individual elasticities are more easily interpreted and are more common in the recreation literature. Due to the significance of the *Travel cost*non-leased private land* interaction terms for the individual models, elasticities associated with non-leased private land trip demand were estimated. Conversely, elasticities associated with own land trip demand were not estimated. Similar to the group price elasticities, demand for big game hunting trips was slightly more elastic for individuals on public land compared to individuals on leased land. Specifically, individual price elasticities for lease site trip demand ranged from -0.309 to -0.262. As a result, a 10 percent increase in travel costs for an individual to a lease site would result in a 2.62 to 3.09 percent decrease in hunting trip demand. Similarly, a 10 percent increase in travel costs to a public site would result in a 3.57 to 4.29 percent decrease in hunting trip demand. Demand for big game hunting trips was slightly more elastic for individuals on leased land compared to individuals on non-leased private land. Price elasticities associated with trip demand to non-leased private land ranged from -0.324 to -0.296.

Table 2.9. Travel cost price elasticities obtained from the hunting site pooled model using an individual unit of consumption and alternative wage rate specifications (mean travel cost)

Specification	Leased land	NLP land	Public land	Own land
None	-0.309 ($22.78)	-0.296 ($13.09)	-0.357 ($10.19)	NS ($7.39)
25%	-0.289 ($38.33)	-0.324 ($21.40)	-0.421 ($16.59)	NS ($13.61)
50%	-0.262 ($53.87)	-0.313 ($29.71)	-0.429 ($22.99)	NS ($19.82)

Note: NLP land indicates non-leased private land. NS indicates insignificance.

Aggregate Consumer Surplus Estimates from Pooled TCM Models

Aggregate CS estimates were calculated for leased land hunters and public land hunters only. The number of Georgia lease hunters in 2012 was estimated by first determining the percentage (84.9%) of survey respondents who hunted big game in 2012. Since the survey indicated that 47.3% of big game hunters in 2012 leased land, the number of Georgia lease hunters in 2012 was estimated to be 169,766. Using a similar technique, the number of Georgia public land hunters in 2012 was estimated to be 121,671. Aggregate estimates for leased land hunting and public land hunting calculated using three approaches. Aggregate CS estimates varied greatly based on unit of consumption and wage rate assumptions. However, the results do show that the aggregate net economic value of lease hunting was greater than public land hunting across all estimation approaches and assumptions (Table 3.10). For lease hunting specifically, the results show the importance of accounting for fixed costs such as lease price. The second aggregation approach incorporated lease price by adding a separate regressor in the TCM models. Aggregate estimates from this approach were considerably lower than estimates obtained from the approach that did not account for lease price. However, aggregate estimates from the approach that

Table 2.10. Aggregate estimates of the 2012 net economic value of Georgia big game lease and public land hunting using three estimation approaches based on unit of consumption and wage rate assumptions

Users	Unit	No wage rate	25% of wage	50% of wage
Approach 1				
Lease hunting	Group	$197,236,000	$402,092,000	$627,796,000
	Individual	$312,628,000	$596,964,000	$931,005,000
Public land hunting	Group	$ 30,449,000	$ 53,252,500	$ 79,572,300
	Individual	$ 47,724,800	$ 54,744,300	$ 70,661,400
Approach 2				
Lease hunting	Group	$169,261,000	$330,866,000	$512,898,000
	Individual	$259,818,000	$468,025,000	$725,620,000
Public land hunting	Group	$ 31,248,300	$ 55,916,600	$ 84,088,000
	Individual	$ 38,054,700	$ 52,520,100	$ 71,420,900
Approach 3				
Lease hunting	Group	$ 56,334,944	$261,239,021	$486,996,949
	Individual	$171,754,479	$456,157,245	$790.277,566
Public land hunting	Group	$ 29,383,845	$ 52,187,296	$ 78,507,167
	Individual	$ 46,659,590	$ 53,679,111	$ 69,596,239

Note: The number of Georgia big game lease and public land hunters in 2012 was estimated to be 169,766 and 121,671 respectively. The average number of lease and public land trips taken in 2012 was estimated to be 20.78 and 10.95 trips per hunter respectively.

subtracted per year lease price from per year CS estimates were considerably lower than estimates obtained using the separate regressor approach.

Dataset for Leased Land Travel Cost Model

The average number of big game hunting trips an individual took to a lease site was 20.78 with a standard deviation of 19.05 (Table 2.11). The lowest reported number of trips taken was one while 104 was the highest reported number of trips taken. Based on wage rate assumptions, average group travel costs to lease sites ranged from $39.22 to $103.76. Individual travel costs ranged from $23.41 to $54.62. The average household wage rate was $40.17 per hour with a standard deviation of $19.95 per hour. The average round-trip distance to a lease site was 158.10 miles with a standard deviation of 189.81 miles. Over 19% of lease hunters indicated they hunted on another lease, 25.48% hunted on their own land,

Table 2.11. General characteristics of lease site trip dataset created from a sample of licensed big game hunters who hunted big game in Georgia in 2012 (n=265)

Variable	Min	Max	Mean	SD	Missing
Trips	1	104	20.78	19.05	0
Group TC ($) - no wage rate	0.25	248.00	39.22	47.07	0
Group TC ($) - 25% of wage rate	0.46	510.90	71.49	87.25	0
Group TC ($) - 50% of wage rate	0.67	823.40	103.76	129.96	0
Individual TC ($) - no wage rate	0.06	248.00	23.41	32.23	0
Individual TC ($) - 25% of wage rate	0.17	421.49	39.01	54.55	0
Individual TC ($) - 50% of wage rate	0.27	679.31	54.62	79.63	0
Household wage rate ($/hour)	6.01	78.13	40.17	19.95	0
Round trip distance to residence (miles)	1	1000	158.10	189.81	0
Hunts on another lease (%)	-	-	19.25	39.50	0
Hunts on own land (%)	-	-	25.48	43.66	2
Hunts on non-leased private land (%)	-	-	38.02	48.64	2
Hunts on public land (%)	-	-	25.10	43.44	2
Size (acres)	20	12000	1072.79	1661.65	0
Membership	1	80	11.34	11.31	0
Lease price ($)	75	6000	830.25	704.75	0
Lease rate ($/acre)	2.20	65.00	11.35	7.59	0
Party size	1	7	2.05	0.95	0
Years hunted big game	1	55	27.31	13.30	3
QDM practiced (%)	-	-	61.85	48.67	16
Recent timber harvest (%)	-	-	68.08	46.71	5
Age	21	80	50.58	13.26	0
Retired (%)	-	-	21.84	41.39	0
Population density (1000 people/sq. mi)	0.01	8.88	0.62	0.94	0
Household income ($1000s)	12.50	162.50	83.55	41.48	0

38.02% hunted on non-leased private land, and 25.10% hunted on public land. Average lease size was 1,072.79 acres with a standard deviation of 1,661.65 acres. Average lease membership size was 11.34 total members with a standard deviation of 11.31 members. The average lease price paid by each respondent was $830.25 with a standard deviation of $704.75. Average lease rate was $11.35 with a standard deviation of $7.59. Average hunting party size was 2.05 hunters with a standard deviation of 0.95 members. The average big game hunting experience of each respondent was 27.31 years with a standard deviation of 13.30 years. Over 61% of lease sites practiced QDM while 68.08% had a timber harvest within the last 10 years. Average age was 50.58 years with a standard deviation of 13.26 years. Over 21% of lease hunters were retired. Average population density for each respondent's zip code was 0.62 thousand persons per square mile with a standard deviation of 0.94 thousand persons per square mile. Average household income was $83.55 thousand with a standard deviation $41.48 thousand.

Lease Site TCM Model Results

Lease site big game hunting trip demand was modeled as a function of trip costs, big game hunting substitutes, demographics, and lease-specific characteristics. Tests for overdispersion were significant in the preliminary Poisson models indicating the appropriate use of negative binomial regression. Since lease trip demand was truncated at zero, truncated negative binomial regression was used. To account for possible misspecification, the truncated negative binomial models were estimated using robust standard errors (Englin and Moeltner 2004).

Travel costs had a negative and significant effect on the number of trips taken by a group indicating that trip demand decreased as travel costs increased (Table 2.12). *Lease price* was positive and significant indicating that lease site trip demand increased as lease price increased. *Size* was positive and significant indicating that trip demand increased with increasing lease size. *Size squared* was negative and significant indicating that trip demand increased with increasing size but at a non-constant rate. *Membership* was negative and significant while *Membership squared* was positive and significant. These results indicate a quadratic relationship where trip demand decreased with increasing membership but

Table 2.12. Results from zero-truncated negative binomial regression of lease site big game hunting trip demand based on a group unit of consumption and alternative wage rate assumptions (n=238)

Variable	No wage rate	25% wage rate	50% wage rate
Travel cost	-0.0081***	-0.0042***	-0.0027***
	(0.0013)	(0.0006)	(0.0004)
Lease price	0.0001**	0.0001*	0.0001*
	(0.0001)	(0.0001)	(0.0001)
Size	0.0003***	0.0003***	0.0003***
	(0.0001)	(0.0001)	(0.0001)
Size squared	-2.12E-08**	-2.26E-08***	-2.28E-08***
	(8.62E-09)	(8.67E-09)	(8.66E-09)
Membership	-0.0375***	-0.0385***	-0.0389***
	(0.0122)	(0.0121)	(0.0122)
Membership squared	0.0003**	0.0004**	0.0004**
	(0.0001)	(0.0001)	(0.0001)
Recent timber harvest	-0.0837	-0.0812	-0.0796
	(0.1001)	(0.1007)	(0.1013)
QDM practiced	-0.1545	-0.1584	-0.1624
	(0.1012)	(0.1015)	(0.1018)
Party size	-0.0661	-0.0808*	-0.0862*
	(0.0489)	(0.0482)	(0.0482)
Years hunted big game	0.0172***	0.0171***	0.0172***
	(0.0043)	(0.0043)	(0.0043)
Hunts on another lease	-0.1272	-0.1183	-0.1139
	(0.1186)	(0.1175)	(0.1174)
Hunts on own land	-0.2576**	-0.2531**	-0.2497**
	(0.1117)	(0.1122)	(0.1126)
Hunts on non-leased private land	0.1857*	0.1869*	0.1903*
	(0.1048)	(0.1049)	(0.1052)
Hunts on public land	-0.0579	-0.0509	-0.0483
	(0.1075)	(0.1071)	(0.1072)
Age	-0.0158**	-0.0163**	-0.0163**
	(0.0062)	(0.0064)	(0.0065)
Retired	0.1645	0.1819	0.1882
	(0.1517)	(0.1551)	(0.1573)
Population density (1000/square mile)	-0.0465	-0.0575	-0.0649
	(0.0638)	(0.0583)	(0.0564)
Household income (1000s)	-0.0043***	-0.0030**	-0.0026*
	(0.0013)	(0.0013)	(0.0013)
Intercept	4.1636***	4.0972***	4.0718***
	(0.3382)	(0.3367)	(0.3368)
Overdispersion	0.4009	0.4060	0.4098
McFadden R^2	0.0555	0.0542	0.0531
Log-likelihood	-897.22	-898.54	-899.54

***, **, and * indicates significance at the 1%, 5%, and 10% levels respectively.
Note: Robust standard errors are reported. Twenty-seven observations from the original sample of lease hunting sites were dropped due to missing data.

also at a non-constant rate. Two site specific variables, *QDM practiced* and *Recent timber harvest* were both insignificant. *Party size* was negative and significant at the 10% level for two wage rate specifications indicating that group lease site trip demand decreased as the size of the group increased. *Years hunted big game* was positive and significant indicating that lease site trip demand increased with greater hunter experience. *Hunts on own land* was negative and significant and *Hunts on non-leased private land* was positive and significant. These results demonstrate that hunting on one's own land was a substitute to hunting on leased land while hunting on non-leased private land was a complement. *Age* was negative and significant indicating that lease hunting trip demand decreased with age. However, *Retired* was positive and insignificant indicating that retirement status did not have a significant effect on lease site trip demand. *Population density* was insignificant suggesting that urban or rural residence did not significantly influence trip demand. *Household income* was negative and significant across all wage rate specifications indicating that greater household income had a negative effect on lease site trip demand.

Results from the individual models are very similar to the results obtained from the group models (Table 2.13). *Travel costs* had a negative and significant effect on the number of trips taken by an individual indicating that trip demand decreased as travel costs increased. Similarly, *Lease price* was positive and significant while *Size* was positive and significant and *Size squared* was negative and significant. In addition, *Membership* was negative and significant while *Membership squared* was positive and significant. Two site specific variables, *QDM practiced* and *Recent timber harvest* were both insignificant. One difference between the models involves *Party size*. Since the individual models specified demand for the individual and not the group, *Party size* was not needed and was omitted from the models. In contrast to the group models, *Population density* was negative and significant for the individual models indicating that hunters in urban areas took a greater number of lease hunting trips.

Table 2.13. Results from zero-truncated negative binomial regression of lease site big game hunting trip demand based on an individual unit of consumption and alternative wage rate assumptions (n=238)

Variable	No wage rate	25% wage rate	50% wage rate
Travel cost	-0.0118***	-0.0069***	-0.0046***
	(0.0022)	(0.0013)	(0.0008)
Lease price	0.0001**	0.0001**	0.0001**
	(0.0001)	(0.0001)	(0.0001)
Size	0.0003***	0.0003***	0.0003***
	(0.0001)	(0.0001)	(0.0001)
Size squared	-2.07E-08**	-2.15E-08**	-2.15E-08**
	(8.60E-09)	(8.65E-09)	(8.63E-09)
Membership	-0.0336***	-0.0342***	-0.0346***
	(0.0125)	(0.0124)	(0.0124)
Membership squared	0.0003**	0.0003**	0.0003**
	(0.0001)	(0.0002)	(0.0002)
Recent timber harvest	-0.0558	-0.0581	-0.0586
	(0.1017)	(0.1025)	(0.1032)
QDM practiced at site	-0.1404	-0.1459	-0.1536
	(0.1059)	(0.1047)	(0.1043)
Years hunted big game	0.0176***	0.0176***	0.0178***
	(0.0043)	(0.0043)	(0.0043)
Hunts on another lease	-0.0474	-0.0544	-0.0571
	(0.1231)	(0.1222)	(0.1222)
Hunts on own land	-0.2503**	-0.2588**	-0.2603**
	(0.1109)	(0.1113)	(0.1119)
Hunts on non-leased private land	0.1861*	0.1920*	0.1982*
	(0.1076)	(0.1063)	(0.1061)
Hunts on public land	-0.0538	-0.0474	-0.0454
	(0.1110)	(0.1104)	(0.1105)
Age	-0.0109*	-0.0123*	-0.0129*
	(0.0065)	(0.0065)	(0.0066)
Retired	0.2053	0.2169	0.2202
	(0.1538)	(0.1557)	(0.1577)
Population density (1000/square mile)	-0.0938*	-0.1028**	-0.1103**
	(0.0481)	(0.0471)	(0.0463)
Household income (1000s)	-0.0036***	-0.0028**	0.0026*
	(0.0013)	(0.0013)	(0.0013)
Intercept	3.6160***	3.6148***	3.6199***
	(0.3097)	(0.3063)	(0.3057)
Overdispersion	0.4242	0.4231	0.4262
McFadden R^2	0.0496	0.0498	0.0491
Log-likelihood	-902.87	-902.64	-903.38

***, **, and * indicates significance at the 1%, 5%, and 10% levels respectively.

Note: Robust standard errors are reported. Twenty-seven observations from the original sample of lease hunting sites were dropped due to missing data.

Lease Site Consumer Surplus and Price Elasticities

Per person CS estimates obtained from the group and individual specification lease site models were estimated (Table 2.14). CS estimates increased when larger wage rate fractions were assumed. Using a group specification, per trip per person CS point estimates associated with lease hunting ranged from $59.58 to $177.27. Using an individual specification, per trip per person CS point estimates ranged from $84.66 to $219.02. Per person CS estimates using an individual specification were consistently higher than CS estimates obtained using a group specification. CS estimates obtained from the lease site only models were fairly similar to lease site CS estimates obtained from the pooled models. From the pooled models, per trip per person lease site CS ranged from $47.98 to $145.39 for the group models and $73.65 to $205.69 for the individual models.

Table 2.14. Per person consumer surplus point estimates obtained from the lease site model using alternative unit of consumption and wage rate specifications (95% confidence intervals)

Wage rate	Group unit of consumption	Individual unit of consumption
None	$59.58	$84.66
	($40.48, 78.69)	($52.72, $116.60)
25%	$115.44	$145.35
	($80.32 $150.57)	($91.83, $198.87)
50%	$177.27	$219.02
	($121.68, $232.86)	($143.63, $294.41)

Note: Average hunting party size was 2.08.

Lease site elasticities obtained using a group specification were estimated (Table 2.15). Price elasticities associated with lease hunting trip demand ranged from -0.295 to -0.265 based on wage rate specifications. As a result, a 10 percent increase in group travel costs would lead to a 2.65 to 2.95 percent decrease in group trip demand. Group price elasticities for hunting on leased land obtained from the previous multiple site travel cost model ranged from -0.392 to -0.343 suggesting some robustness. Lease size elasticities ranged from 0.295 to 0.322 and lease membership elasticities ranged from -0.355 to -0.339 based on wage rate specifications. These results indicate that groups reacted to changes in travel costs similarly to changes in lease size and membership. Income elasticities ranged from -0.355 to -0.215 based on wage rate assumption. When no wage rate was assumed, the income elasticity indicated that a

Table 2.15. Elasticities obtained from lease site model using a group unit of consumption and alternative wage rate specifications

Specification	Price	Size	Membership	Income
None	-0.295	0.295	-0.339	-0.355
25%	-0.279	0.316	-0.351	-0.247
50%	-0.265	0.322	-0.355	-0.215

10 percent increase in household income would result in a 3.55 decrease in group trip demand. When half of the wage rate was assumed, a 10 percent increase in household income would result in a 2.15 decrease in group trip demand.

Elasticities associated with lease site trip demand obtained using an individual specification were also estimated (Table 2.16). Price elasticities associated ranged from -0.256 to -0.228 based on wage rate specifications. As a result, a 10 percent increase in individual travel costs would lead to a 2.28 to 2.56 percent decrease in individual trip demand. Price elasticities from the pooled individual models ranged from -0.309 to -0.262. Similar to the estimated price elasticities, lease size elasticities ranged from 0.284 to 0.296 and lease membership elasticities ranged from -0.308 to -0.295 based on wage rate specifications. Income elasticities ranged from -0.303 to -0.215 based on wage rate assumption.

Table 2.16. Elasticities obtained from lease site model using an individual unit of consumption and alternative wage rate specifications

Specification	Price	Size	Membership	Income
None	-0.246	0.284	-0.295	-0.303
25%	-0.243	0.295	-0.304	-0.235
50%	-0.228	0.296	-0.308	-0.215

Aggregate Consumer Surplus Estimates from Lease Site TCM Model

Aggregate per year CS estimates associated with big game hunting on lease sites were calculated from results of the lease site only TCM model (Table 2.17). Similar to the aggregate estimates reported for the pooled model, three approaches were used to estimate the aggregate net economic value of lease hunting in Georgia in 2012. Generally, estimates from individual models were higher than those from group models and estimates from wage-based models were higher than those from the no wage model. Similar to results from the pooled models, estimates from the approach that subtracted lease price from

Table 2.17. Aggregate estimates of the 2012 net economic value of Georgia big game lease hunting using three estimation approaches based on unit of consumption and wage rate assumptions

Users	Unit	No wage rate	25% of wage	50% of wage
Approach 1	Group	$225,810,000	$431,866,000	$659,334,000
	Individual	$321,306,000	$551,879,000	$828,912,000
Approach 2	Group	$210,183,000	$407,242,000	$625,362,000
	Individual	$298,658,000	$512,757,000	$772,645,000
Approach 3	Group	$ 84,916,364	$291,030,155	$518,542,367
	Individual	$184,434,761	$411,062,116	$688,160,741

Note: The number of Georgia big game lease site and public land hunters in 2012 was estimated to be 169,766 and 121,671 respectively. The average number of lease site and public land hunting trips taken in 2012 was estimated to be 20.78 and 10.95 trips per hunter respectively.

per year CS estimates (Approach 3) were considerably lower than estimates obtained using the approach that accounted for lease price by adding a separate regressor (Approach 2).

Alternative Specification of Lease Site Model

An alternative specification of the lease site model was estimated to determine the travel cost interaction effects of lease specific attributes such as *Size* and *Membership*. Similar to Hesseln et al. (2004), travel cost interaction terms were used to determine whether these variables shifted trip demand or affected the slope of the demand curve. However, results using this alternative specification indicated that the travel cost interaction effects were mostly insignificant (Appendix C). Specifically, *Membership*travel costs* was insignificant across all unit of consumption and wage rate assumptions while *Size*travel costs* was insignificant except for two wage rate specifications assuming an individual unit of consumption. These results suggest that *Size* and *Membership* shift demand but do not affect the slope of the lease site demand curve.

Discussion and Conclusion

This study provide a number of useful insights into the economic value of big game hunting and how this value is influenced by access type. Results indicate that leased land hunting trips were valued more than big game hunting trips on public land. Access costs associated with hunting on leased and public were accounted for by including additional covariates. As a result, the CS estimates indicate that hunting on leased land was valued more than hunting land public land despite differences in access costs. These results show that hunters valued the benefits of leasing (i.e. controlled access, less crowding, potential control over management/rules) more than the benefits of hunting on public land (i.e. low access costs). In addition, CS estimates for hunting all forms of private land were higher than CS estimates associated with public land.

CS estimates related to hunting are consistent with estimates obtained from previous studies. Assuming an individual unit of consumption and a 0.25 wage rate specification for the opportunity cost of time, per trip per person CS estimates associated with leased land, non-leased private land, and public land were $132.67, $66.14, and $39.43 respectively. Expressed in 2012 dollars, Offenbach and Goodwin (1994) obtained per trip per person CS estimates of $336.83 and $369.84 for general hunting sites in Kansas. Creel and Loomis (1990) obtained per trip per person estimates of $141.62 and $150.99 for public hunting sites in California using truncated count data regression. Bergstrom and Cordell (1991) obtained a per trip per person CS estimate of $58.55 for nationwide big game hunting on public sites in America. Welfare estimates associated with big game hunting in Georgia were not trivial and were significantly influenced by access type.

Findings from this research are consistent with literature examining hunter preferences. For instance, Luloff et al. (2004) found that Pennsylvania hunters believed that success and satisfaction were lower on public lands. Similarly, Brown et al. (2001) found that nearly two thirds of hunters in New York preferred to hunt on private land due to perceived quality of habitat, crowding and convenience. Implications for this study's findings exist due to potential trends involving declining hunting access. A number of studies have found that hunting access on private lands is declining (Lauber and Brown 2000; Brown et al. 2001; Jagnow et al. 2006). If declining hunting private land hunting access occurs in Georgia, hunting participation may decrease and more pressure could be placed on public lands such as WMAs. From an economic perspective, an increase in hunting trip demand to public lands would be "inefficient" due to public land's lower CS estimates. In addition, trip demand associated with hunting on public land was found to be more slightly more elastic than trip demand associated with other access options. As a result, public land hunters are likely more responsive to price changes. If costs associated with hunting on public land increase due to economic factors or potential policy changes affecting access costs, trip demand would be affected more by public land hunters. This presents potential equity concerns since the only access option for many hunters may be public land.

In addition to deriving measures of economic value, this research identified factors affecting big game hunting trip demand. Similar to previous studies, a number of demographics significantly influenced big hunting trip demand. In addition, the presence of food plots had a positive effect of hunting trip demand. This demonstrates that hunting site improvements can increase demand to a hunting site. Though not entirely comparable, Creel and Loomis (1990) found a positive and significant relationship between the number of deer seen and hunting trip demand. Hunting experience had a positive effect on hunting trip demand. This result contrasts with previous studies which found a positive but insignificant relationship involving hunting experience (Balkan and Kahn 1988; Offenbach and Goodwin 1994). Similar to Offenbach and Goodwin (1994) and Bergstrom and Cordell (1991), trip demand decreased as the age of the hunter increased. However, trip demand increased for retired hunters. Previous studies examining hunting trip demand have not considered the effect of retirement status on trip demand. This result has potential implications considering Georgia's aging hunter population. As demonstrated by national survey findings related to the state of Georgia, the percentage of Georgia hunters aged between 45 and 54 increased from 17 to 26 percent from 2001 to 2011. In addition, the percentage of 55-64 years olds increased from 14 to 38 percent during the same period. These results demonstrate that a increasing population of retired hunters could result in increased hunting trip demand in Georgia.

Household income had a negative or insignificant effect on hunting trip demand. This result indicates that trip demand decreased or was not affected by increasing income and is similar to findings made by other wildlife recreation travel cost studies (Balkan and Kahn 1988; Creel and Loomis 1990; Rockel and Kealy 1991; Yen and Adamowicz 1993; Zawacki et al. 2000). Even though participation and trip frequency have not been examined jointly by hunting TCM studies, wildlife viewing studies have shown that income can affect each decision differently (Rockel and Kealy 1991; Sun et al. 2015). For instance, Rockel and Kealy (1991) found that income had a positive and significant effect on wildlife viewing participation but an insignificant effect on trip demand. Though wildlife viewing and hunting are different activities, income likely affects the decision to become a hunting trip taker. Considering that the median household income of this study's sample was nearly $62,500 and Georgia's 2012 median household income was approximately $49,000, these figures suggest that Georgia hunters as a group were wealthier than the general population of Georgia. Even though income may positively affect the decision to become a hunting trip taker, income may not necessarily positively affect the number of trips taken. One explanation for this is that hunting is an inferior good. As described by Boman et al. (2013), the inferior nature of hunting may be explained by a growing older hunter demographic that has limited amounts of disposable income. This explanation seems particularly relevant to this study considering the average age and retirement status of the sample. Boxall et al. (1996) posited that higher income individuals have less available time to pursue recreation. In addition, Boman et al. (2013) also argued that the possible inferior nature of hunting may be due to limited access options and the inability to find suitable hunting land.

Factors specifically affecting lease site hunting trip demand were also identified. The significance of the lease size quadratic term indicates that lease size did not affect trip demand at a constant rate. This quadratic effect indicates that hunters generally preferred large leases over small leases to avoid congestion and to find suitable hunting spots. However, the marginal utility of added lease size decreased for larger leases. Hussain et al. (2010) examined lease choice and found a similar result suggesting a diminishing value of added lease size. Similar to lease size, the lease membership quadratic term was also significant. The quadratic effect of lease membership size on demand indicates that hunters generally took more trips to sites with fewer members. However, the effect of added lease membership diminished once membership became larger. These findings are consistent with previous studies which hunter preferences for less crowded conditions (Gan and Luzar 1993; Munn et al. 2011). Though timber management activities have been found to affect moose hunter preferences in Canada (Boxall and Macnab 2000), a significant effect involving recent forest harvest was not found for this study. It should be noted, however, that the recent timber harvest variable was not defined clearly. Similarly, a definition of QDM was not clearly specified in the survey questionnaire. The ambiguous definitions of both variables were clear limitations and may have contribute to each variable's insignificance. Hunting on one's own land was found to be a substitute to hunting on leased land while hunting on non-leased private land was found to be a complement. For hunters who have the ability to hunt with exclusive access on their own property, hunting on their own land can serve as a substitute to hunting on leased land. However, a clear explanation does not exist regarding non-leased private land being a complement.

The results of this research should be of use to both public wildlife agencies and private landowners who supply fee, restricted, or exclusive hunting access to their land. If declining private hunting access occurs in Georgia, more hunters may have to turn to public land, resulting in welfare loss. Alternatively, the large CS estimates associated with hunting on non-leased private land demonstrate that these landowners potentially have an untapped source of revenue they are not exploiting. Though owners of non-leased private land may be interested in supplying access only to friends and family, results suggest that leasing may be a viable option for these landowners. Results may also be useful from an ecosystem services perspective. Many studies have estimated the economic value of a number of ecosystem services related to recreation. Consumer surplus estimates from this study can be used to provide additional estimates of the monetary value of recreation ecosystem services.

Aggregate consumer surplus estimates indicate that the total value of lease hunting in Georgia was conservatively near $200 million. For public land, aggregate consumer surplus was estimated to be near $50 million. Since a hunting license is not required for hunters who hunt on their own land or hunt on the land of immediate family members, aggregate estimates for hunting on one's own land and hunting on non-leased private land were not calculated. Estimates of total consumer surplus can be used to provide a comparison of the relative value of recreational activities. Expressed in 2012 dollars, Bergstrom and Cordell (2001) found that the total consumer surplus associated with big game hunting on public land was near $3.2 billion dollars. Though lower than estimates associated with lease hunting, the total value of hunting on public land in Georgia demonstrates that public hunting land access is a valued resource in

Georgia. For policymakers, the importance of this resource shows that investments related to the protection or improvement of public hunting land are justified. Estimates from the aggregation approach that subtracted fixed costs from per year CS estimates were considerably lower than estimates obtained from specifying fixed costs as an independent variable. This suggests that incorporating fixed costs by adding a separate regressor may still overestimate CS in some instances. This effect was less pronounced with public land hunting when fixed costs were considerably lower.

Demand associated with big game hunting trip demand was generally inelastic. Specifically, however, public hunting trip demand was relatively more elastic than private hunting demand. A recent proposal by Georgia DNR officials to raise license fees could potentially negatively affect big game hunting trip demand. Specifically, Georgia DNR has proposed to increase the cost of a big game hunting license from $19 to $40 and a sportsman combo license from $55 to $60 (Kirby 2015). Though license fees are dissimilar to true access costs (i.e. park admission fee, ski lift ticket), a tenuous assumption can be made to include license fees as part of the total costs needed to take a hunting trip. If this assumption is made, the elasticities show that hunters would respond to a license increase by taking less trips. In addition, the elasticities indicate that public land hunters would be more responsive to a price change than other groups. The overall effect of a decrease in hunting trip demand would be a decrease in the economic value of big game hunting in Georgia.

This effect of a license fee increase can be illustrated with an example. First, all of the calculations to come assume an individual unit of consumption and a 0.25 wage rate specification. For lease hunters and public land hunters, elasticities calculated were -0.289 and 0.421 respectively for specification. Average trip costs for lease hunters and public land hunters at this specification were $38.33 and $16.59 respectively. In addition, the average number of trips taken by lease hunters and public land hunters was 20.78 and 10.95 respectively. For simplicity, an assumption is made that the proposed $21 big game hunting license increase will be apply to all big game hunters. Though the resident big game hunting license is the most popular license with big game privileges, other license types provide big game privileges (i.e. sportsman, lifetime). Since license fee is not a true access cost, the effect of the proposed fee increase was estimated by dividing the fee increase by the average number of big game hunting trips taken by each group. Using this information, the fee increase decreased the total number of big game hunting trips to lease sites by 0.78% resulting in a welfare loss of $3.6 million. For public land hunters, the fee increase decreased the total number of trips to public sites by 5.42% resulting in a welfare loss of $2.8 million. This scenario demonstrates that a fee increase would have a greater effect on visitation to public hunting land. However, the fee increase would have a greater effect on aggregate CS for lease land hunting.

Overall, the survey's response rate (24.4%) was low compared to similar recent hunting studies. In addition, a formal nonresponse check could not be conducted since very limited information was known about survey non-respondents. However, demographics from the sample are fairly similar to findings made by the three most recent versions of the National Survey on Fishing, Hunting, and Wildlife Associated Recreation (USFWS 2001, 2006, 2011). Even though the national surveys did not present demographics related to Georgia big game hunters specifically, the surveys did present demographics for Georgia hunters in general. The three most recent national surveys indicate that Georgia hunters were overwhelmingly male, white, and non-Hispanic. The national surveys also show that Georgia hunters became older from 2001 to 2011. In 2001, 17% of Georgia hunters were 45 to 54 years old while 14% were 55 to 64 years old. In 2011. 26% were 45 to 54 years old while 38% were 55 to 64 years old. The national surveys also indicate that Georgia hunters became more educated from 2001 to 2011. 17% of hunters had at least four years of college education in 2001 compared to 31% in 2011. The percentage of Georgia hunters who hunted on public land was consistently near 20% from 2001 to 2011. During the same period, the percentage of hunters who hunted on some form of private land was consistently near 90%. It should be noted however that Georgia hunters who hunt exclusively on their own land or land owned by immediate family members are not required to possess a hunting license. Even though the set of demographics presented in the national surveys are not exhaustive, the demographic snapshots of Georgia hunters from 2001 to 2011 closely resemble the present study's demographic snapshot of Georgia big game hunters in 2012. Despite a fairly low response rate, a comparison of the present study's sample with summary statistics from recent national surveys demonstrates that nonresponse bias likely did not occur.

A number of limitations involving the travel cost models exist do exist however. For instance, a tenuous assumption was made to specify the same per mile vehicle operating cost for each observation. Though this practice is common in the literature, every hunter does not drive the same type of vehicle to his or her hunting site. In addition, the rate of travel for every hunter is likely not the same. Questions related to vehicle type and rate of travel may be needed to accurately estimate travel costs. To derive big game hunting trip demand, a pooled model was used that combined trip observations to different site types. Ideally, if enough observations were available for each site type, separate travel cost models could have been estimated for each access option. These individual models could have included variables specific to each general type. For instance, a public hunting trip demand model could have included variables related to game species, seasons, quota hunts, and general rules and regulations. Another limitation involved specifying multiple hunting sites for each hunter as additional observations. Though this practice is common in the literature, the hunting trip data was not truly independent. Though efforts were made to include lease cost in the models, the literature is sparse with regard to the treatment of fixed costs. The inclusion of a separate lease cost independent variable decreased CS estimates associated with lease hunting, but the aggregate estimates showed that this practice still likely overestimated the total value of lease hunting. Also, substitutes may not have been properly specified in the travel cost models. Given constraints associated with our survey instrument, the only potential substitutes available were hunting to different site types. In reality, however, a number of substitutes for big game hunting may exist ranging from fishing and wildlife watching to golf and shooting clay pigeons.

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CHAPTER 3

IDENTIFYING PREFERENCES FOR BIG GAME HUNTING LEASE ATTRIBUTES IN GEORGIA USING A CHOICE EXPERIMENT

Abstract

Lease hunting on private forestland is popular in Georgia and other parts of the Southeastern USA. Despite the popularity of leasing, little is known about hunter preferences for lease characteristics. The objective of this study was to identify hunter preferences for attributes related to big game leases and to derive measures of economic value for these attributes. To accomplish this objective, a mail survey was sent to 3,000 licensed big game hunters in Georgia and yielded a response rate of 24.4%. In the choice experiment component of the survey, hunters were presented alternatives representing different combinations of lease attributes. Each choice alternative had varying levels of the following attributes: price, lease size, lease membership, buck harvest regulations, and recent forest management activity. Choice responses, analyzed with conditional logit and multinomial probit regression models, revealed that Georgia big game hunters preferred leases with greater acreages and leases with fewer members. Hunters also preferred leases with more restrictive buck harvesting regulations and sites that had not been recently clearcut.

When results from the choice experiment were compared with a travel cost model, the comparison showed that lease size and lease membership had a significant effect on lease choice and lease site trip demand. Variables related to buck harvesting regulations and recent forest management activity did not significantly affect lease site trip demand. As an informal check for convergent validity, the use of two modeling approaches to examine preferences lease attributes provided a greater understanding of lease hunters in Georgia. A better understanding of big game hunter lease preferences could help landowners make management decisions that improve the marketability of their leases.

Introduction

Hunting is a popular and economically important form of outdoor recreation in the United States. In 2011, there were an estimated 13.7 million hunting participants in America compared to 12.5 million in 2006 (USFWS 2011). As population growth continues, the number of hunting participants is expected to increase even though the hunting participation rate is projected to decrease (White et al. 2014). Economically, total expenditures related to hunting in the United States were estimated at $33.7 billion in 2011. This represented a $7.5 billion increase in expenditures compared to the figure reported in 2006 (USFWS 2011).

In the state of Georgia, there were approximately 392,000 resident and nonresident hunters in 2011who generated 965 million dollars in total expenditures. In 2011, 89% of Georgia hunters hunted big game, and roughly 60% of all hunting expenditures in Georgia were related to big game hunting (USFWS 2011). Georgia big game hunters have various access options such as public land, private lease land, and private non-lease land. Most hunters in Georgia (76%) exclusively hunt on private land while a small percentage (22%) hunts on private and public land (USFWS 2011).

From the demand perspective, lease hunting is a popular alternative for many hunters who lack their own private hunting land or prefer an alternative to hunting on public land. In recent decades, the popularity of lease hunting has generally increased. Little public hunting land combined with rapid population growth caused the proliferation of lease hunting first in Texas (Baen 1997). In North Carolina, lease hunting became important as the reported white-tailed deer harvest increased from 23,184 in 1976-77 to 78,265 in 1987-88 (Mason 1989). By the mid-1980s, 84% of the reported deer harvest in North Carolina was from private hunting clubs (Mason 1989). The percentage of forest industry land in the southeast leased to hunting clubs and individuals increased to 76% in 1994 from 64.5% in 1994 (Marsinko et al. 1998; Morrison et al. 2001). In Georgia, the estimated farm gate value of hunting leases for white-tailed deer was approximately $108 million in 2006 (Boatwright and McKissick 2006). In 1999, this value was approximately $50 million. The popularity of lease hunting demonstrates that hunters are willing to pay a premium for a higher quality hunting experience (Hussain et al. 2004). Similar to other purchasing decisions, hunters maximize utility by choosing leases that possess attributes important to them while considering monetary and time costs.

From the supply perspective, landowners provide fee access opportunities primarily to generate revenue. In addition, landowners are benefited by greater access control and reduced property damage due to trespassing (Marsinko et al. 1992). Lease agreements protect landowners by stipulating where the hunting boundaries are, what activities are permitted, and how facilities should be maintained. Lease agreements can also protect landowners by including liability clauses (Wright et al. 2002). To successfully generate revenue however, lessors must effectively manage and market their leases to hunters (Hussain et al. 2010). Effective lease management and marketing is facilitated by understanding hunter preferences for lease attributes. Though contingent valuation has been used to examine hunter willingness to pay for hunting leases, attribute based methods are needed to explicitly examine the economic values associated with each attribute (Hussain et al. 2003; Hussain et al. 2010). By analyzing hunting leases with an attribute based approach, hunter preferences for lease attributes can be identified.

Previous Studies

Attribute based methods have been used recently to examine a number of issues related to natural resources. For instance, researchers examined timber harvest preferences in Maine (Boyle et al. 2001), the rock climbing site preferences of recreationists in Scotland (Hanley et al. 2002), preferences for wetland management approaches in Greece (Birol et al. 2006), and the costs of air pollution impacts in South Korea (Yoo et al. 2008). Specifically related to wildlife recreation, Adamowicz et al. (1994) examined angler site preferences with a choice experiment (CE) and found that attributes such as water quality and fishing success significantly affected site choice. Mackenzie (1990) used a choice experiment (CE) variation called conjoint analysis and asked licensed to hunters to rate four hunting trip scenarios based on the following attributes: travel time, cost, type of group, license fee, congestion, and chance of bagging a deer. Similarly, but using a CE, Boxall et al. (1996) found that hunter access, site congestion, and moose populations significantly affected moose hunter site preferences in Canada. Boxall and Macnab (2000) found that distance to residence, hunter access, site congestion, and evidence of forestry activity affected hunter site preferences.

Hussain et al. (2003) used a conjoint analysis to examine attributes affecting white-tail deer hunter lease preferences in Alabama. This study found that five attributes significantly affected lease choice, but harvest success, lease rate, and accessibility had the greatest effect on lease preferences (Hussain et al. 2003). Similarly, Hussain et al. (2010) examined lease hunting in Mississippi with a CE and used the following attributes to examine lease choice: game diversity, distance from residence, onsite access, lease rate, lease duration, and lease size. This study found that hunters preferred leases where deer could be hunted along with turkey and waterfowl. In addition, leases between 500-1,000 acres were preferred over leases possessing 500 acres. Leases 90 miles away from a hunter’s residence were not preferred over leases 30 miles from a hunter’s residence. Onsite access was an insignificant attribute while a lease duration of three years was preferred over a one year lease duration.

Studies examining hunter preferences have also used approaches such as contingent valuation and hedonic regression to examine hunter preferences. Using a contingent valuation and sample selection approach, Munn et al. (2011) examined factors affecting a hunter’s decision to lease and factors affecting hunter willingness to pay (WTP) for a lease. Significant factors affecting the decision to lease included perception of crowding on public land, hunting avidity, availability of other hunting access options, and income. Significant factors affecting WTP for a lease included perception of crowding on public land, availability of game species, and lease duration (Munn et al. 2011). Lease size did not significantly influence WTP for a lease. A hedonic study of hunting lease revenue by Hussain et al. (2007) found no significant relationship between lease price per acre and lease size while Shrestha et al. (2002) and Rhyne et al. (2009) found that lease price per acre decreased with increasing acreage. In contrast, Livengood (1983) found that the lease price paid by deer hunters increased with greater lease acreage.

Studies examining site congestion found that crowded conditions were not preferred by waterfowl hunters (Gan and Luzar 1993) and increased the likelihood of Mississippi hunters choosing to lease (Munn et al. 2011). Similarly, Hussain et al. (2003) used found that deer hunters preferred lease sites that possessed a smaller likelihood for crowded conditions. A limited number of studies have examined hunter preferences for different timber and wildlife management approaches. For example, Boxall and Macnab (2000) used a CE and found that moose hunters and wildlife viewers in Canada favored less intensive forest management activities that helped create wildlife openings. Meanwhile, Boxall et al. (1996) found that evidence of recent forestry activity had no significant effect on moose hunter site selection. Stribling et al. (1992) used contingent valuation and examined the effect of harvest regulations on WTP for a lease. This study found that WTP for a lease did not significantly increase with the opportunity to harvest more than two deer.

Attribute based approaches have not been used extensively to examine hunting in general and lease hunting specifically. Notable exceptions include Boxall et al. (1996) and Boxall and Macnab (2000) which examined moose hunting in Canada and Hussain et al. (2003) and Hussain et al. (2010) which examined lease hunting in Alabama and Mississippi respectively. Since hunting leases can be considered composite goods that can be broken down into their specific attributes, a CE was chosen to examine lease choice behavior and the tradeoffs between lease attributes. Though Hussain et al. (2003) and Hussain et al. (2010) identified a number of significant lease site preferences related to factors such as site congestion and game diversity, the effect of different management approaches on lease choice has not been examined fully. Specifically, a greater understanding of lease hunters preferences related to buck harvesting regulations and recent forest management activity is needed. By taking into account these potentially important lease attributes, a greater understanding of lease site management preferences can be achieved. The findings could then be used to inform private landowners and timber companies on lease hunter management preferences. Landowners could then use this knowledge to adopt management approaches aimed at improving the marketability of their leases and increasing profit. Hunters can be divided on the issue of harvest restrictions with some supporting the current regulations and others advocating stronger restrictions. An example of a popular management approach that advocates harvesting older, more mature bucks and letting younger bucks reach maturity is Quality Deer Management (QDM) (Miller and Marchinton 2007). Results identifying the harvest preferences of hunters could be valuable for advocates of QDM and state officials involved with setting harvest regulations.

O*bjectives*

The objective of this study was to determine big game hunters' preferences for lease related attributes and to estimate willingness to pay associated with each attribute. A secondary objective of this research was to conduct an informal convergent validity check by comparing results from the lease hunting CE with results from a lease site travel cost model.

Methodology

Choice Experiment Background

A choice experiment (CE) is a stated preference attribute-based approach that involves respondents choosing between alternative goods that are defined in terms of their characteristics (Holmes and Adamowicz 2003). An application of the characteristics theory of value (Lancaster 1966), the CE approach assumes that consumer utility is derived from the attributes that a good possesses rather than from the good itself. Similar to hedonic regression, A CE treats an environmental amenity as a composite good with distinct attributes and attempts to estimate the marginal economic value associated with each attribute (Holmes and Adamowicz 2003). This approach can be especially useful in a number of natural resource policy settings since the focus is often not the complete loss or preservation of an environmental good but rather the appropriate adjustment of relevant attributes that make up the good (Hussain et al. 2010). A CE can also be useful when analyzing preferences for proposed regulations or attribute levels that do not currently exist (Ryan et al. 2007).

There are a number of advantages associated with choosing a CE over other nonmarket approaches. For instance, a CE is a preferred approach if the objective of the research is to understand the tradeoffs between lease price and other attributes associated with the lease. In addition, welfare estimates obtained from contingent valuation approaches may be affected by respondents neglecting to take into account potential alternatives (Boxall et al. 1996). By examining how changes in various attributes affect willingness to pay, landowners and policymakers can obtain a better understanding of how different management strategies impact lease preferences. From an operational perspective, a CE can provide a number advantages over contingent valuation. For instance, a CE avoids the “explicit elicitation” of willingness to pay values and other potential problems associated with contingent valuation such as protest bids, strategic bias, and yeah saying (Hanley et al. 2001). However, it should be noted that potential concerns associated with conducting a CE include choice complexity, choice set length, and the potential for strictly dominated alternatives (Hanley et al. 2002).

A CE also provides advantages over revealed preference approaches such as hedonic regression and the travel cost method. In contrast to revealed preference approaches that rely on examining actual market behavior, a CE provides greater flexibility by allowing the researcher to explicitly frame the research question and control which attributes are included in the analysis (Ryne et al. 2007). In addition, attribute levels beyond the range of those currently observed in the marketplace can be examined using a CE (Hanley et al. 2002). However, revealed preference approaches are benefited by being derived from actual behavior and are unaffected by hypothetical market effects (Hanley et al. 2002). Travel cost studies examining hunter behavior such as Sarker and Surry (1998) and Offenbach and Goodwin (1994) derived hunting trip demand curves and estimated measures of net benefit associated with taking a hunting trip. As a result, a CE can examine factors affecting lease choice while a lease site travel cost model can identify factors affecting lease site trip demand. The use of both approaches can provide a greater understanding of two decisions faced by potential lease hunters: which lease to choose and how many trips to take to a lease site.

Study Area

The study was conducted in the state of Georgia, USA. A detailed description of the study area can be found in Chapter 2 on page 16.

Survey and Sampling Design

A mail questionnaire was designed for the general purpose of better understanding big game hunting in Georgia. A detailed description of the survey questionnaire can be found in Chapter 2 on page 17. The choice experiment component of the survey was located in Section D of the questionnaire (Appendix A). In this section, respondents were asked to choose their preferred hunting club from six choice sets. Each choice set contained two hunting club alternatives as well as a status quo (neither club) option. Each lease respondent's lease site information was gathered in Section B of the questionnaire. Respondents were asked to provide information (i.e. size, number of members) for each of their hunting sites. The sampling frame for this study included all licensed hunters (resident and nonresident) who had big game hunting privileges in Georgia in 2012. A detailed description of the survey's sampling frame and survey implementation procedures can be found in Chapter 2 on page 18.

Choice Experiment Survey Component

A crucial step in designing a CE involves identifying relevant attributes and creating realistic choice scenarios. Leases available to Georgia hunters may not be comparable to those available to other states. For instance, Hussain et al. (2010) found that Mississippi hunters preferred lease lengths of three years over lease lengths of one year. Based on results of a 2015 online lease hunter survey, 87% of lease hunters in Georgia purchased a lease with a duration of one year (Mingie and Mengak 2015). This indicates that most Georgia hunters do not have the ability to choose a lease with a duration of more than one year. In addition, 98% of Georgia lease hunters indicated they hunted deer (Mingie and Mengak 2015). Due to the popularity of deer hunting, the focus of the Georgia lease hunter CE was white-tailed deer hunting only.

Specifically, the present study expands on the work of Hussain et al. (2010) by examining hunting club preferences in Georgia using the following five attributes:

1. club dues,
2. lease size,

3. club membership,
4. recent forest management activity
5. buck harvest regulation pertaining to buck limits and antler restrictions

This concise list of lease attributes was chosen to alleviate choice complexity concerns and to make the CE manageable for respondents (Hanley et al. 2002).

Overall, the levels for the club dues, lease size, and club membership attributes were chosen to create realistic dollar per acre lease rates for each lease scenario. Six levels were used for the club dues attribute while three levels were used for the lease size and lease membership attributes (Table 3.1). Following Boxall and Macnab (2000), the three levels associated with the recent forest management activity attribute included no forest management, a clearcut, and a thinning. Mindful of current Georgia harvest restrictions and alternative management strategies such as Quality Deer Management (QDM), three levels involving the buck harvesting regulation attribute were specified.

Table 3.1. Attributes and attribute levels defined for the choice experiment component of the questionnaire which asked respondents to indicate their preferred deer hunting club choice

Attribute	Levels
Club dues	$440, $480, $520, $560, $600, $640 annually
Lease size	200 acres, 300 acres, 400 acres
Club membership	6 members, 7 members, 8 members
Recent forest management activity	No management, 50% of lease clearcut, 50% of lease thinned
Buck harvesting regulation	1 buck limit with size restriction, 1 buck limit with no size restriction, 2 buck limit with size restriction

The experimental design of the CE was specified using SAS macros (Kuhfeld 2010). First, given the CE's number of attributes and levels, the number of choice sets needed to obtain reliable parameter estimates was determined to be 18. From a set of candidate factorial designs, the design with the greatest *D-efficiency* was chosen. The use of the *D-efficiency* criterion ensured that the most balanced and orthogonal design possible was specified (Kuhfeld 2010). Since the computational burden associated with responding to 18 choice sets is fairly high, the 18 choice sets were broken up into three blocks of six. As a result, each respondent specified their lease choice from six choice sets only. Within each choice set, two hunting club alternatives were presented along with a status quo option (neither club alternative). The status quo option was included to prevent forced choices and to ensure that willingness to pay estimates for each attribute could be estimated (Roe et al. 1996). A respondent may choose the status quo as a default "not to choose" option or may be a legitimate choice if the choice alternatives presented do not align well with the respondent's preferences (Boxall et al. 2009). The decision not to choose may also represent a preference for inaction (omission) or non-participation (Boxall et al. 2009). The inclusion of a status quo option is common in the CE literature. However, studies do not typically retrieve information from each respondent to determine each individual's actual status quo option. If possible, each individual's actual status quo should be retrieved in order to remove any doubt regarding what constitutes each alternative (Pedersen and Gyrd-Hansen 2013). Still, to this researcher's knowledge, only one study has examined the effect of specifying the actual status quo of each respondent (Pedersen and Gyrd-Hansen 2013). Overall, each respondent was asked to make six repeated choices and specify their most preferred club choice (if any) for each choice set. Examples of the choice sets used can be found in the survey questionnaire (Appendix A).

Hunter Specific Characteristics

Similar to Hussain et al. (2010), hunter specific characteristics for each respondent were specified (Table 3.2). Hunter specific characteristics considered by Hussain et al. (2010) included age, household income, hunting avidity, and presence of other hunting access options. Hussain et al. (2010) found that older and less wealthy hunters were more likely to choose the lease site status quo option. In addition, hunters with other access options were more likely to choose the status quo option (Hussain et al. 2010). Hunter specific characteristics considered for this study included *Age*, *Household income, Years hunted big game*, *Hunts on leased land*, and a number of potential hunting access alternatives. Specifically, the hunting access alternatives included *Hunts on own land, Hunts on non-leased private land,* and *Hunts on public land*. In the survey, respondents were asked to specify their household income by checking one of seven categories containing different income ranges. For the analysis, *Household income* was treated as a continuous variable by using the midpoints associated with each income category (Sun et al. 2015).

Table 3.2. Hunter specific characteristics defined for the choice experiment component of the questionnaire which asked respondents to indicate their preferred deer hunting club choice

Characteristic	Definition
Age	Respondent’s age (years)
Household income	Respondent’s household income ($1000s)
Years hunted big game	Number of years respondent has hunted big game in Georgia
Hunts on leased land	1=hunted on leased land in 2012, 0=otherwise
Hunts on own land	1=hunted on own property in 2012, 0=otherwise
Hunts on NLP land	1=hunted on non-leased private land in 2012, 0=otherwise
Hunts on public land	1=hunted on public land in 2012, 0=otherwise

Estimation Technique

The theoretical framework associated with choice experiments is the Random Utility Model (Ryan et al. 2007). Based on this framework, the indirect utility function for each respondent (U_i) contains two components: a deterministic component and a stochastic component (Boxall and Macnab 2000). The deterministic component (V) is specified as a linear index of the attributes (X) of the different alternatives (j) in the choice set (Hanley et al. 2001). The stochastic component (e) represents unobservable influences on choice behavior. Mathematically, the equation can be shown as (Hanley et al. 2002):

$$U_{ij} = V_{ij}(X_{ij}) + e_{ij} = bX_{ij} + e_{ij}.$$

The probability of a respondent choosing option g rather than alternative option h can be expressed as the probability of the utility associated with option g being greater than all other options. This can be demonstrated by the following equation (Hanley et al. 2002):

$$P\left[\left(U_{ig} > U_{ih}\right)\forall h \neq g\right] = P[\left(V_{ig} - V_{ih}\right) > \left(e_{ih} - e_{ig}\right)].$$

Next, the distribution of the error terms needs to be specified. A typical assumption for the errors is that they are independently and identically distributed with an extreme value (Weibull) distribution (Hanley et al. 2002). This distribution can illustrated with the following formula (Hanley et al. 2001):

$$P\left(e_{ij} \leq t\right) = F(t) = \exp(-\exp(-t).$$

As a result, the probability of any alternative g being more preferred can be expressed using the logistic distribution (McFadden 1973). This specification known as the conditional logit model is illustrated with the following equation (Hanley et al. 2001):

$$P\left[\left(U_{ig} > U_{ih}\right), \forall h \neq g\right] = \frac{\exp(\mu V_{ig})}{\sum_j \exp(\mu V_{ij})}$$

where μ is a scale parameter. The model can then be estimated using maximum likelihood. As a result, the associated log-likelihood function (Hanley et al. 2001) is described below where y_{ij} is an indicator variable which becomes one if respondent i chooses option j and N is the total number of observations.

$$\log L = \sum_{I=1}^{N} \sum_{J=1}^{j} y_{ij} \, log \left\{ \frac{\exp(V_{ij})}{\sum_{j=1}^{J} \exp(V_{ij})} \right\}$$

A concise description of the utility function can be expressed as the linear function of the attributes vector (X_1, X_2, X_3, X_4, X_5) = (club dues, lease size, club membership, recent forest management activity, and buck harvesting strategy).

This utility function also includes an alternative specific constant (ASC) dummy variable associated with the status quo option in the choice set (Yoo et al. 2008). The ASC captures the utility of a lease alternative that the attributes do not capture (Adamowicz et al. 1994). To incorporate hunter specific characteristics into the model and to determine each characteristic's effect on lease choice, the ASC can be interacted with each hunter specific characteristic (Hussain et al. 2010). Similar to Pedersen and Gyrd-Hansen (2013), different assumptions regarding the status quo option were considered. One approach used the common treatment in the literature where the status quo option was interpreted simply as a preference for neither lease option. For lease hunters, the second approach specified the status quo as each individual's actual lease choice in 2012. Specifically, the size, membership size, and per person price paid by each hunter was specified for each lease hunter's actual lease choice in 2012. For the third approach, lease size, lease membership size, and per person price was specified along with the recent forest management activity and buck harvest regulations attributes. In the portion of the survey where respondents provided information on their 2012 hunting sites, hunters were asked to indicate whether their site practiced QDM or had a timber harvest in the last 10 years. To translate this information to the CE attribute levels, a few assumptions were made. First, for a lease site practicing a QDM, the buck harvest regulation level specified was as the “one buck limit with size restriction” level, QDM involves harvesting older, more mature bucks and often involves limiting the number of bucks harvested by each lease member (Georgia Department of Natural Resources 2015b). For the forest management attribute, a site with a recent timber harvest was specified as the “50% of lease clearcut” level. The assumptions made regarding the individual status quo treatment for the recent forest management activity and buck harvest regulations attributes are very tenuous. However, the use of three specifications regarding the treatment of status quo option provides a sensitivity analysis and could provide insight into the effect of choosing a status quo interpretation.

Parameter estimates from the CE can be used to estimate marginal willingness to pay for each attribute in the utility function. Specifically, marginal WTP can be estimated using the following formula (Hanley et al. 2001):

$$WTP = \frac{-b_c}{b_y}$$

where b_c is the coefficient associated with any of the non-price attributes and b_y is the coefficient of the price attribute (club dues). Confidence intervals associated with marginal willingness to pay estimates can be obtained using methods such as Monte Carlo simulation or the delta method (Hole 2007).

An important caveat involving the model specification above is that responses to the choice sets must obey the Independent from Irrelevant Alternatives (IIA) assumption. This assumption states that “the relative probabilities of two options being selected must be unaffected by the introduction or removal of other alternatives” (Hanley et al. 2001). This assumption comes from the conditional logit’s assumed independence of the Weibull error terms across different choice set options (Hanley et al. 2002). The IIA assumption can be tested by following a procedure that involves conducting likelihood ratio tests comparing the full model’s results with results obtained when one of the choice alternatives is left out. Hausman tests (Hausman and McFadden 1984) and a robust method that relies on seemingly unrelated estimation (White 1996) can be used to test the IIA assumption. If the null hypothesis of the IIA assumption is rejected, errors associated with the choice set alternatives are correlated, violating the independence assumption underlying the multinomial logit (Ryan et al. 2007). More complex statistical models such as the multinomial probit (Hausman and Wise 1978), nested logit (McFadden 1980), or random parameters logit (Train 1998) should be used to relax the IIA assumption. Methods were used to test the IIA assumption for the lease site CE and results can be found in the following section.

Lease Hunter Only Model

An additional CE model was fit to a reduced sample consisting only of big game hunters who leased land in Georgia in 2012. A comparison of parameter estimates from the full and reduced sample models could identify differences in preferences between the general big game hunter population and big game hunters who already lease. Also, the creation of a lease hunter only dataset provided the opportunity to estimate a lease site travel cost model. The travel cost method can be used to examine the relationship between the number of trips taken to a site and covariates such as travel costs, site-specific characteristics, substitutes, and demographics. Comparing parameter estimates from the two approaches can provide an informal convergent validity check (Hanley et al. 2002). In addition, insights can be obtained regarding factors affecting the lease choice decision and factors affecting trip demand to lease sites.

Overview of the Travel Cost Method

The following is an overview of the travel cost method. A more detailed description of this nonmarket valuation approach can be found in Chapter 2. The travel cost method is a well-established nonmarket valuation approach to model recreation demand and derive economic values for recreation resources. In contrast to contingent valuation and CE approaches which rely on values directly elicited from respondents, the travel cost method is a revealed preferences approach based on the respondents' actual consumption behavior (Boyle 2003). The theoretical basis of the travel cost method centers on the economic concepts of utility maximization and weak complementarity (Freeman 2003). The travel cost method assumes that increasing trip costs decrease the number of trips a recreationist takes all else being equal (Pearse and Holmes 1993). As a result, a recreationist maximizes utility by choosing a number of trips that reflect their budgetary limits, which may include time, and personal tastes and preferences. Since the travel costs incurred while visiting a site can be thought as a proxy for the price of the services offered by the site, individual trip behavior is affected by a change in travel cost in a manner similar to a change in admission costs (Freeman 2003). An ordinary demand curve can be derived from this relationship between travel costs and trips taken. Additional factors affecting trip demand can include potential substitutes or complements, site-specific characteristics, and individual demographics. Consumer surplus estimates can then be derived from the demand curve to determine a total use or access value for the site (Boyle 2003).

Considering the discrete, non-negative nature of the dependent variable (i.e. number of trips), count data models have become standard practice when estimating recreation demand (Zawacki et al. 2000; Edwards et al. 2011; Hill et al. 2014). With count data models, a discrete probability distribution rather than a continuous probability distribution is assumed for the dependent variable (Betz et al. 2003). Examples of count data models include Poisson and negative binomial regression. A key assumption associated with Poisson regression is that the mean and variance of the dependent variable are equal. If this assumption is violated, the use of a negative binomial model is advised. Generally, when examining trip behavior, most respondents take fewer trips while a small number of respondents take many trips. As a result, overdispersion is common when examining recreation trip behavior necessitating the use of a negative binomial model. When collecting survey data needed to model recreation demand, two concerns often arise: endogenous stratification and truncation. Endogenous stratification occurs when individuals who more frequently visit a site are more likely to be included in the sample. Since a mail questionnaire was used to gather data for the present study and all individuals with big game hunting privileges in a given stratum had an equal chance of being included in the sample, endogenous stratification was not a concern. Truncated data occurs when information on non-participants is unknown and the probability distribution only applies to values above zero. If an untruncated estimator is used to model truncated data, parameter estimates will be biased and inconsistent (Martinez-Espineira & Amoako-Tuffour 2008). For the present study, since limited information was collected on respondents who did not take hunting trips to lease sites, values of zero for the dependent variable were uncommon. As a result, truncated estimators were used.

Results

Survey Responses

A detailed description of the survey's responses and general sample characteristics can be found in Chapter 2 on page 28.

Choice Experiment Data and Model Selection

Similar to the survey sample, most hunters who completed the CE were male (93.84%), white (98.35%), and non-Hispanic (100%) (Table 3.3). The average age of a hunter was 50.50 years while 23.16% indicated they were retired. Most of the hunters came from a rural background (64.46%) while around a third (33.06%) possessed a Bachelor's degree. Average household income was $79.52 thousand.

Table 3.3. Sample statistics of 2012 Georgia big game hunters who responded to the big game hunting mail questionnaire and completed the questionnaire's choice experiment component (n=497)

Variable	Min	Max	Mean	Missing
Age (years)	20	83	50.50	0
Male (%)	-	-	93.84	10
Hispanic (%)	-	-	0.00	23
White (%)	-	-	98.35	11
Bachelor's degree (%)	-	-	33.06	10
Rural background (%)	-	-	64.46	13
Retired (%)	-	-	23.16	9
NRA member (%)	-	-	36.48	9
QDMA member (%)	-	-	6.98	10
Years hunted big game	1	60	26.79	7
Hunt deer (%)	-	-	99.61	0
Hunt turkey (%)	-	-	64.85	0
Hunt bear (%)	-	-	9.90	0
Hunted on own land (%)	-	-	38.62	5
Hunted on public land (%)	-	-	34.15	5
Hunted on leased land (%)	-	-	47.48	0
Hunted on non-leased private land (%)	-	-	53.25	5
Preferred choice set option A (%)	-	-	32.41	0
Preferred choice set option B (%)	-	-	28.85	0
Preferred status quo choice option (%)	-	-	38.74	0
Household income ($1000s)	12.50	162.50	79.52	0

Nearly all of the respondents (99.61%) hunt deer, 64.85% hunt turkey, and 9.90% hunt bear. Over 38% of respondents hunted on their own land, 34.15% hunted on public land, 53.25% hunted on non-leased private land, and 47.48% leased land. Regarding CE responses, choice set A was preferred 32.41% of the time while choice set B was preferred 28.85% of the time. The status quo option (neither choice set A or B) was preferred 38.74% of the time. Responses to the CE questions indicate that one of the choice set options was preferred the majority of the time, but the popularity of the status quo option indicates that either the hunters were not interested in leasing or did not find preferable lease options in the choice sets.

Lease choice was first analyzed using a conditional logit regression model with alternative assumptions regarding the status quo option. Categorical attributes were effects coded to ensure that the effect of each attribute level could be estimated (Bech and Gyrd-Hansen 2005). Effects coding is dissimilar to dummy coding in that the reference category is coded as a -1 rather than a zero. Similar to Boxall and Macnab (2000), attributes related to lease size and membership were treated as continuous variables for the statistical models. Hausman and robust methods were used to test the conditional logit's IIA assumption. The results indicate that the IIA assumption was consistently violated especially when either lease option B or the status quo option was omitted (Table 3.4). As a result, multinomial probit regression was used to model lease choice and to relax the conditional logit's IIA assumption.

Table 3.4. P-values of Hausman and robust methods used to test the lease choice conditional logit model's IIA assumption (Chi-squared statistic)

Status quo specification	Test	Option A omitted	Option B omitted	Status quo omitted
Neither option SQ	Hausman	0.115	<0.001	ANM
		(20.49)	(39.64)	
	Robust	0.157	<0.001	<0.001
		(20.40)	(41.11)	(97.23)
Individual SQ (size, membership, price)	Hausman	<0.001	<0.001	ANM
		(47.81)	(96.07)	
	Robust	<0.001	<0.001	<0.001
		(75.01)	(105.38)	(328.66)
Individual SQ (all attributes)	Hausman	<0.001	<0.001	<0.001
		(39.17)	(68.05)	(256.31)
	Robust	<0.001	<0.001	<0.001
		(61.07)	(100.50)	(318.61)

Note: ANM indicates that the assumptions of the Hausman test were not met.

Choice Experiment Parameter Estimates

For the multinomial probit models, standard errors were adjusted to account for potential intragroup correlation (Hussain et al. 2010). Estimates obtained from all specifications are similar in terms of sign and significance indicating robustness across all treatments of the status quo option (Table 3.5). Overall, all five lease attributes significantly affected the lease choice of Georgia big game hunters. Hunters preferred greater lease sizes and smaller membership sizes. However, it should be noted that the CE's lower and upper limits for lease size were 200 and 400 acres respectively. In addition, the CE's lower and upper limits for lease membership were 6 and 8 members respectively. The 50% of lease clearcut level had a negative effect on lease choice while the 50% of lease thinned level had a positive effect on lease choice. The one buck limit with no size restriction level was not preferred by hunters while the two buck limit with size restriction level was preferred by hunters. *Hunting club dues* was negative and significant indicating that the likelihood of choosing a lease option decreased as hunting club dues increased.

The alternative specific constant associated with the status quo option (ASC_{SQ}) was negative and significant indicating that choosing the status quo was preferred significantly less than choosing one of the lease options (Table 3.5). The hunter age interaction term (ASC_{SQ}*Age*) was negative and significant indicating that older respondents were more likely to choose the status quo rather than a lease option. ASC_{SQ}**Household income* was insignificant suggesting that household income had no effect on choosing the status quo. ASC_{SQ}**Years hunted big game* was insignificant indicating that hunter experience had no effect on choosing the status quo. ASC_{SQ}**Leased land in* 2012 was insignificant suggesting that being a lease hunter did not significantly influence the decision to choose a lease option or the status quo. The interaction terms associated with alternative hunting site types were mostly insignificant. However, interaction terms associated with hunting on non-leased private land and hunting on public land were significant for at least one specification. These results indicate potentially that individuals who hunt on non-leased private land or public land were less likely to choose the status quo option rather than one of the lease options.

Table 3.5. Lease site choice experiment parameter estimates obtained from multinomial probit models based on alternative specifications of the status quo option for lease hunters

Variable	Neither Option SQ		Individual SQ Size, Memb., Price		Individual SQ All Attributes	
	Coef.	SE	Coef.	SE	Coef.	SE
Lease size	0.0046***	0.0006	0.0002**	0.0001	0.0002***	0.0001
Lease membership	-0.2105***	0.0314	-0.0082**	0.0039	-0.0101**	0.0043
Recent forest management						
50% of lease clearcut	-0.1832***	0.0429	-0.0070**	0.0033	-0.0083**	0.0035
50% of lease thinned	0.1116***	0.0378	0.0040*	0.0021	0.0049**	0.0024
Buck harvest regulation						
1 buck without size restriction	-0.2341***	0.0428	-0.0090**	0.0043	-0.0116**	0.0050
2 buck with size restriction	0.1032***	0.0385	0.0041*	0.0023	0.0051*	0.0026
Hunting club dues	-0.0022***	0.0004	-0.0001**	0.0001	-0.0001***	0.0001
ASC_{SQ}	-1.4503***	0.4158	-0.9109***	0.3331	-0.9462***	0.3372
Hunter specific characteristic						
ASC_{SQ}*Age	0.0171***	0.0052	0.0190***	0.0055	0.0185***	0.0056
ASC_{SQ}*Household income	-0.0001	0.0015	-0.0007	0.0016	1.6E-7	1.6E-6
ASC_{SQ}*Years hunted game	-0.0066	0.0054	-0.0069	0.0057	-0.0063	0.0059
ASC_{SQ}*Hunts on lease	-0.0483	0.1318	-0.0858	0.1435	-0.1212	0.1498
ASC_{SQ}*Hunts on public land	-0.0763	0.1281	-0.0854	0.1368	-0.0865*	0.1397
ASC_{SQ}*Hunts on own land	-0.1666	0.1370	-0.1900	0.1473	-0.2663	0.1516
ASC_{SQ}*Hunts on NLP land	-0.2322*	0.1337	-0.2385*	0.1430	-0.2292	0.1473
Model fit						
Number of observations	8838		8838		8532	
Sample size	490		490		473	
Log-likelihood	-2960.758		-2979.129		-2865.046	
Wald chi-squared	155.120		75.930		76.300	
Probability > chi-squared	<0.001		<0.001		<0.001	

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively. Standard errors are adjusted for intragroup correlation. NLP refers to non-leased private land. Reference levels for the non-price lease attributes were 200 acres, 6 members, no timber management, and 1 buck limit with size restriction respectively. ASC_{SQ} indicates the alternative specific constant for the status quo option.

Willingness to Pay Estimates from the Choice Experiment Model

Models assuming each individual's actual lease status quo produced WTP estimates of higher absolute value and wider confidence intervals (Table 3.6). Confidence intervals at the 95-percent level were obtained using the delta method (Hole 2007). Considering the lower and upper limits of the lease size attribute, an average hunter was willing to pay $2 to $2.50 more in club dues for each additional acre.

Table 3.6. Willingness to pay estimates for lease attributes obtained from multinomial probit regression models based on alternative specifications of the status quo option (95% confidence intervals)

Variable	Neither Option SQ	Individual SQ Size, Memb., Price	Individual SQ All Attributes
	WTP ($)	WTP ($)	WTP ($)
Lease size	2.10	2.46	2.45
	(1.41, 2.78)	(1.19, 3.74)	(1.14, 3.76)
Lease membership	-96.73	-118.78	-119.71
	(-133.19, -60.27)	(-190.74, -46.82)	(-195.54, -43.87)
Forest management			
50% of lease clearcut	-84.19	-101.13	-97.73
	(-127.72, -40.66)	(-168.72, -33.55)	(-165.26, -30.20)
50% of lease thinned	51.26	57.18	57.98
	(18.04, 84.49)	(9.18, 105.18)	(9.42, 106.54)
No forest management*	32.93	43.95	39.75
Buck harvesting restriction			
1 buck without size restriction	-107.58	-129.65	-137.67
	(-155.23, -59.93)	(-214.23, -45.06)	(-229.09, -46.25)
2 buck with size restriction	47.45	58.40	60.48
	(13.84, 81.06)	(6.47, 110.33)	(7.71, 113.26)
1 buck with size restriction*	60.13	71.25	77.19

Note: * indicates the attribute's reference category. Confidence intervals were estimated using the delta method.

Considering the lower and upper limits of the lease membership attribute, an average hunter was willing to pay $100 to $120 less in club dues for each additional club member. The 50% of lease clearcut level had a greater effect on WTP than the 50% of lease thinned level. Here, an average hunter was willing to pay $84 to $101 less in club dues if the leased land recently had 50% of its acreage clearcut. Conversely, an average hunter was willing to pay $51 to $58 more in club dues if the leased land recently had 50% of its acreage thinned. Since effects coding was used, the WTP associated with the reference category can be estimated by using the following formula (Juutinen et al. 2011):

$$WTP_{REF} = (WTP_A * -1) + (WTP_B * -1)$$

where WTP_{REF} is WTP associated with the reference category and WTP_A and WTP_B are WTP estimates associated with the non-reference category attributes. As a result, an average hunter was willing to pay $33 to $44 more in club dues if the site practiced no forest management activity. An average hunter was willing to pay $108 to $138 less in club dues if the buck harvesting regulation on the lease was a one buck limit with size restriction. In contrast, an average hunter was willing to pay $47 to $60 more in club dues if the buck harvesting regulation was a two buck limit with size restriction. Concerning the reference category, an average hunter was willing to pay $60 to $77 more in club dues if the harvest regulation was a one buck limit with size restriction.

For estimates of total welfare, the status quo specification assumed was the default specification common in the literature. Within the limits of the CE's design, the size and membership combination that produced the highest welfare combination was 400 acres and 6 total members (Table 3.7). Conversely, the size and membership combination that produced the lowest welfare combination was 200 acres and 8 members. The lease scenario that produced the highest welfare estimates possessed 400 acres, 6 members, a recent thinning of 50% of the lease's acreage, and a buck harvest regulation consisting of a one buck limit with size restriction. The lease scenario that produced the lowest welfare estimates possessed 200 acres, 8 members, a recent clearcut of 50% of the lease's acreage, and a buck harvest regulation consisting of a one buck limit without size restriction.

Table 3.7. Welfare estimates of alternative lease choice scenarios derived from willingness to pay estimates obtained from choice experiment multinomial probit models

Size	Membership	Forest management	Buck harvest regulations	Welfare ($)
400 acres	6	None	1 without restriction	184.97
400 acres	6	50% lease clearcut	1 without restriction	67.85
400 acres	6	50% of lease thinned	1 without restriction	203.30
400 acres	6	None	1 with restriction	352.68
400 acres	6	50% lease clearcut	1 with restriction	235.56
400 acres	6	50% of lease thinned	1 with restriction	371.01*
400 acres	6	None	2 with restriction	340.00
400 acres	6	50% lease clearcut	2 with restriction	222.88
400 acres	6	50% of lease thinned	2 with restriction	358.33
200 acres	8	None	1 without restriction	-428.49
200 acres	8	50% lease clearcut	1 without restriction	-545.61#
200 acres	8	50% of lease thinned	1 without restriction	-410.16
200 acres	8	None	1 with restriction	-260.78
200 acres	8	50% lease clearcut	1 with restriction	-377.90
200 acres	8	50% of lease thinned	1 with restriction	-242.45
200 acres	8	None	2 with restriction	-273.46
200 acres	8	50% lease clearcut	2 with restriction	-390.58
200 acres	8	50% of lease thinned	2 with restriction	-255.13

Note: * indicates the best alternative and # indicates the worst alternative.

Lease Hunter Only Dataset

A lease hunter only dataset was constructed to compare the lease attribute preferences of the general big game hunting population with the preferences of lease hunters specifically. This dataset also provided the opportunity to estimate a lease site travel cost model for lease hunters. Only big game hunters who leased land in Georgia in 2012 were included in this dataset. Individuals with incomplete lease information related to trips taken, lease size, membership, price, QDM practiced, and recent forest management activity were omitted. For individuals who hunted on multiple leases, the most frequently visited lease site was considered.

Overall, the new dataset contained a sample of 236 big game lease hunters. Summary statistics from this dataset were very similar to summary statistics obtained from the general big game hunter sample. Similar to the big game hunter sample, most respondents were male (94.35%), white (98.27%), and non-Hispanic (100%) (Table 3.8). The average age of a lease hunter was 50.88 years while 22.51% indicated they were retired. Most of the lease hunters came from a rural background (64.47%) while around a third (30.13%) possessed at least a Bachelor's degree. Average household income for a lease hunter was $82.27 thousand. Nearly all of the lease hunters (99.57%) hunted deer while 67.95% hunted turkey and 6.41% hunted bear. Over 26% hunted on their own land, 26.07% hunted on public land, 37.61% hunted on non-leased private land, and 10.59% hunted on another lease. Choice set A was preferred 32.34% of the time while choice set B was preferred 28.68% of the time. The status quo option (neither choice set A or B) was preferred 38.98% of the time by lease hunters. Finally, details related to each lease hunter's actual lease site were obtained also. On average, lease hunters took 22.71 trips to their lease site. Average lease size was 1,090 acres while the average lease membership size was 11.92 total members. QDM was practiced on 64.29% of the leases while a recent timber harvest was conducted on 68.83% of the leases. Assuming a 25% wage rate, the average travel cost to the lease site was $71.39 while the average round-trip distance to the lease site was 159.70 miles.

Table 3.8. Sample statistics of 2012 Georgia big game lease hunters who responded to the big game hunting mail questionnaire and completed the questionnaire's choice experiment component (n=236)

Variable	Min	Max	Mean	Median	Missing
Age (years)	21	80	50.88	52	0
Male (%)	-	-	94.35	-	6
White (%)	-	-	98.27	-	5
Bachelor's degree (%)	-	-	30.13	-	7
Rural background (%)	-	-	64.47	-	8
Retired (%)	-	-	22.51	-	5
NRA member (%)	-	-	35.06	-	5
QDMA member (%)	-	-	5.63	-	5
Years hunted big game	1	55	27.28	26	3
Hunt deer (%)	-	-	99.57	-	2
Hunt turkey (%)	-	-	67.95	-	2
Hunt bear (%)	-	-	6.41	-	2
Hunted on own land (%)	-	-	26.50	-	2
Hunted on public land (%)	-	-	26.07	-	2
Hunted on non-leased private land (%)	-	-	37.61	-	2
Hunted on another lease (%)	-	-	10.59	-	0
Household income ($1000s)	12.50	162.50	82.27	74.10	0
Stated preferences questions					
Preferred choice set option A (%)	-	-	32.34	-	0
Preferred choice set option B (%)	-	-	28.68	-	0
Preferred status quo option (%)	-	-	38.98	-	0
Revealed preferences questions					
Trips to lease site	1	161	22.71	15	0
Travel costs to lease site ($)	0.60	510.90	71.39	41.15	0
Round trip distance to lease site (miles)	1	1000	159.70	100	0
Lease size (acres)	30	12000	1090.17	500	0
Lease membership	1	150	11.92	7	0
QDM practiced at lease site (%)	-	-	64.29	-	12
Recent timber harvest (%)	-	-	68.83	-	5

Lease Hunter Only Choice Experiment Parameter Estimates

Based on results from Hausman and robust tests, the IIA assumption also did not hold for the lease hunter only model. As a result, a multinomial probit was used to relax the conditional logit's IIA assumption. Parameter estimates obtained using different status quo specifications were similar suggesting robustness across specification type (Table 3.9). Overall, estimates from the lease hunter model are similar to estimates from the general big game hunter population model. These results suggest that general big game hunter lease preferences were similar to lease hunter lease preferences. However, it should be noted that the 50% of lease thinned attribute level was insignificant for lease hunters and the

Table 3.9. Lease hunter lease site choice experiment parameter estimates obtained from multinomial probit models based on alternative specifications of the status quo option.

Variable	Neither Option SQ		Individual SQ Size, Memb., Price		Individual SQ All Attributes	
	Coef.	SE	Coef.	SE	Coef.	SE
Lease size	0.0052***	0.0009	0.0002**	0.0001	0.0002***	0.0001
Lease membership	-0.2365***	0.0470	-0.0089**	0.0044	-0.0111**	0.0048
Forest management						
50% of lease clearcut	-0.2347***	0.0694	-0.0079**	0.0039	-0.0093**	0.0043
50% of lease thinned	0.0911	0.0557	0.0026	0.0023	0.0036	0.0029
Buck harvesting restriction						
1 buck without size restriction	-0.3038***	0.0659	-0.0114**	0.0055	-0.0157**	0.0067
2 buck with size restriction	0.1309**	0.0585	0.0048	0.0030	0.0062*	0.0035
Hunting club dues	-0.0018***	0.0006	-0.0001*	0.0001	-0.0001*	0.0001
ASC_{SQ}	-1.3710***	0.6163	-1.2321***	0.4457	-1.3503***	0.4562
Hunter specific characteristics						
ASC_{SQ}*Age	0.0197**	0.0079	0.0237***	0.0085	0.0225**	0.0088
ASC_{SQ}*Household income	-0.0014	0.0021	-0.0005	0.0023	0.0014	0.0024
ASC_{SQ}*Years hunted big game	-0.0117	0.0082	-0.0134	0.0089	-0.0125	0.0095
ASC_{SQ}*Hunts on another lease	0.3190	0.2804	0.4083	0.3011	0.4691	0.3060
ASC_{SQ}*Hunts on public land	-0.0948	0.1899	-0.1194	0.2070	-0.1249	0.2152
ASC_{SQ}*Hunts on own land	0.1360	0.1999	0.1541	0.2188	-0.0051	0.2341
ASC_{SQ}*Hunts on NLP land	-0.2051	0.1844	-0.1884	0.2029	-0.1669	0.2147
Model fit						
Number of observations	4194		4194		3888	
Sample size	233		233		216	
Log-likelihood	-1380.518		-1387.288		-1273.765	
Wald chi-squared	76.440		39.200		40.17	
Probability > chi-squared	<0.001		<0.001		<0.001	

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively. Standard errors are adjusted for intragroup correlation. NLP refers to non-leased private land. Reference levels for the non-price lease attributes were 200 acres, 6 members, no timber management, and 1 buck limit with size restriction respectively. ASC_{SQ} indicates the alternative specific constant for the status quo option.

two buck limit with size restriction level was insignificant for lease hunters for one model specification. Similar to before, lease hunters preferred greater lease sizes and smaller membership sizes. The 50% of lease clearcut level was not preferred by lease hunters while the 50% of lease thinned attribute level was insignificant. The one buck limit with no size restriction level was not preferred by lease hunters and the two buck limit with size restriction level was preferred but for only two model specifications. *Hunting* *club dues* was negative and significant indicating that the likelihood of choosing a lease option decreased with increasing club dues. The alternative specific constant associated with the status quo option (ASC_{SQ}) was negative and significant indicating that lease hunters preferred choosing one of the lease options rather than the status quo. The hunter age interaction term (ASC_{SQ}*Age*) was negative and significant indicating that older lease hunters were more likely to choose the status quo rather than a lease option. All of the remaining hunter specific interaction terms (ASC_{SQ}**Household income*, ASC_{SQ}**Years hunted big game*, ASC_{SQ}**Hunts on another lease*, ASC_{SQ}**Hunts on public land*, ASC_{SQ}**Hunts on own land*, and ASC_{SQ}**Hunts on NLP land*) were insignificant.

Willingness to Pay Estimates for Lease Hunter Only Choice Experiment Model

Lease attribute willingness to pay (WTP) estimates from the lease hunter choice experiment models were calculated (Table 3.10). Similar to Hussain et al. (2010) and Juutinen et al. (2011), WTP estimates for insignificant attributes were also calculated. Confidence intervals at the 95-percent level were obtained using the delta method (Hole 2007) and were estimated only for significant attribute levels. Similar to previous results, models assuming each individual's actual lease status quo produced WTP estimates of higher absolute value and wider confidence intervals. Compared with WTP estimates from the general population model, estimates from the lease hunter model were of higher absolute value for each significant lease attribute. Considering the lower and upper limits of the lease size attribute, an average lease hunter was willing to pay $3 to $4 more in club dues for each additional acre. Considering the lower and upper limits of the lease membership attribute, an average lease hunter was willing to pay $130 to $200 less in club dues for each additional club member. An average lease hunter was willing to pay $130 to $170 less in club dues if the leased land recently had 50% of its acreage clearcut. Conversely, an average hunter was willing to pay $51 to $60 more in club dues if the leased land recently had 50% of its acreage thinned. It should be noted however that this level was insignificant. Regarding the reference category, an average lease hunter was willing to pay $80 to $115 more in club dues if the site practiced no forest management activity. An average lease hunter was willing to pay $170 to $260 less in club dues if

Table 3.10. Lease hunter willingness to pay estimates for lease attributes obtained from multinomial probit regression based on alternative specifications of the status quo option (95% confidence intervals)

Variable	Neither Option SQ	Individual SQ Size, Memb., Price	Individual SQ All Attributes
	WTP ($)	WTP ($)	WTP ($)
Lease size	2.91	3.94	3.63
	(1.09, 4.74)	(-0.79, 8.67)	(-0.54, 7.81)
Lease membership	-132.85	-196.11	-182.24
	(-221.29, -44.41)	(-451.72, 59.50)	(-414.34, 49.85)
Forest management			
50% of lease clearcut	-131.81	-172.54	-153.40
	(-235.97, -27.65)	(-406.22, 61.14)	(-355.80, 49.01)
50% of lease thinned	51.17#	57.33#	59.87#
No forest management*	80.64	115.21	93.53
Buck harvesting restriction			
1 buck without size restriction	-170.61	-249.86	-257.61
	(-284.79, -56.43)	(-567.43, 67.71)	(-575.28, 60.05)
2 buck with size restriction	73.53	104.50#	102.52
	(5.53, 141.53)		(-41.75, 246.79)
1 buck with size restriction*	97.08	145.36	155.09

Note: * indicates the attribute's reference category and # indicates insignificant attributes. Confidence intervals were estimated using the delta method.

the buck harvesting regulation on the lease was a one buck limit with size restriction. In contrast, an average lease hunter was willing to pay $73 to $105 more in club dues if the buck harvesting regulation was a two buck limit with size restriction. Concerning the reference category, an average lease hunter was willing to pay $100 to $155 more in club dues if the harvest regulation was a one buck limit with size restriction.

The lease scenario that produced the highest welfare estimates for lease hunters contained 400 acres, 6 members, no forest management, and a buck harvest regulation consisting of a one buck limit with size restriction (Table 3.11). This combination is similar to the best scenario for big game hunters in general. The one exception involves the recent forest management activity attribute. For lease hunters, no forest management was preferred over having 50% of the lease being thinned. The lease scenario that produced the lowest welfare estimates possessed 200 acres, 8 members, a recent clearcut of 50% of the

Table 3.11. Lease hunter welfare estimates of alternative lease choice scenarios derived from willingness to pay estimates obtained from choice experiment multinomial probit models

Size	Membership	Forest management	Buck harvest regulations	Welfare ($)
400 acres	6	None	1 without restriction	344.93
400 acres	6	50% lease clearcut	1 without restriction	132.48
400 acres	6	50% of lease thinned	1 without restriction	315.46
400 acres	6	None	1 with restriction	612.62*
400 acres	6	50% lease clearcut	1 with restriction	400.17
400 acres	6	50% of lease thinned	1 with restriction	583.15
400 acres	6	None	2 with restriction	589.07
400 acres	6	50% lease clearcut	2 with restriction	376.62
400 acres	6	50% of lease thinned	2 with restriction	559.60
200 acres	8	None	1 without restriction	-570.77
200 acres	8	50% lease clearcut	1 without restriction	-783.22[#]
200 acres	8	50% of lease thinned	1 without restriction	-600.24
200 acres	8	None	1 with restriction	-303.08
200 acres	8	50% lease clearcut	1 with restriction	-515.53
200 acres	8	50% of lease thinned	1 with restriction	-332.55
200 acres	8	None	2 with restriction	-326.63
200 acres	8	50% lease clearcut	2 with restriction	-539.08
200 acres	8	50% of lease thinned	2 with restriction	-356.10

Note: * indicates the best alternative and [#] indicates the worst alternative.

lease's acreage, and a buck harvest regulation consisting of a one buck limit without size restriction. This is similar to the lowest welfare producing alternative for the general population of big game hunters.

Travel Cost Model Parameter Estimates

Lease site trip demand was modeled using truncated negative binomial regression. *Travel costs* had a negative and significant effect on the number of trips taken to a lease site indicating that demand decreased as travel costs increased (Table 3.12). *Lease size* was positive and significant indicating hunters took more trips to a lease site as acreage increased. *Lease membership* was negative and significant indicating that hunters took more trips to lease sites with smaller membership sizes. It should be noted that an alternative travel cost model can be found in Chapter 2 which included *Lease size* and *Lease membership* quadratic terms. *Lease size squared* was negative and significant while *Lease membership squared* was positive and significant indicating significant quadratic relationships between these two attributes and lease site trip demand. *QDM practiced* and *Recent timber harvest* were both insignificant suggesting that these two management activities had no effect on lease site trip demand. *Years hunted big*

Table 3.12. Parameter estimates from zero-truncated negative binomial regression that modeled big game hunting trip demand to lease sites in Georgia

Variable	Coefficient	Std. error	P-value
Travel costs (0.25 wage rate assumed)	-0.0044	0.0007	<0.001
Lease size (acres)	0.0001	<0.0001	0.001
Lease membership	-0.0075	0.0036	0.037
QDM practiced	0.1264	0.1165	0.278
Recent timber harvest	-0.0141	0.1220	0.908
Hunts on another lease	0.1081	0.1466	0.461
Hunts on own land	-0.4163	0.1284	0.001
Hunts on public land	-0.1181	0.1211	0.501
Hunts on non-leased private land	-0.0816	0.1131	0.296
Household income ($1000s)	-0.0021	0.0013	0.093
Age (years)	-0.0141	0.0054	0.009
Years hunted big game	0.0193	0.0058	0.001
Constant	3.7103	0.3247	<0.001
Overdisperion	0.4573		
Model fit			
Number of observations	217		
Log-likelihood	-845.227		
Wald chi-squared	100.640		
Probability > chi-squared	<0.001		

Note: Robust standard errors were used. Nineteen observations were dropped due to missing data

game was positive and significant indicating that demand for big game hunting on lease sites increased with greater hunter experience. Concerning substitute variables, *Hunts on own land* was negative and significant indicating that hunting on one's own land was a substitute for hunting on leased land. The other substitute variables (*Hunts on another lease*, *Hunts on non-leased private land*, and *Hunts on public land*) were insignificant. Regarding demographics, *Age* was negative and significant indicating big game hunting trip demand to lease sites decreased with increasing hunter age. *Household income* was negative and insignificant indicating that big game hunting trip demand to lease sites decreased with increasing income. The intercept term was positive and significant.

Similar to Hanley et al. (2002), an informal convergent validity check was conducted by comparing lease choice parameter estimates with lease site trip demand parameter estimates. Overall, in terms of sign and significance, the estimates obtained from the choice experiment and travel cost models for lease hunters were fairly similar. It is important to note, however, that the choice experiment modeled the decision to choose a lease while the travel cost model examined trip demand to lease sites. As a result, the two approaches did not model the same decision for lease hunters. Greater lease acreage was found to increase both the likelihood of choosing a lease and taking more trips to a lease site. Similarly, greater lease membership decreased both the likelihood of choosing a lease and taking more trips. Recent forest management activity on a lease decreased the likelihood of choosing a lease when a clearcut was used. However, a recent timber harvest on a lease site did not significantly affect trip demand to the site. However, the forest management variables used for the different modeling approaches were not defined similarly. A one buck limit with size restriction was preferred when choosing a lease. However, practicing QDM at a lease site did not significantly affect trip demand to the site. Substitutes to hunting on a lease site had varying effects on the decision to choose a lease and the number of trips taken to a lease site. For instance, in terms of trip demand, hunting on one's own land was found to be a substitute to hunting on a lease site while the other potential substitutes were insignificant. In contrast, the lease choice of hunters was not significantly influenced by alternative hunting sites. Variables related to age had similar effects on lease choice and lease site trip demand. Household income negatively influenced trip demand but had no significant effect on lease choice.

Discussion and Conclusion

Georgia hunter preferences for lease attributes were examined using a choice experiment (CE). From the CE model's parameter estimates, marginal economic values for each attribute were estimated. Results indicate that a number of attributes significantly affected the lease choice of Georgia hunters. In addition, the lease preferences of the general big game hunter population were very similar to the preferences of big game lease hunters specifically. Hunters preferred leases that were larger and had fewer members. In addition, hunters preferred the most restrictive buck harvesting regulation option available (one buck limit with size restriction). Preferences regarding forest management were generally mixed. The least preferred forest management option consistently involved a clearcut of half of the lease's acreage. For the general big game hunter population, a thinning of half of the lease's acreage was preferred over no forest management. In contrast, lease hunters specifically preferred no forest management over a thinning.

Even though the number of attributes chosen was limited, the results provide a number of insights regarding big game hunter preferences for lease attributes. Georgia big game hunters preferred larger leases. However, considering this attribute's upper (400 acres) and lower (200 acres) limits, it is not possible to make broad generalizations regarding the effect of lease size on lease choice. The one previous lease CE study, Hussain et al. (2010), found that lease sizes between 500 and 1000 acres were preferred over a 500 acre lease size. Lease sizes over 1,000 acres were preferred less than a lease size of 500 acres (Hussain et al. 2010). Though the attribute levels used by Hussain et al. (2010) were fairly ambiguous, results from this study indicate that the marginal utility obtained from added lease size possibly diminishes once a certain size is reached. This assertion is similar to findings made earlier in this dissertation (see Chapter 2). From the travel cost models estimated, lease size squared was significant indicating the leases size did not significantly affect lease site trip demand at a constant rate. It should be noted, however, that lease choice and the number of trips taken to a lease site are different decisions facing hunters.

Studies have also used approaches such as contingent valuation and hedonic regression to understand hunter preferences for lease size. Munn et al. (2011) used a contingent valuation approach and found that lease size did not influence hunter WTP for a lease. However, Livengood (1983) found that increasing lease size increased the lease price paid by each hunting club member. Within this attribute's very narrow limits, hunters were willing to pay approximately $2 to $3 more in club dues for each additional lease acre. This finding shows that the effect of lease size on lease choice is not trivial. For landowners, this suggests that greater lease revenue can be achieved with larger leases. However, the added value of increasing lease size may not be constant and could diminish for larger leases (Hussain et al. 2010).

Consistent with previous studies (Gan and Luzar 1993; Hussain et al. 2003), Georgia big game hunters preferred leases with fewer members. Considering the narrow limits specified for this attribute, it cannot be concluded that increasing membership at all levels decreases hunter WTP for a lease. Similar to the lease size attribute, the effect of increasing membership on WTP may not be constant. From estimated travel cost models, a lease membership quadratic term was significant indicating that membership did not affect lease site trip demand linearly (see Chapter 2). Though lease site trip demand and lease choice are different, this finding suggests that membership may have a nonlinear effect on lease choice. The results of this study do show that lease membership can have a significant effect on hunter WTP. For instance, hunters were willing to pay approximately $130 to $150 less in club dues for each additional lease member. For club managers, an increase in membership can increase revenue but would likely result in decreased hunter satisfaction.

Results also demonstrate that lease choice was significantly affected by different forest and wildlife management approaches. Results involving the forest management attribute indicate that hunters preferred lease choices that had not being recently managed with clearcuts. In addition, the less intensive practice of thinning significantly affected lease choice and hunter WTP but only for big game hunters in general. For lease hunters, this attribute level was insignificant. Consistent with results of the present study, Boxall and Macnab (2000) found that moose hunters in Canada preferred small, irregular shaped cutovers rather than more intensive forest management activities such as clearcutting. A hedonic study (Hussain et al. 2007) found that a site’s percentage of cutover forest land negatively influenced lease revenue per acre. For landowners, the results indicate that harvesting a lease’s timber can have a significant effect on hunter WTP for a lease. While owners of forestland may obtain the majority of their income from the sale of standing timber, revenue from hunting leases can offset timberland management expenses (Corriero 2005). In addition, hunting leases can have a significant effect on forestland values. Hussain et al. (2013) found that the overall capitalization rate of hunting lease income into forestland value was 7.55%. These studies suggest that private forest landowners do not have to rely solely on timber harvesting to generate revenue. However, for forest landowners who lease and harvest timber, results from this study indicate that harvesting timber can have a significant effect on hunter WTP for a lease.

Results also indicate that hunters preferred the most restrictive buck harvesting regulation option. Specifically, hunters preferred a one buck limit with size restriction over a one buck limit with no size restriction. In addition, in terms of WTP, hunters preferred a one buck limit with size restriction over a two buck limit with size restriction. Overall, these results demonstrate that hunters were willing to pay more for deer management strategies that advocate harvesting mature bucks rather than younger ones. This is consistent with the growing popularity of Quality Deer Management (QDM) and other nontraditional deer management approaches. For instance, from 2010 to 2013, Georgia's percentage of 3.5 year old antlered deer harvested out of the total number of bucks harvested increased from 20% to 31%. (Adams and Ross 2015). In addition, the number of antlerless deer harvested in Georgia increased by 14% from 2011 to 2013 (Adams and Ross 2015). Results also indicate that hunters may be willing to support more restrictive statewide harvesting regulations. Though wildlife policy changes are dictated by factors other than hunter preferences, the results could be of interest to Georgia wildlife officials.

Overall, estimates from the lease hunter model are similar to estimates from the general big game hunter population model. These results suggest that general big game hunter lease preferences were similar to lease hunter lease preferences. However, it should be noted that the 50% of lease thinned attribute level was insignificant for lease hunters but significant for big game hunters in general. Compared to the WTP estimates from the general population model, estimates from the lease hunter model were of higher absolute value for each significant lease attribute. This indicates that the two samples had similar lease attribute preferences, but lease hunters specifically valued the attributes more than big game hunters in general.

As an informal check for convergent validity, results from the lease hunter CE model were compared with results from a lease hunter travel cost model. Results from the two approaches indicate that factors affecting lease choice and trip demand to lease sites were fairly similar especially with regard to lease size and lease membership. A similar informal convergent validity check was conducted by Hanley et al. (2002). For the present study, it is important to note that the choice experiment modeled the decision to choose a lease while the travel cost model examined trip demand to lease sites. Since the two approaches did not model the same decision for lease hunters, a potential comparison of derived economic values would not be directly comparable.

Parameter estimates from both approaches, however, can be compared in terms of sign and significance. Greater lease acreage positively affected lease choice and lease site trip demand. In addition, greater lease membership negatively affected lease choice and lease site trip demand. Clearcutting decreased WTP for a lease while thinning was preferred less than no forest management for lease hunters. In contrast, lease site trip demand was not significantly affected by a recent timber harvest. It is important to note however that the recent timber harvest variable used for the travel cost analysis was not defined clearly. Specifically, hunters were asked whether their site's last timber harvest was less than 10 years ago. This variable's lack of definitiveness may have contributed to its insignificance. Deer harvest regulations had a significant effect on lease choice but not lease site trip demand. Similar to the recent timber harvest variable, the QDM variable used for the travel cost analysis was not defined as clearly as the buck harvest regulation attribute. Since individual definitions for QDM may differ from hunter to hunter, the QDM variable's lack of clarity may have contributed to its insignificance. As a result of the variable definitions not being directly comparable, it cannot be inferred that harvesting regulations affect lease choice and lease site trip demand differently.

Potential lease hunting substitutes had varying effects on lease choice and lease site trip demand. For instance, a significant substitute for lease site trip demand was hunting on one's own land. Other potential substitutes for hunting on leased land were insignificant. Previous hunting site travel cost studies have been unable to identify significant hunting substitutes (Balkan and Kahn 1988; Luzar et al. 1992; Sarker and Surry 1998). The lease choice of hunters was not significantly influenced by alternative hunting sites. In contrast, Hussain et al. (2010) found that possessing hunting site alternatives significantly affected choosing the CE's status quo option. Age had a similar effect on lease choice and lease site trip demand. Similar to previous studies (Offenbach and Goodwin 1994; Bergstrom and Cordell 1991), increasing age decreased lease site trip demand. Similar to Hussain et al. (2010), younger hunters were more likely to choose the CE's status quo option. Household income negatively influenced trip demand but had no significant effect on lease choice. Hunting travel cost studies have found similar negative income coefficients (Creel and Loomis 1990; Balkan and Kahn 1988). The contrasting effect of income could potentially be related to a step process. For instance, Rockel and Kealy (1991) found that income positively influenced wildlife watching participation but did not affect wildlife watching trip demand.

This study makes a contribution to the hunting literature by identifying additional significant attributes affecting lease choice. The study also makes a methodological contribution by specifying each lease hunter's actual lease site status quo. Despite the contributions made by the current analysis, a few important limitations regarding the study should be addressed. First, the levels for both the lease size and the lease membership attributes do not accurately reflect what actual lease options are available to most lease hunters in Georgia. Summary statistics from a separate portion of the survey indicated that the average lease size in Georgia was around 1,000 acres while the average membership size was near 11 members. However, it should be noted that the median lease size was near 500 acres. Nevertheless, it would be imprudent to make far reaching inferences regarding the results of the lease size and lease membership attributes. In addition, a few attribute levels should have been defined differently. For example, for the buck harvest regulations attribute, a more appropriate attribute level would have involved Georgia's current state regulation (two antlered deer with one having at least four points on one side). The choice experiment also contained a small number of attributes. This was done to keep the choice sets as manageable as possible for survey respondents. In reality though, other attributes beyond the ones examined here affect the lease choice decision. Examples include game diversity (Hussain et al. 2010) and harvest success and accessibility (Hussain et al. 2003). The focus and contribution made by this study was the identification of management specific attributes with practical implications for landowners and club managers. Finally, even though our survey sample was likely representative of the big game hunter population in Georgia, the survey's response rate was relatively low (24.4%) compared to similar studies. For instance, Hussain et al. (2010) and Hussain et al. (2004) achieved a response rates of 32% and 54% for hunters in Mississippi and Alabama respectively.

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CHAPTER 4

A HEDONIC ANALSIS OF BIG GAME HUNTING CLUB DUES IN GEORGIA

Abstract

Hunting lease revenue can be a reliable supplemental income for forest landowners. While previous studies have examined the effect of various factors on lease rates, few studies have explicitly looked at factors affecting per person hunting club dues. The objective of this research was to conduct a hedonic analysis of big game hunting club dues in Georgia using a variety of club specific, site specific, and location specific characteristics. To achieve this objective, a mail survey was sent to 3,000 licensed big game hunters in Georgia and yielded a response rate of 24.4%. A multivariate regression analysis was applied to explain variation in hunters' self-reported big game hunting club dues in 2012. From the estimated hedonic model, implicit price was computed for each significant characteristic. Club size, presence of food plots, and game quality had a positive and significant effect on club dues. Membership had a negative and significant effect on club dues. Results from this research should be of interest to landowners interested in increasing hunting club revenue and landowners interested in providing fee access hunting opportunities on their land. Results can also provide additional estimates of the monetary value of ecosystem services such as recreation.

Introduction

In the United States, lease hunting has become a popular alternative for many hunters who lack free access options or quality hunting land. Typically, hunters obtain hunting access rights to a site by purchasing a lease outright or by becoming a member of a hunting club. Despite the popularity of lease hunting, the percentage of landowners providing fee access opportunities on their land remains fairly small (Lauber and Brown 2000; Brown et al. 2001; Jagnow et al. 2006). With leasing, a benefit to hunters is a potentially superior hunting experience, while benefits to forest landowners include additional income, access control, and reduced property damage due to trespassing (Marsinko et al. 1992; Hussain et al. 2007). For many landowners, hunting lease revenues can be critical considering forest landowner property taxes (Arano et al. 2002) and the number of years it may take for timber sale revenues to materialize (Yarrow and Yarrow 1999). Promoting lease hunting can be beneficial from a economic (i.e. jobs, income) and a ecological (i.e. habitat management, population control) standpoint (English and Bergstrom 1994; Benson 2001).

One specific form of lease hunting involves hunting clubs. In contrast to independent lease holders, hunting club members are subject to club rules and bylaws that guide the behavior of club members (Plum Creek 2015a). Club rules guiding club member behavior identify what is expected of each club member and what is not allowed. Specific areas addressed by club rules include guest privileges and regulations, hunter safety, land management, rules of the hunt, and maintenance of facilities or structures such as stands (Miller 2002). Club bylaws can be set to establish how the club is organized and managed. Specific items addressed by club bylaws can include how membership is established, how members can be removed from the club, how disputes are addressed, and how club officers are determined (Plum Creek 2015a). To make management decisions, clubs can put all decisions to a vote, elects officers, or allow all decisions to be made a by single person (Plum Creek 2015a). Hunting clubs can offer members advantages not available to independent lease holders. Examples include fellowship with other members and an increased sense of safety and security (Stribling 1996).

Lease fees can be influenced by a number of factors such as lease type, site size, quality of habitat, lease members, and the hunting opportunities provided. Due to this variability, it is difficult to provide landowners and clubs information regarding specific dollar amounts to charge (Pierce et al. 2015). As a result, methods of determining hunting lease prices are varied and often informal. Lease price can be estimated by identifying the going rate in the area or by subjectively evaluating the quality and quantity of the property's wildlife habitat (Pierce et al. 2015). Another method involves setting the lease price as the cost of managing the property. To make a profit, ten or 30 percent is added to this breakeven price (Pierce et al. 2015). Lease suppliers connect with hunters by relying on word of mouth, family, friends, work contacts, or website postings (Hussain et al. 2007; Plum Creek 2015b). The hedonic pricing approach has been applied to hunting leases in recent years and can be used to better understand factors affecting lease price. With the hedonic approach, the price of a good is assumed to be the result of the attributes it possesses. Results from a hedonic analysis can identify marginal economic values associated with hunting lease attributes. These values, in turn, can help landowners identify what attributes are important in determining lease prices.

Previous Studies

Many recent hedonic studies have examined factors affecting the per acre price of hunting leases (Standiford and Howitt 1993; Shrestha and Alavalapati 2004; Zhang et al. 2006; Hussain et al. 2007; Rhyne et al. 2009; Munn and Hussain 2010). Fewer and less recent studies have examined factors affecting the price paid per hunting club member for access rights (Livengood 1983; Pope and Stoll 1985; Messonier and Luzar 1990). Deer hunting access rights was the primary focus of a few studies (Livengood 1983; Pope and Stoll 1985; Messonier and Luzar 1990; Standiford and Howitt 1983). Many studies did not focus specifically on one game species. A number of studies examined rates from the perspective of landowners or ranchers (Standiford and Howitt 1993; Shrestha and Alavalapati 2004; Zhang et al. 2006; Hussain et al. 2007). One study specifically surveyed hunting clubs (Messonier and Luzar 1990) and two examined publicly auctioned leases owned by the state of Mississippi (Rhyne et al.

2009; Munn and Hussain 2010). Livengood (1983) and Pope and Stoll (1985) surveyed licensed hunters. Hedonic studies have examined leases prices in Texas (Livengood 1983; Pope and Stoll 1985), Louisiana (Messonier and Luzar 1990), California (Standiford and Howitt 1993), Florida (Shrestha and Alavalapati 2004), Alabama (Zhang et al. 2006), and Mississippi (Hussain et al. 2007; Rhyne et al. 2009; Munn and Hussain 2010).

Overall, these hedonic studies have identified a number of factors affecting hunting lease prices. Results regarding the effect of lease size have not always agreed. Studies modeling the effect of size on hunting club dues have found a positive relationship (Livengood 1983; Pope and Stoll 1985). Similarly, Messonier and Luzar (1990) found that acres per member had a positive effect on club dues. Studies examining the effect of lease size on lease rates have found a negative relationship (Standiford and Howitt 1993; Shrestha and Alavalapati 2004; Zhang et al. 2006; Rhyne et al. 2009; Munn and Hussain 2010). Hussain et al. (2007) found no significant relationship between lease size and lease rates in Mississippi. Similar to acres per hunter, Livengood (1983) and Shrestha et al. (2004) examined the relationship between the number of hunters on a lease and lease price. Livengood (1983) found that the effect of increasing membership on hunting club dues was negative while Shrestha and Alavalapati (2004) found no significant relationship between number of hunters and lease rates.

A number of studies (Hussain et al. 2007; Rhyne et al. 2009; Munn and Hussain 2010) found that proportion of hardwood forest cover positively influenced lease rates while proportion of pine and mixed forest cover negatively influenced lease rates. These results coincide with literature on game big game habitat (Harris et al. 1984; Dickson 2004) which suggests that hardwood forests can provide a year-long source of food, more diverse food types, and an ideal habitat for deer. These factors, in turn, can lead to higher deer densities. Zhang et al. (2006) found that habitat improvements (i.e. food plots, wildlife feeders) made by landowners positively affected lease price per acre. Similarly, Zhang et al. (2006) found that services provided to hunters such as stands, food, lodging, and guidance also had a positive effect on lease rates. Meanwhile, Pope and Stoll (1985) found that amenities provided to hunters such as blinds, guidance, electricity, and feeder did not significantly affect club dues. Similarly, Messonier and Luzar

(1990) found that the presence of a cabin on a site did not significantly affect club dues. One important distinction between Zhang et al. (2006) and the two club studies (Pope and Stoll 1985; Messonier and Luzar 1990) was the dependent variable specified. In addition, Zhang et al. (2006) bundled site amenities into one variable despite the range of services offered. As a result, bundling may have confounded results. A few studies have also examined the effect of game quality or the presence of trophy bucks on lease rates. Rhyne et al. (2009) and Munn and Hussain (2010) found that leases located in counties with higher projected Boone and Crockett (BC) scores possessed higher lease rates. Meanwhile, Standiford and Howitt (1993) found no significant premium associated with game quality.

Location-specific factors such as distance to urban areas or sub-market location have also been examined by hedonic studies. Researchers have reported conflicting results regarding the effect of distance to urban areas with some reporting comparatively higher lease rates in rural areas compared to urban areas (Shrestha and Alavalapati 2004; Rhyne et al. 2009) and one reporting the opposite (Pope and Stoll 1985). One distinction between these studies is that Pope and Stoll (1985) analyzed factors affecting club dues. The studies that found a positive relationship involving distance analyzed factors affecting lease rates. Within a study area, distinct and separate lease markets may exist. If the hedonic model does not account for possible market segmentation, the model's coefficients may be inaccurate (Freeman et al. 2014). Hussain et al. (2007) and Rhyne et al. (2009) found that segments within their study areas had varying and significant effects on lease rates. For example, leases along the Delta and coastal regions of Mississippi possessed higher lease rates than leases located in the eastern part of the state near the Alabama border (Rhyne et al. 2009).

Despite past research examining hunting lease prices, a number of gaps in the literature exist. Most recent hedonic studies have examined leases prices from a per acre perspective. The few studies that have examined factors influencing club dues are two decades old. The majority of lease hedonic studies have not considered the effect of different timber management activities on hunting lease rates. One exception, Hussain et al. (2007), found that the percentage of cutover land on a lease negatively affected lease rates in Mississippi. Timber management can occur on lease sites and the effects may or may not be preferred by hunters. Regarding buck harvesting regulations, leases or hunting clubs may insist that hunters on their land limit their harvest to one buck or bucks of a certain size. No hedonic study has examined the effect of different harvesting limits or wildlife management practices on lease prices. Recent hedonic studies have primarily examined leases in either Mississippi or Alabama. Though possibly similar to the lease markets in these states, Georgia contains one large population center (Atlanta) and a larger population than states such as Mississippi or Alabama. These factors illustrate that Georgia's lease market may be unique. Outputs from this research should provide a greater understanding of hunting club characteristics and the hunting lease market in Georgia. In addition, results from this study can provide additional estimates of the monetary value of recreation related ecosystem services.

Objective

The objective of this study was to use an hedonic approach to estimate the marginal economic value of factors affecting individual big game hunting club membership dues in Georgia.

Methodology

Hedonic Pricing Model

In nonmarket valuation, the hedonic method is one approach to estimate economic values associated with environmental or recreation amenities. The underlying assumption of the hedonic method is that the price of a good is a function of its many attributes (Rosen 1974). Since heterogeneous goods possess varying qualities and characteristics, price variation involving these goods can be observed (Taylor 2003). The hedonic method relies on a good's price variation to estimate the value of the good's attributes. As a result, economic values for nonmarket goods such as environmental amenities are not directly observed but are inferred from observable market transactions (Taylor 2003). By observing market transactions for a heterogeneous good, implicit prices for characteristics related to the good can be estimated (Taylor 2003). Implicit price is a measure of marginal willingness to pay (WTP) for a good's characteristic. Since hedonic valuation involves measuring WTP associated with an increase in the quantity of a good's attribute, the welfare measure estimated is compensating surplus (Mitchell and

Carson 1989). Compensating surplus can be defined as the change in disposable income or expenditure that holds utility constant, given a change in a characteristic such as a hunting lease's total acreage (Morrison and MacDonald 2006). With hedonic valuation, the most commonly used approach to value environmental goods involves housing markets (Sander et al. 2010; Tapsuwan et al. 2012). Similarly, factors affecting lease price by can be examined by modeling price as a function of lease attributes (Pope and Stoll 1985; Shrestha and Alavalapati 2004; Rhyne et al. 2009).

A hedonic price function models a good's price as a function of it characteristics. Hunting club dues can be modeled simplistically as a function of club specific characteristics such as total membership and game management approach, site specific characteristics such as land cover type and amenities present, and location specific characteristics such as proximity to nearby populations centers. Mathematically, a general hunting club dues hedonic equation can be expressed as the following:

$$P_i = \sum \beta_j \, Club_{ij} + \sum \beta_k \, Site_{ik} + \sum \beta_l \, Location_{il} + \varepsilon_i$$

where P_i is the per person dues paid by a club member of the *i*th club, $Club_{ij}$ is the *j*th club specific variable of the *i*th club, $Site_{ik}$ is the *k*th site specific variable of the *i*th club, $Location_l$ is *l*th location specific variable of the *i*th club, ε_i is the error term, and β_0, β_j, β_k, and β_l are parameters to be estimated.

Variable Definitions

To estimate the Georgia hunting lease hedonic model, a number of variables were constructed from the survey instrument (Table 4.1). Since the objective of this research was to identify factors influencing per person club dues for big game hunting clubs in Georgia, the dependent variable was specified as club dues paid by each club member. This is similar to previous lease studies (Livengood 1983; Pope and Stoll 1985). In contrast, many recent lease studies have examined factors affecting lease price per acre (Shrestha and Alavalapati 2004; Rhyne et al. 2009)

A number of club specific independent variables were constructed to determine their effect on per person club dues. *Size* was specified as a continuous variable and was expressed in acres. Livengood (1983) found that greater acreage had a positive effect on dues paid by deer hunting club members in

Texas. Similarly, Pope and Stoll (1985) found that lease size had a significant effect on hunting club dues paid in Texas. *Membership* was specified as a continuous variable and represented the club's total number of members. Livengood (1983) found that the number of a hunters on a lease had a negative effect on club dues. Though not explored in previous hedonic studies, quadratic effects involving *Size* and *Membership* were tested. Using a choice experiment approach, Hussain et al. (2010) found that lease sizes between 500 and 1,000 acres were preferred over a smaller lease size of 500 acres. However, lease sizes over 1,000 acres were not preferred over a lease size of 500 acres. To determine whether the impact of greater lease size on club dues diminished with increasing size, *Size squared* was considered as an additional independent variable. Similarly, to determine whether the impact of greater club membership on club dues diminished with increasing membership size, *Membership squared* was also considered.

Management specific variables related to hunting clubs were also specified. A dummy variable (*Recent timber harvest*) indicating whether or not the timber on the club's site had been harvested in the last ten years was created. Most studies have not examined the effect of timber harvesting on club dues or lease price. However, Hussain et al. (2007) found that the percentage of cutover land on a lease negatively affected lease rates in Mississippi. The inclusion of a timber harvest variable could identify how club dues are affected by recent timber management. An additional dummy variable (*Food plots*) was created indicating whether or not food plots were present on the hunting club's site. This variable was included to examine whether or not providing additional food sources for game had a positive effect on club dues. Though not directly comparable, Zhang et al. (2006) found that the lease rate set by landowners in Alabama was positively affected by habitat improvements such as food plots. A dummy variable was also created indicating whether or not Quality Deer Management (QDM) was practiced on the site. Previous studies examining hunter or lease hunter preferences have not examined the effect of a site practicing QDM. However, lease or hunting club online postings associated with Rayonier or the Georgia Outdoor News (GON) Marketplace often promote their site's use of QDM. As a result, the effect of QDM on hunting club dues was examined.

Site specific variables related to each club were also examined. For instance, the predominant forest cover type of each lease site was specified using four dummy variables (*Planted pine forest*, *Natural pine forest*, *Hardwood forest*, and *Mixed forest*). Similar lease rate hedonic studies (Hussain et al. 2007; Rhyne et al. 2009; Munn and Hussain 2010) found that lease rates were positively affected by a site's proportion of hardwood forest compared to other forest cover types. Literature on big game hunting suggests that hardwood forests provide a number of benefits such as a year-long source of food, more diverse food types, and an ideal habitat for deer (Harris et al. 1984; Dickson 2004). To account for possible site quality differences between leases in terms of their ability to produce large trophy bucks, a dummy variable (*Trophy buck county*) was created indicating whether or not the club was located in a county with a large number of recent Boone and Crockett entries. The trade publication Georgia Outdoor News created a trophy buck index by compiling Boone and Crockett score data recorded from 2000 to 2010 (Kirby 2010). To create the dummy variable, clubs located in counties with index scores of 70 or above were assigned a one. Georgia's 35 best trophy buck producing counties possessed index scores of 70 or above. Using a similar metric based on Boone and Crockett scores, Rhyne et al. (2009) found that game quality had a positive effect on lease rates for publicly auctioned leases in Mississippi. A developed camping dummy variable (*Developed camping*) was created indicating whether or not the club possessed developed camping amenities such as power and running water. Pope and Stoll (1985) found that the presence of a cabin had a positive effect on club dues while the presence of running water and electricity had an insignificant effect. Finally, a fishing ponds dummy variable (*Fishing ponds*) was created indicating whether or not fishing ponds were present on the club site. Pope and Stoll (1985) found that fishing privileges on a club did not significantly affect club dues.

A number of location specific variables related to each club were also created. Similar to Rhyne et al. (2009), the straight line distance in miles (*Metro distance*) from each club to the nearest Georgia metropolitan area was determined using ArcGIS. Based on the 2010 U.S. Census, Georgia contained the following 14 metropolitan areas: Atlanta, August, Savannah, Columbus, Macon, Athens, Gainesville, Warner Robins, Albany, Valdosta, Dalton, Brunswick, Rome, and Hinesville-Fort Stewart (U.S.

Table 4.1. Definitions of variables used to conduct hedonic analysis of factors affecting big game hunting club dues in Georgia

Variable	Definition	Mean
Club dues	Georgia per person big game hunting club dues in 2012 ($)	716.36
Size	Total size of the club (acres)	845.60
Membership	Hunting club's total membership	180.87
Planted pine forest	Dummy variable, 1=site's predominant forest cover type is planted pine, 0=otherwise	0.24
Natural pine forest	Dummy variable, 1=site's predominant forest cover type is natural pine, 0=otherwise	0.13
Hardwood forest	Dummy variable, 1=site's predominant forest cover type is hardwoods, 0=otherwise	0.07
Mixed forest	Dummy variable, 1=site's predominant forest cover type is mix hardwoods/pine, 0=otherwise	0.56
Recent timber harvest	Dummy variable, 1=timber harvested on site within last 10 years; 0=otherwise	0.67
Food plots	Dummy variable, 1=food plots present on site; 0=otherwise	0.87
QDM	Dummy variable, 1=Quality Deer Management practiced on site; 0=otherwise	0.61
Developed camping	Dummy variable, 1=developed camping (water, power) available on site; 0=otherwise	0.33
Fishing ponds	Dummy variable, 1=fishing ponds present on site; 0=otherwise	0.26
Trophy buck county	Dummy variable, 1=site located in county with many recent B&C trophy buck entries; 0=otherwise	0.28
Ridge and valley	Dummy variable, 1=site located in ridge and valley physiographic region; 0=otherwise	0.06
Piedmont	Dummy variable, 1=site located in Piedmont physiographic region, 0=otherwise	0.53
Upper coastal plain	Dummy variable, 1=site located in upper coastal plain region; 0=otherwise	0.29
Lower coastal plain	Dummy variable, 1=site located in lower coastal plain region; 0=otherwise	0.12
Metro distance	Straight line distance from hunting club to nearest metropolitan area (miles)	21.70

Department of Commerce 2010). Previous studies have found conflicting results regarding proximity to urban areas (Pope and Stoll 1985; Rhyne et al. 2009). To account for possible differences between clubs based on Georgia's physiographic regions, dummy variables corresponding to each region were created (*Ridge and valley, Piedmont, Upper coastal plain, Lower coastal plain*). One club located in the Blue Ridge Mountain region of Georgia was grouped into the ridge and valley region. Similar studies (Hussain et al. 2007; Rhyne et al. 2009) have examined the effect of market segmentation on lease prices. Georgia's physiographic regions vary based on factors such as elevation, climate, and forest cover type (Turner and Ruscher 1988). Elevations in the ridge and valley and mountain regions range from 183 meters to 1,432 meters. Average annual temperatures range from 12.8 to 16.1 degrees Celsius and the predominant forest cover types are oak-hickory and oak-pine. For the Piedmont, elevation ranges from 112 to 142 meters and average annual temperatures range from 15.0 to 17.8 degrees Celsius. The major forest types of the Piedmont are loblolly-shortleaf pine and oak-pine. The coastal plain regions range in elevations from 0 meters to 300 meters and average annual temperatures range from 18.9 to 21.1 degrees Celsius. Predominant forest types of the coastal plain include longleaf-slash pine and loblolly-shortleaf pine. The upper coastal plain exhibits a rolling topography while the lower coastal plain is generally flat (Turner and Ruscher 1988). Estimated 2012 deer densities for both the Piedmont and upper coastal plain regions were 25-30 deer per square mile. For the ridge and valley and lower coastal plain regions, estimated deer densities in 2012 were 20-25 deer per square mile (Georgia Department of Natural Resources 2014).

Hedonic Model Estimation

Typically, hedonic functions can be estimated using ordinary least squares (OLS) regression. However, potential econometric concerns related to non-constant variance, multicollinearity, and spatial autocorrelation may need to be accounted for in the OLS model. For instance, OLS assumes homoscedasticity of the residuals and a violation of this assumption would produce biased estimates of the model's standard errors. To test for heteroscedasticity, tests such as White's test or the Breusch-Pagan test can be used to test the assumption of homoscedasticity of the residuals. If heteroscedasticity does exist, potential approaches to address the issue include logging the dependent variable or using robust standard errors (Sander et al. 2010). Another assumption of OLS is that the covariates cannot be highly correlated with each other. Multicollinearity does not necessarily bias results but produces large standard errors. To eliminate possible multicollinearity concerns, variables that are highly correlated with other variables should be removed from the model. To test for multicollinearity, simple correlations and variance inflation factors (VIFs) involving the model's independent variables can be examined (Greene 2003). Finally, spatial autocorrelation occurs when observations (i.e. hunting clubs) within close proximity to each other are more similar to each other than those that are distant from each other. Spatial autocorrelation can produce biased coefficients and larger standard errors (Anselin et al. 1996). To test for the general presence of spatial autocorrelation in the OLS residuals, statistics such as Moran's I can be estimated. To determine the particular form of spatial autocorrelation present in the data, Lagrange multiplier tests can be used to determine if a spatial lag (i.e. autocorrelated dependent variable), spatial error (i.e. spatially dependent error term), or mixed model is needed to address spatial autocorrelation concerns (Anselin et al. 1996). However, in the case of point observations such as hunting clubs, an exact location or address for each lease is needed to test for and potentially account for spatial autocorrelation.

With hedonic regression, theory does not provide guidance on which functional form to choose. As a result, an appropriate functional form can be determined using Box-Cox tests. With simpler specifications such as the log-linear functional form, hedonic price functions have been shown to perform better especially when some of the attributes affecting price are unobserved or are measured with error (Cropper et al. 1988). After an empirically and theoretically appropriate hedonic model is chosen, marginal implicit prices for attributes related to hunting leases can be estimated by differentiating the hedonic price equation with respect to the attribute of interest (e.g., lease size). For example, when a semi-logarithmic functional form is used, the implicit price of an attribute is calculated simply by multiplying the attribute's coefficient by the mean of the model's dependent variable (Taylor et al. 2003).

Study Area

The study was conducted in the state of Georgia, USA. A detailed description of the study area can be found in Chapter 2 on page 16.

Survey and Sampling Design

A mail questionnaire was designed for the general purpose of better understanding big game hunting in Georgia. A detailed description of the survey questionnaire can be found in Chapter 2 on page 17. In Section B of the questionnaire, respondents were asked to provide information related to their three most visited hunting sites in Georgia in 2012. These hunting sites could include their own land, public land, family or friend's land, or land leased through a club or independently. Site information on each reported hunting club was extracted from this section of the survey. The sampling frame for this study included all licensed hunters (resident and nonresident) who had big game hunting privileges in Georgia in 2012. A detailed description of the survey's sampling frame and survey implementation procedures can be found in Chapter 2 on page 18.

Results

Survey Responses

A detailed description of the survey's responses and general sample characteristics can be found in Chapter 2 on page 28. From the sample of 563 licensed Georgia hunters who hunted big game in 2012, a screener question was used to identify big game hunters who leased land in Georgia in 2012. An additional screener question identified lease hunters who were members of a hunting club. Though the majority of club members identified were members of one hunting club, respondents were able to provide information on up to three club memberships they purchased. Similar to recreation trip demand studies (Zawacki et al. 2000; Englin and Moeltner 2004), multiple club membership entries from an individual were treated as additional observations.

Descriptive Statistics

The final sample identified 230 Georgia big game hunting clubs purchased in 2012. Responses with incomplete club price, size, membership, and county information were excluded. In addition, observations with very large per person dues (greater or equal to $6,000) were determined to be outliers and were excluded from the sample. Similarly, observations with very large reported club size (greater or equal to 6,000 acres) were excluded from the sample. Average per person club dues were $716.36 with $65.00 being the lowest amount paid for club membership and $3000 being the highest (Table 4.2). The average size of a club was $845.60 acres with a standard deviation of 971.50 acres. The smallest reported club size was 30 acres while 5000 acres was the largest reported size. Average club membership was 10.87 members with two being the smallest membership size and 66 being the largest. Overall, the summary statistics reported are fairly similar to statistics obtained from comparable hunting lease studies in the South (Rhyne et al. 2009, Zhang et al. 2006). No lease hedonic study focusing on Georgia exists. However, a recent descriptive analysis of Georgia hunting leases based on an online convenient sample indicated that the average price paid, size, and membership of Georgia leases in 2013 was $1,079, 934

Table 4.2. Descriptive statistics of sample of Georgia big game hunting clubs identified from a mail questionnaire that targeted licensed big game hunters in Georgia in 2012 (n=230)

Variable	Mean	Median	SD	Min	Max
Club dues ($)	716.36	563.00	509.94	65.00	3000.00
Size	845.60	470.50	971.50	30.00	5000.00
Membership	10.87	8.00	9.12	2.00	66.00
Planted pine forest	0.24	-	0.43	0.00	1.00
Natural pine forest	0.13	-	0.34	0.00	1.00
Hardwood forest	0.07	-	0.26	0.00	1.00
Mixed forest	0.56	-	0.50	0.00	1.00
Recent timber harvest	0.67	-	0.47	0.00	1.00
Food plots	0.87	-	0.34	0.00	1.00
QDM	0.61	-	0.49	0.00	1.00
Developed camping	0.33	-	0.47	0.00	1.00
Fishing ponds	0.26	-	0.44	0.00	1.00
Trophy buck county	0.28	-	0.45	0.00	1.00
Ridge and valley	0.06	-	0.23	0.00	1.00
Piedmont	0.53	-	0.50	0.00	1.00
Upper coastal plain	0.29	-	0.45	0.00	1.00
Lower coastal plain	0.12	-	0.33	0.00	1.00
Metro distance	21.70	18.56	15.12	1.00	55.72

Note: Clubs with incomplete price, size, membership, and county information were omitted.

acres, and eight members respectively (Mingie and Mengak 2014). These figures are consistent with the findings of the present study.

Additional site specific and management related characteristics for each club were collected. Approximately 24% of the clubs were on sites where the predominant forest cover type was planted pine. Approximately 13% of the sites consisted mostly of natural pine, 7% consisted mostly of hardwoods, and 56% consisted mostly of a hardwood/pine mix. Nearly 70% of the club sites experienced a timber harvest in the last ten years. In addition, 87% of the sites contained food plots while 61% of the sites practiced QDM. Based on Boone and Crockett records compiled from 2000 to 2010, 26% of the clubs were located in counties that have recently produced a large number of trophy bucks. Over 30% of the sites offered facilities for developed camping such as power and running water while 26% of the sites possessed fishing ponds.

The physiographic region of each club was also identified. Approximately 6% of clubs were located in the ridge valley region along Georgia's borders with Alabama and Tennessee. Over 50% of clubs were located in the Piedmont region of central Georgia in areas near metropolitan Atlanta and Interstates 20 and 85. Nearly 30% of clubs were located in Georgia's upper coastal plain nears cities such as Augusta and Albany. Approximately 12% of clubs were located in Georgia's lower coastal plain near cities such as Savannah and Valdosta. The average straight line distance from a club to the nearest metropolitan area was 21.70 miles.

Factors Influencing Hunting Club Dues

With hedonic regression, theory does not provide guidance on which functional form to choose. As a result, a Box-Cox procedure was used and identified an appropriate lambda value near zero. As a result, the hedonic model's dependent variable was specified as the natural log of per person club dues. Diagnostic tests were conducted to determine if the underlying assumptions regarding OLS regression held in the case of the hedonic lease model. Results from a Breusch-Pagan test indicated that the assumption of homoscedasticity was rejected. As a result, a sandwich covariance matrix estimator was used to account for model misspecification (Zeileis 2006). Specifically, White's standard errors were specified (White 1980). A Pearson correlation matrix indicated no strong correlations between any pair of independent variables (Appendix D). In addition, no VIF score above ten was reported except for variables with associated quadratic terms. Since factors above ten are common when quadratic terms are used, multicollinearity was determined not to be a concern. Due to data constraints regarding a lack of information on the exact location of leases identified, tests for spatial autocorrelation were not conducted.

Overall, eight of the 18 independent variables in the model were found to be significant at the 10% significance level (Table 4.3). The model's adjusted R-squared value indicated that 49.7% of the variation in per person club dues was explained by the model's independent variables. *Size* was positive and significant indicating that an additional acre increased per person club dues by 0.14% on average. The lease size quadratic term was negative and significant indicating that the effect of lease size on club dues

Table 4.3. Parameter estimates of hedonic regression that modeled factors influencing big game hunting club dues in Georgia in 2012

Variable	Coefficient	Std. Error	VIF	Implicit price($)
Size	0.0014***	0.0001	16.6376	1.01
Size squared	-2.04E-07***	2.66E-08	11.7883	-
Membership	-0.0924***	0.0105	11.9622	-66.19
Membership squared	0.0011***	0.0002	8.2685	-
Planted pine forest	0.0780	0.1420	3.4950	-
Natural pine forest	0.0239	0.1415	2.4967	-
Mixed forest	-0.0425	0.1338	3.9425	-
Recent timber harvest	0.0591	0.0721	1.2739	-
Food plots	0.2157**	0.1065	1.1043	154.52
QDM	0.0263	0.0731	1.1987	-
Developed camping	-0.0184	0.0737	1.3128	-
Fishing ponds	-0.0821	0.0879	1.1091	-
Trophy buck county	0.1829**	0.0759	1.3320	131.02
Ridge and valley	-0.2148*	0.1113	1.1024	-153.87
Upper coastal plain	-0.1010	0.0894	1.6117	-
Lower coastal plain	-0.1548	0.1212	1.6255	-
Metro distance	0.0012	0.0023	1.5222	-
Intercept	6.0822***	0.1853	-	-
Number of observations	208			
F-statistic	13.050			
Adjusted R-squared	0.497			

Note: Dependent variable is the natural log of per person club dues. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively. Robust standard errors are reported. Implicit prices are evaluated at the mean value for club dues.

was non-constant. *Membership* was negative and significant indicating that each additional lease member decreased club dues by 9.24% on average. The lease membership quadratic term was positive and significant indicating that club dues decreased at a non-constant rate as membership increased.

The effect of lease size on club membership dues was represented using a graph (Figure 4.1). This graph shows a strong positive relationship between lease size and club dues from zero to about 2,500 acres. The curve begins to flatten out after 3,000 acres, and an inflection point is reached near 3,500 acres. Results from the graph demonstrate that club dues increased with increasing size. However, this effect diminished for larger leases.

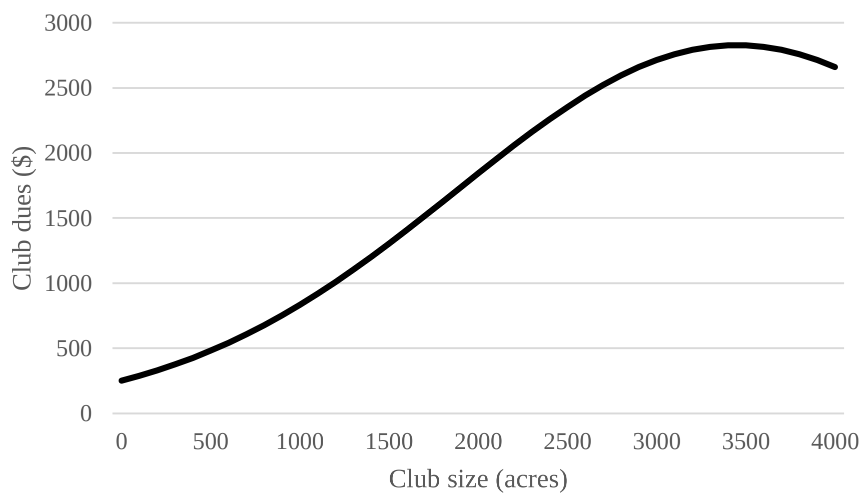

Figure 4.1. The effect of lease size on hunting club dues identified by the club dues hedonic model

The effect of membership size on club membership dues was also represented using a graph (Figure 4.2). This graph shows a strong negative relationship between membership and club dues from two to roughly 20 members. Near 20 to 25 members, the curve begins to flatten out. Results involving club membership indicate that the effect of increasing membership on club dues was negative. However, the effect of added members on club dues diminished with larger membership sizes.

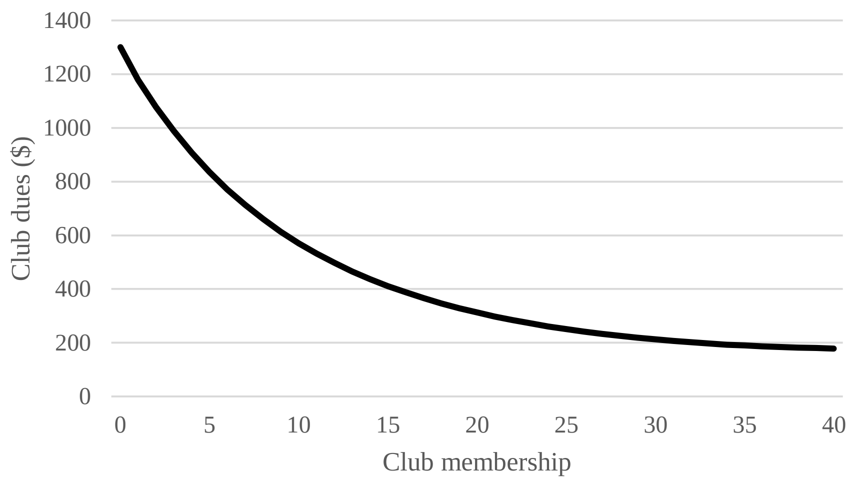

Figure 4.2. The effect of membership on hunting club dues identified by the club dues hedonic model

The effect of additional site specific and management factors on club dues was also examined. *Planted pine forest*, *Natural pine forest*, and *Mixed forest* were insignificant. These results indicate no significant differences in club dues existed between forest types compared to the reference level (*Hardwood forest*). *Recent timber harvest* was insignificant indicating no significant difference in club dues between recently harvested sites and sites that had not been recently harvested. *Food plots present*, however, was positive and significant indicating that the presence of food plots on a site increased club dues by 21.57% on average. In contrast, *QDM* was insignificant indicating no significant difference in club dues between clubs that practiced QDM and clubs that did not practice QDM. *Trophy buck county* was positive and significant indicating that club dues increased by 18.29% on average if the lease was located in a county with a recent history of producing trophy bucks. Site amenities such as *Developed camping* and *Fishing ponds* were both insignificant.

Location specific factors were also examined. Compared to the Piedmont region reference level, *Ridge and valley* had a negative effect on club dues. In contrast, *Upper coastal plain* and *Lower coastal plain* were both insignificant. *Distance to metro* had an insignificant effect on club dues. This result indicates that club proximity to population centers had an insignificant effect on club dues.

With a log-linear functional form, implicit prices were calculated by multiplying the variable's coefficient by average club dues ($716.36). An additional acre of club size increased club dues by $1.01. In contrast, an additional club member decreased club dues by $66.19. The presence of food plots on a club site increased club dues by $154.52 while being located in a county with a recent history of producing trophy bucks increased dues by $131.02. Compared to being located in the Piedmont, dues located in the ridge and valley region were $153.87 lower.

Discussion and Conclusion

This paper used a hedonic pricing approach to examine factors affecting hunting club dues in Georgia. Significant factors affecting club dues included lease size, membership, presence of food plots, and game quality. These results are mostly consistent with previous findings. The positive effect of lease size on club dues coincides with previous studies (Livengood 1983; Pope and Stoll 1985). Previous studies have not examined lease size quadratic terms. However, Hussain et al. (2010) used a choice experiment and found that the effect of size on lease choice was insignificant for large lease sizes (over 1,000 acres). Similar to Livengood (1983), increasing membership had a negative effect on hunting club dues. Previous studies have not examined quadratic effects involving membership.

In contrast with previous lease rate studies (Hussain et al. 2007; Rhyne et al. 2009; Munn and Hussain 2010), forest cover type had an insignificant effect on club dues. The insignificant result of the forest type variables may indicate that forest type or habitat quality has no effect on club dues. However, the forest type variables were defined imprecisely. Studies such as Rhyne et al. (2009) were able to define each site's percentage of hardwoods and pine out of the site's total acreage. The variable definitions used for this study may have contributed to insignificant results involving forest type. As an alternative, a deer density variable was constructed to account for potential habitat differences. However, this variable was insignificant as well. Previous studies have generally not examined the effect of forest management on lease rates or club dues. However, Hussain et al. (2007) found that a site's percentage of cutover land had a positive effect on lease rates. Results from this study indicate that a recent timber harvest had an insignificant effect on lease club dues. However, this variable's imprecise definition may have contributed to its insignificance.

Consistent with Zhang et al. (2006), the presence of food plots had a positive effect on hunting club dues. This result indicates that efforts to increase a site's quality can have a positive effect on club dues and hunter willingness to pay (WTP). Previous studies have not examined the effect of harvest regulations or wildlife management approaches on lease rates or club dues. The insignificant effect of QDM on club dues demonstrates that harvesting regulations may have an effect on club dues or hunter WTP. However, this variable's definition was also vague and imprecise. QDM may mean different things for individual hunters. As a result, this variable's ambiguity may have contributed to its insignificance. Similar to Rhyne et al. (200) and Munn and Hussain (2010), game quality had a positive effect on club dues. Though this variable was able to control for differences in game quality in counties across the state, the variable's definition does not lead to a clear interpretation.

Results from this study concerning the effect of site amenities on club dues were consistent with previous studies. For example, Pope and Stoll (1985) found that fishing privileges had an insignificant effect on club dues. In addition, the presence of running water and the presence of electricity both were insignificant (Pope and Stoll 1985). Similarly, Messonier and Luzar (1990) found that the presence of cabin had an insignificant effect on club dues. However, Zhang et al. (2006) found that per acre lease rates were positively affected by the presence of site amenities (i.e. food, lodging, guidance).

Studies such as Rhyne et al. (2009) and Hussain and Munn (2010) were able to identify a number of significant market segments in their lease rate studies. Results from this study indicate that club dues were only significantly different in the ridge and valley region. Due to this region's topography and relatively lower deer densities compared to the Piedmont and upper coastal plain regions, club dues may potentially be lower in the ridge and valley region. However, the number of observations from this region was low suggesting that more information on clubs in this regions is needed. In contrast with the results of this research, previous studies have found a negative (Pope and Stoll 1985) or positive relationship (Shrestha and Alavalapati 2004; Rhyne et al. 2009). Though straight line distance to a nearest metropolitan area was ultimately chosen (Rhyne et al. 2009), another version of this variable considered involved utilizing recent Rural-Urban Continuum Codes. However, results using this specification indicated that distinctions such as metropolitan, metropolitan adjacent, and metropolitan nonadjacent had no significant effect on club dues. Together, these results suggest that proximity to metropolitan areas had an insignificant on club dues in Georgia.

Though this research identified a number of significant factors affecting club dues, less than half of the variation in club prices was explained by the hedonic model. This suggests that additional factors have a significant on hunting club dues in Georgia. However, this study contributes to the current body of knowledge by examining factors affecting club dues and not lease rates. Previous studies used data collected from landowners (Zhang et al. 2006; Hussain et al. 2007) or government sources (Rhyne et al. 2009; Hussain and Munn 2010) to model factors affecting lease rates. From the demand perspective, hunters may not be necessarily interested in a lease's per acre rate. Instead, many interested lease hunters choose from available club listings and pay annual club dues for hunting access rights. As a result, this paper was able to identify significant factors affecting hunter preferences for hunting clubs.

Results from this research have potential implications for landowners and clubs. Though many private forest landowners are likely constrained by the amount of land they can devote to a hunting lease, results suggest that one additional acre added can increase individual club dues by approximately one dollar. For private timber companies such as Plum Creek, this result suggests that increasing the amount of land under leases could increase revenue generated from hunting leases. The effect of increasing membership size on club dues showed that adding one lease member decreased club dues by approximately $66 on average. Though adding membership can increase revenue, the results show that hunters preferred fewer members and less crowded conditions. Results also found that the presence of food plots on a site increased individual club dues by $154 on average. Though site improvements in the form of food plots was preferred by hunters, a considerable amount of costs is associated with creating and maintaining food plots. For example, excluding costs for equipment, fuel, or labor, costs associated with establishing food plots (i.e. lime, fertilizer, seed, and herbicide) can typically range from $150-200 per acre (Harper 2008). Even though hunters may prefer the presence of established food plots, landowners and clubs may not have the financial resources to create them. Results also indicated that game quality had a positive effect on hunting club dues. However, practicing QDM had an insignificant effect. Though the insignificance of the QDM variable can possibly be attributed to the variable's vague definition, these results suggest that game quality has a significant effect on club dues while management efforts that can lead to improve game quality (i.e. QDM) may not necessarily have a significant impact.

Despite its contribution, this paper has a number of limitations. Though the sample included 230 hunting club observations in Georgia, the sample size may not be necessarily large enough to make generalizations for all hunting clubs in Georgia that hunt big game. For comparison, the sample size used by Rhyne et al. (2009) was 715 while the sample size used by Pope and Stoll (1985) was 310. In addition, a number of variables considered possessed unclear and vague definitions. Specific examples include the forest type variables, *QDM*, and *Recent timber harvest*. More effective variable definitions could have involved percentages based on forest type. However, since the survey respondents were hunters and not landowners, the accuracy of these potential variables could have been questions. A formal concise definition of QDM could have been included in the survey questionnaire. Though this inclusion may have lengthened the survey or caused existing portions to be removed, the QDM question would have been clarified. Similarly, more specific options related to timber harvesting (clearcutting, thinning, exact year since last cut) should have been included in the questionnaire. Finally, a methodological concern exists as well. For instance, the exact location of hunting club observations was unknown. Though previous studies examining hunting club dues have not tested for spatial autocorrelation, hunting club dues from different club dues may be correlated based on proximity. Future lease price studies could attempt to account for spatial autocorrelation.

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CHAPTER 5

CONCLUSION AND IMPLICATIONS

The studies presented in this dissertation provide a better understanding of various aspects of big game hunting in Georgia. Previous nonmarket hunting studies have focused on states such as Alabama and Mississippi, but none have explicitly examined Georgia. In addition, studies have not been examined hunting from more than one analytical perspective. This dissertation, however, examined big game hunting using three established nonmarket approaches: the travel cost method, choice modeling, and hedonic pricing. Results from the three studies mostly complemented each other. Specifically, factors such as lease size and membership affected trip demand, lease choice, and individual hunting club dues similarly. However, when factors (i.e. forest management, buck harvest regulations) were defined differently for each analysis, results did not always coincide. Though lease size and membership had similar effects on lease choice and hunting club dues, it should be noted that WTP estimates obtained from the two approaches were considerably different. These findings demonstrate how effective survey design and clear variable definitions are needed to provide consistent results from nonmarket techniques.

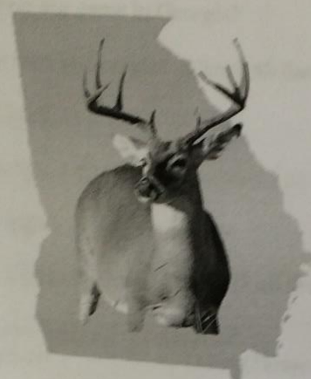
This dissertation provides a number of contributions to the existing literature on hunting. First, the value of a big game hunting trip was significantly different for various land access options (i.e. leased land, public land). The effect of access type on hunting trip demand has not been previously examined. In addition, unlike previous studies, fixed costs associated with hunting (i.e. lease price) were considered by this study's travel cost analysis. Results indicate that lease price had a positive effect on hunting trip demand suggesting that hunters who invested more in higher quality leases took more trips to their sites. A methodological contribution of the choice experiment study was its treatment of the status quo option. Previous studies have assumed that a preference for the status quo simply indicated that the respondent did not prefer either choice option. For this study, an additional specification was used which defined each lease hunter's actual hunting option in 2012 as his or her status quo. Results from different status quo specifications were consistent suggesting robustness across treatment of the status quo option. The majority of recent hedonic studies of hunting leases have examined factors affecting per acre lease rates rather than individual hunting club dues. For most lease hunters, hunting club dues represents a market clearing price rather than a lease's per acre rate. As a result, analyzing lease price from this demand perspective was appropriate and is a contribution to the literature.

Results produced from this dissertation provide a number of implications. For landowners, lease size had a positive effect while club membership had a negative effect on hunting trip demand, lease choice, and membership dues. Many private forestland owners are likely constrained by the amount of land they can devote to hunting leases. However, private timber companies have the ability to adjust the size of their leases. The choice experiment and hedonic studies found that willingness to pay for a hunting club increased by approximately $1 to $2 for each additional acre added on average. However, the management costs associated with providing more acreage for leases may not make this decision cost effective. The choice experiment and hedonic studies also found that increasing a club's membership by one decreased willingness to pay for the hunting club by approximately $70 to $100 on average. This result shows that hunters did not prefer larger membership sizes and crowded conditions. However, despite the effect on hunter satisfaction, clubs can choose to increase the size of their memberships to generate more revenue. Results from the choice experiment implied that hunters preferred lease choices with a more restrictive buck harvesting regulation. This result indicates that landowners can improve the marketability of their leases by imposing stricter regulations. Though statewide harvest regulations are dictated by factors beyond hunter preferences, public wildlife officials may find the results of this research useful as well. The big game hunting demand models indicated that consumer surplus estimates associated with hunting on leased land were higher than public land estimates. In addition, trip demand to public sites was marginally more price elastic than trip demand to private sites such as leases. This result suggests that policy or regulation changes affecting hunting costs would affect hunter groups differently. Since hunters who hunted on public land were more responsive to a change in price, policies that increase hunting costs such as Georgia's proposed increase in license fees would have a greater effect on visitation to public sites. However, any increase in hunting costs would likely lead to a decrease in trip demand causing the total value of big game hunting in Georgia to decrease.

Despite the contributions made by this dissertation, a number of limitations should be acknowledged. First, the mail survey used for each study was structured and labeled as a leasing of private land for big game hunting survey. As a result, hunters who did not lease or were not interested in leasing may have simply disregarded the survey. This potentially skewed the sample in terms of household income and access type visited (i.e. public land, private land). However, it should be noted that this assertion would be difficult to prove empirically. Also, household income, proportion of hunters who hunted on private land, and proportion of hunters who hunted on public land were consistent with findings made by recent national surveys. From a methodological perspective, additional limitations should be acknowledged. For the travel cost and hedonic studies, imprecise definitions were used for variables related to timber and deer management. Though more precise variable definitions were used for the choice experiment, more appropriate attribute levels should have been chosen to provide more meaningful results. In addition, for the travel cost study, hunting substitutes were not specified and fixed costs were accounted for by simply creating additional independent variables. The literature is sparse on the treatment of fixed costs in travel cost models, and additional research is needed to address this issue. Though previous studies have attempted to explain the potential inferior nature of hunting, the effect of income on hunting participation and trip demand has not been adequately addressed. Additional research on this issue is needed and could include examining hunting using a two stage or sample selection approach. Overall, many aspects related to lease hunting have not been examined. For instance, future studies should take into account differences based on game species hunted. Whether the focus is deer or waterfowl, leases are not homogeneous and can vary greatly in terms of management and site characteristics. In addition, hunters are also heterogeneous and lease preferences could vary for different types of hunters. Additional research on lease hunting in different markets is needed and should incorporate various analytical approaches.

APPENDIX A

Georgia Hunter Survey
Leasing of Private Land for Big Game Hunting



The University of Georgia

Warnell School of Forestry and Natural Resources

2013

You have been randomly selected as a big game hunter in Georgia to participate in this survey. If you are less than 18 years old, please do not complete the survey.

SECTION A. RECREATIONAL EXPERIENCE

We would like to ask a few questions about your **big game hunting** experience in Georgia. (As specified by the Georgia Department of Natural Resources, Wildlife Resources Division, big game species in Georgia include deer, turkey, and bear only.)

A1. Have you ever hunted for big game in Georgia?

☐ Yes, go to question **A2.** ☐ No, go to Section **E.**

A2. How long have you been hunting big game in Georgia? ____________ Years

A3. What type of big game do you hunt in Georgia? (Check all that apply.)

☐ Deer ☐ Turkey ☐ Bear

A4. While hunting big game in Georgia, what type of weapon(s) do you use? (Check all that apply.)

☐ Rifle ☐ Shotgun ☐ Bow ☐ Muzzleloader

A5. What other game species do you hunt in Georgia? (Check all that apply.)

☐ Feral pigs/hogs ☐ Waterfowl ☐ Quail ☐ Dove ☐ Raccoon
☐ Rabbit ☐ Squirrel ☐ Other (Please specify.)______________

A6. How important are the following factors when selecting a site to hunt big game in Georgia? (Check only ONE box per ROW.)

	Not Important ← 1	2	3	4	→ Very Important 5
Close distance to my residence	☐	☐	☐	☐	☐
On-site roads that are in good condition	☐	☐	☐	☐	☐
Hunting that is not crowded	☐	☐	☐	☐	☐
No trespasser or poacher problems	☐	☐	☐	☐	☐
No security or vandalism problems	☐	☐	☐	☐	☐
Close distance to hunting companions	☐	☐	☐	☐	☐
Family members or guests permitted	☐	☐	☐	☐	☐
ATV's or off-road vehicles allowed	☐	☐	☐	☐	☐
ATV's or off-road vehicles NOT allowed	☐	☐	☐	☐	☐
Primitive camping (no power, no water) available	☐	☐	☐	☐	☐
Developed camping (power, running water) available	☐	☐	☐	☐	☐
Recreational opportunities other than hunting	☐	☐	☐	☐	☐
Reasonable lease rate or hunting club dues	☐	☐	☐	☐	☐
Stable hunting club membership with low turnover	☐	☐	☐	☐	☐

1

A7. How important are the following wildlife and forest management factors when selecting a site to hunt game in Georgia? (Check only ONE box per ROW.)

	Not Important ← 1	2	3	4	→ Very Important 5
Presence of food plots or wildlife openings	☐	☐	☐	☐	☐
Forestland at site is actively managed	☐	☐	☐	☐	☐
Good chance to harvest lots of big game	☐	☐	☐	☐	☐
Good chance to harvest high quality or trophy game	☐	☐	☐	☐	☐
Good chance to see nongame wildlife	☐	☐	☐	☐	☐
Quality Deer Management (QDM) practiced	☐	☐	☐	☐	☐
Baiting practices allowed	☐	☐	☐	☐	☐
Baiting practices NOT allowed	☐	☐	☐	☐	☐

SECTION B. BIG GAME HUNTING EXPERIENCES IN 2012

We would like to ask a few questions about your **big game hunting** experiences in Georgia specifically in **2012**.

B1. In 2012, did you hunt for big game (e.g. deer, turkey, or bear) in Georgia?

☐ Yes, go to question **B3**. ☐ No, go to question **B2**.

B2. Please tell us why you did not hunt big game in Georgia in 2012.

☐ I usually hunt big game every year, but 2012 was an exception; go to Section **C**.
☐ I have quit big game hunting altogether; go to Section **E**.
☐ I do not use the big game hunting privileges that come with my Georgia hunting license; go to Section **E**.

B3. In 2012, how many big game hunting **trips** did you take to the following land ownership types in Geor (Please count each time you traveled to and hunted on a site and then returned to your residence. If you m multiple trips to a site on the same day, include the total number of trips you made on that day in your cou

My own land	______trips
Private land leased through a club or otherwise	______trips
Private land that is not leased (e.g. friend's or relative's land)	______trips
Public land (e.g. Wildlife Management Area (WMA), National Forest)	______trips

B4. If you leased private land in Georgia in 2012, what was the ownership type of the land leased?

☐ Commercial (e.g. timber companies) ☐ Non-commercial (e.g. private landowners)
☐ Both ☐ I did not lease land for hunting.

B5. Please provide the following information for the sites in Georgia you most frequently hunted big game in **2012**. Please provide information for **up to 3** sites. These sites can be leased land, land associated with a hunting club, your own land, a friend's or relative's land, or public land (e.g. WMA, National Forest).

	Site 1	Site 2	Site 3
Land ownership type (leased land, land associated with a hunting club, my own land, friend's or relative's land, or public land) (Please choose **ONE**.)			
Location of site (county in Georgia)			
Size of the site (acres)	_______ acres	_______ acres	_______ acres
One way distance (in miles) from your residence to the site	_______ miles	_______ miles	_______ miles
Number of years you have hunted on the site			
Number of big game hunting trips you took to the site in 2012			
Number of other people that travel with you in the same vehicle on a typical hunting trip to the site			
If you were a member of a hunting club for this site, your personal club dues (per year) in 2012	$_______/yr	$_______/yr	$_______/yr
Number of other club members for this site in 2012 (if applicable)			
If you personally leased the land, what was the total price (per year) in 2012?	$_______/yr	$_______/yr	$_______/yr
Your personal management expenses for this site in 2012? (e.g. food plot establishment, creating wildlife openings, road/fence maintenance)	$_______/yr	$_______/yr	$_______/yr
Number of bucks per hunter allowed by the lease or club in 2012 (if applicable)			
Did the lease or club have buck size or antler restrictions in 2012? (if applicable) (yes or no)			
Number of does per hunter allowed by the lease or club in 2012 (if applicable)			
QDM practiced at the site? (yes or no)			
Number of turkeys per hunter allowed by the lease or club in 2012 (if applicable)			
Number of permanent stands allowed per hunter at site			
Site's dominant forest species type (planted pine, natural pine, hardwoods, or mixed hardwoods/pine) (Please choose **ONE**.)			
Was the site's last timber harvest less than 10 years ago? (yes or no)			
Fishing ponds present at the site? (yes or no)			
Developed camping amenities available at the site? (e.g. power and running water) (yes or no)			
Food plots present at the site? (yes or no)			

SECTION C. LEASING OF PRIVATE LAND FOR BIG GAME HUNTING

C1. In **2012**, did you lease private land **in Georgia** for the purpose of big game hunting either as club member or as an independent leaseholder?

- ☐ Yes, I did lease private land. (Please go to Section **D.**)
- ☐ No, I did not lease private land. (Please answer question **C2.**)

C2. Below is a list of possible reasons why some hunters may not lease private land for big game hunting. Please indicate your level of disagreement/agreement with these statements. (Check only ONE box per ROW.)

	Strongly Disagree ◄ 1	2	3	4	► Strongly Agree 5
I have my own forestland for hunting.	☐	☐	☐	☐	☐
I am able to hunt on private land owned by family or friends.	☐	☐	☐	☐	☐
I am satisfied with my big game hunting experience on public land in Georgia.	☐	☐	☐	☐	☐
I lease private land for hunting in another state(s).	☐	☐	☐	☐	☐
Leasing private land is not worth it to me.	☐	☐	☐	☐	☐
I cannot find a lease that meets my hunting objectives.	☐	☐	☐	☐	☐
Landowners who lease are more focused on timber management rather than managing for wildlife.	☐	☐	☐	☐	☐
There are few lease opportunities near my residence.	☐	☐	☐	☐	☐
I do not have enough information on current leasing opportunities.	☐	☐	☐	☐	☐
Landowners are unwilling to lease their land because they are unfamiliar with me.	☐	☐	☐	☐	☐
It is difficult to find and keep other hunting club members.	☐	☐	☐	☐	☐
Other club members often violate the rules and regulations of the lease.	☐	☐	☐	☐	☐
Liability insurance is too expensive or hard to find.	☐	☐	☐	☐	☐
Leasing agreements contain too much "fine print" and are filled with unnecessary legal jargon.	☐	☐	☐	☐	☐
I feel uncomfortable hunting on private property because of my gender or race.	☐	☐	☐	☐	☐
QDM is not a priority for most Georgia private landowners.	☐	☐	☐	☐	☐
Private leased land often does not offer other recreational activities (e.g., fishing, hiking)	☐	☐	☐	☐	☐
Roads on private leased land are not adequately maintained.	☐	☐	☐	☐	☐
Baiting is often not allowed on private leased land.	☐	☐	☐	☐	☐
ATV's or off-road vehicles are often not allowed on private leased land.	☐	☐	☐	☐	☐

IMPORTANT: PLEASE READ

- Section D involves choosing between potential deer hunting clubs in Georgia.
- Please respond to the questions even if you do not lease land or if you are not a member of a hunting club.
- There are no "right" or "wrong" answers to these questions. We are interested in what you think.

SECTION D. YOUR SELECTION OF PREFERRED DEER HUNTING CLUBS

The next six questions ask you to compare POTENTIAL deer hunting clubs that differ from each other with regard to the following attributes:

- Club lease size (acres)
- Club membership size (total number of club members including yourself)
- Buck harvest restrictions specified by the club (maximum number of bucks per hunter per season)
- Recent forest harvest method used on the land
- Your club dues ($ per year)

Though the list of attributes above is clearly not a reflection of how complex and unique hunting clubs can be, your responses will help us better understand what attributes make hunting clubs more desirable to Georgia big game hunters. For each question, please indicate which club (if any) you would consider joining if available. If you do not prefer either Club A or Club B for each question, please indicate the third option. Remember, there are no "right" or "wrong" answers. We are interested in which alternative you think is best for each case. Remember, these are only potential clubs designed for the purpose of this research.

D1. If Club A and B were available to you, what would be your preferred choice? (Check a box in the last row.)

Lease attributes	**Club A**	**Club B**	**Status Quo**
Club lease size Club membership size Buck restrictions (per hunter) Recent forest harvest type Your club dues (per year)	400 acres 6 total members 1 with 8 points or more 50% of lease thinned $480	200 acres 7 total members 1 with no point restriction 50% of lease clearcut $640	Neither Club A or Club B
Your Choice *(please check one box)*	☐	☐	☐

D2. If Club A and B were available to you, what would be your preferred choice? (Check a box in the last row.)

Lease attributes	**Club A**	**Club B**	**Status Quo**
Club lease size Club membership size Buck restrictions (per hunter) Recent forest harvest type Your club dues (per year)	200 acres 8 total members 1 with 8 points or more 50% of lease thinned $480	400 acres 7 total members 2 with 8 points or more None $520	Neither Club A or Club B
Your Choice *(please check one box)*	☐	☐	☐

D3. If Club A and B were available to you, what would be your preferred choice? (Check a box in the last row.)

Lease attributes	Club A	Club B	Status Quo
Club lease size Club membership size Buck restrictions (per hunter) Recent forest harvest type Your club dues (per year)	400 acres 7 total members 1 with no point restriction 50% of lease clearcut $640	300 acres 8 total members 2 with 8 points or more None $520	Neither Club A or Club B
Your Choice *(please check one box)*	☐	☐	☐

D4. If Club A and B were available to you, what would be your preferred choice? (Check a box in the last row.)

Lease attributes	Club A	Club B	Status Quo
Club lease size Club membership size Buck restrictions (per hunter) Recent forest harvest type Your club dues (per year)	200 acres 7 total members 1 with no point restriction 50% of lease thinned $560	300 acres 6 total members 2 with 8 points or more 50% of lease clearcut $440	Neither Club A or Club B
Your Choice *(please check one box)*	☐	☐	☐

D5. If Club A and B were available to you, what would be your preferred choice? (Check a box in the last row.)

Lease attributes	Club A	Club B	Status Quo
Club lease size Club membership size Buck restrictions (per hunter) Recent forest harvest type Your club dues (per year)	400 acres 6 total members 2 with 8 points or more 50% of lease thinned $600	200 acres 8 total members 1 with 8 points or more 50% of lease clearcut $440	Neither Club A or Club B
Your Choice *(please check one box)*	☐	☐	☐

D6. If Club A and B were available to you, what would be your preferred choice? (Check a box in the last row.)

Lease attributes	Club A	Club B	Status Quo
Club lease size Club membership size Buck restrictions (per hunter) Recent forest harvest type Your club dues (per year)	400 acres 8 total members 1 with no point restriction None $440	200 acres 6 total members 1 with 8 points or more 50% of lease clearcut $600	Neither Club A or Club B
Your Choice *(please check one box)*	☐	☐	☐

SECTION E. VIEWS ON RECENT LEGISLATION

Captive deer breeding is a practice in which white-tailed deer are bred and enclosed in high fences in a manner similar to livestock. After the deer are bred for desirable characteristics, they are sold to landowners and are subsequently hunted in captivity behind high fences. Though traditionally banned, there have been attempts made in recent years to legalize captive deer breeding in many states. One such attempt ultimately failed in Georgia in 2013 (Senate Bill 230).

E1. Before reading this survey, were you **AWARE** of the ban on importing white-tailed deer into Georgia for the purpose of establishing breeding farms?

☐ Yes ☐ No

E2. Do you **AGREE** with the decision to continue the ban on captive deer breeding in Georgia?

☐ Yes, go to **E3** ☐ No, go to **E4** ☐ No opinion, go to Section **F**

E3. Please indicate the reasons why you support the ban on captive deer breeding in Georgia. (Check all that apply.)

☐ Potential spread of wildlife disease (esp. Chronic Wasting Disease)
☐ Damage to the public's perception of "fair chase" ethics
☐ Wildlife should be kept wild and not managed like livestock
☐ Possibility of unnatural manipulation of white tailed deer
☐ Cost and effort needed by state wildlife agencies to regulate captive deer breeding
☐ Other (Please specify.)____________________

E4. Please indicate the reasons why you do **NOT** support the ban on captive deer breeding in Georgia. (Check all that apply.)

☐ Deer breeding provides additional income for private landowners
☐ Deer breeding positively impacts local and state economies
☐ Potential wildlife disease threat is overstated
☐ Landowners should have the ability to manage deer as they see fit on private property
☐ Georgia hunters should have the option to hunt captive raised deer behind a high fence
☐ Other (Please specify.)____________________

SECTION F. SOCIO-DEMOGRAPHIC INFORMATION

These questions will help us to ensure that the people we were surveying are representative of all big game hunters in Georgia. **All responses will be kept strictly confidential.**

F1. Which best describes the area where you grew up? ☐ Rural ☐ Urban ☐ Suburban

F2. Which best describes your highest educational level?

☐ High school or GED
☐ Jr. College or trade school
☐ Bachelor's degree
☐ Graduate degree

F3. Which best describes your current employment status?

☐ Full-time job
☐ Part-time job
☐ Student
☐ Retired
☐ Unemployed
☐ Other (Please specify.)_______________

F4. How many people live in your household?

☐__________# total
☐__________# under 16 years old
☐__________# hunt big game

F5. What is your age? __________ Years

F6. What is your gender? ☐ Male ☐ Female

F7. What is your ethnicity? ☐ Hispanic or Latino ☐ Not Hispanic or Latino

F8. Which of the following categories best describes your race? (Please check one.)

☐ African American or Black
☐ American Indian or Alaska Native
☐ Asian
☐ Native Hawaiian or Pacific Islander
☐ White
☐ Other

F9. Which of the following best describes your annual household income?

☐ Less than $25,000
☐ $25,000 - $50,000
☐ $50,001 - $75,000
☐ $75,001 - $100,000
☐ $100,001 - $125,000
☐ $125,001 - $150,000
☐ $150,001 or more

F10. Are you a member of any of the following associations or groups? (Check all that apply.)

☐ Quality Deer Management Association (QDMA)
☐ National Wild Turkey Federation
☐ Georgia Wildlife Federation
☐ National Rifle Association (NRA)
☐ Nature Conservancy
☐ Ducks Unlimited
☐ Quail Unlimited
☐ Trout Unlimited
☐ The Sierra Club
☐ Other (Please specify.)_______________

Please use the space provided below for any additional comments.

Thank you for completing this survey. If you have any additional questions, please contact:

Neelam Poudyal, Ph.D. – 706.583.8930; npoudyal@uga.edu
James Mingie, MSc – 865.850.6894; jcmingie@uga.edu

Please return this survey using the enclosed postage-paid envelope. If you have misplaced the envelop please return the survey to:

Professor Neelam Poudyal
Warnell School of Forestry and Natural Resources
University of Georgia
180 East Green Street
Athens, GA 30602

APPENDIX B

Sampling plan for 2012 Georgia big game hunting survey

License type	N	% (N)	Prop. allocation	Sample allocation	% (sample)
Disability	9726	2.30	23	40	4.00
Lifetime adult	9392	2.22	22	40	4.00
Lifetime infant	0	0.00	0	0	0.00
Lifetime non-resident grandchild	24	0.01	0	0	0.00
Lifetime senior discount	7228	1.71	17	30	3.00
Lifetime senior discount card	278	0.07	1	0	0.00
Lifetime veteran	553	0.13	1	0	0.00
Lifetime youth	3957	0.94	9	15	1.50
Non-resident big game	27142	6.42	64	65	6.50
Non-resident 3 day big game	7626	1.80	18	20	2.00
Resident big game 1 year	180827	42.78	428	430	43.00
Resident big game 2 year	10443	2.47	25	25	2.50
Resident sportsman 1 year	51545	12.20	122	155	15.50
Resident sportsman 2 year	5026	1.19	12	20	2.00
Senior (+65) lifetime	97381	23.04	230	140	14.00
Senior (+65) lifetime with card	11515	2.72	27	20	2.00

Note: The total number of licenses was 422,663. Since the survey sample (3,000) contained three blocks, the sampling plan was repeated three times.

APPENDIX C

Results from alternative specification zero-truncated negative binomial regression of lease site demand based on an group unit of consumption and alternative wage rate assumptions (n=262)

Variable	No wage rate	25% wage rate	50% wage rate
Travel cost	-0.0101***	-0.0056***	-0.0038***
	(0.0022)	(0.0012)	(0.0008)
Lease price	0.0001**	0.0001*	0.0001*
	(0.0001)	(0.0001)	(0.0001)
Size	0.0002**	0.0002**	0.0002**
	(0.0001)	(0.0001)	(0.0001)
Size*travel cost	5.12E-07	6.07E-07	4.60E-07
	(1.13E-06)	(5.94E-07)	(4.11E-07)
Size squared	-1.62E-08	-1.59E-08*	-1.58E-08*
	(9.18E-09)	(9.21E-09)	(9.23E-09)
Members	-0.0323**	-0.0303*	-0.0300*
	(0.0161)	(0.0159)	(0.0157)
Members*travel cost	0.0001	-0.0001	-0.0001
	(0.0002)	(0.0001)	(0.0001)
Members squared	0.0003	0.0003	0.0002
	(0.0002)	(0.0002)	(0.0002)
Party size	-0.0543	-0.0630	-0.0670
	(0.0473)	(0.0470)	(0.0471)
Years hunted big game	0.0170***	0.0169***	0.0170***
	(0.0043)	(0.0043)	(0.0043)
Hunts on another lease	-0.1888	-0.1685	-0.1608
	(0.1187)	(0.1179)	(0.1179)
Hunts on own land	-0.2763**	-0.2694**	-0.2651**
	(0.1131)	(0.1131)	(0.1132)
Hunts on non-leased private land	0.1511	0.1488	0.1498
	(0.1067)	(0.1064)	(0.1065)
Hunts on public land	-0.0644	-0.0584	-0.0578
	(0.1050)	(0.1040)	(0.1038)
Age	-0.0123**	-0.0124**	-0.0125**
	(0.0049)	(0.0050)	(0.0050)
Population density (1000/square mile)	-0.0427	-0.0427	-0.0462
	(0.0732)	(0.0679)	(0.0655)
Household income (1000s)	-0.0050***	-0.0036***	-0.0031**
	(0.0012)	(0.0012)	(0.0012)
Intercept	4.0007***	3.9063***	3.8671***
	(0.3159)	(0.3163)	(0.3170)
Overdispersion	0.4363	0.4393	0.4430
McFadden R^2	0.0535	0.0525	0.0514
Log-likelihood	-992.04	-993.11	-994.22

***, **, and * indicates significance at the 1%, 5%, and 10% levels respectively.
Note: Robust standard errors are reported. 3 observations from the original sample of lease hunting sites were dropped due to missing data.

Table 7. Results from alternative specification zero-truncated negative binomial regression of lease site demand based on an individual unit of consumption and alternative wage rate assumptions (n=262)

Variable	No wage rate	25% wage rate	50% wage rate
Travel cost	-0.0174***	-0.0112***	-0.0076***
	(0.0030)	(0.0013)	(0.0015)
Lease price	0.0001**	0.0002**	0.0002**
	(0.0001)	(0.0001)	(0.0001)
Size	0.0002**	0.0002**	0.0003**
	(0.0001)	(0.0001)	(0.0001)
Size*travel cost	1.72E-06	1.30E-06**	8.95E-07**
	(1.33E-06)	(6.00E-07)	(3.74E-07)
Size squared	-1.48E-08	-1.51E-08*	-1.52E-08*
	(9.05E-09)	(8.85E-09)	(8.75E-09)
Members	-0.0305*	-0.0296*	-0.0297*
	(0.0157)	(0.0154)	(0.0154)
Members*travel cost	0.0001	0.0001	0.0001
	(0.0002)	(0.0001)	(0.0001)
Members squared	0.0003	0.0003	0.0003
	(0.0002)	(0.0002)	(0.0002)
Years hunted big game	0.0166***	0.0165***	0.0169***
	(0.0043)	(0.0042)	(0.0042)
Hunts on another lease	-0.1038	-0.1063	-0.1091
	(0.1215)	(0.1204)	(0.1206)
Hunts on own land	-0.2401**	-0.2549**	-0.2604**
	(0.1128)	(0.1129)	(0.1134)
Hunts on non-leased private land	0.1871*	0.1845*	0.1853*
	(0.1105)	(0.1091)	(0.1089)
Hunts on public land	-0.0474	-0.0450	-0.0481
	(0.1083)	(0.1064)	(0.1061)
Age	-0.0059	-0.0070	-0.0078
	(0.0051)	(0.0050)	(0.0050)
Population density (1000/square mile)	-0.0868	-0.0895*	-0.0972*
	(0.0539)	(0.0523)	(0.0513)
Household income (1000s)	-0.0046***	-0.0036***	-0.0032***
	(0.0012)	(0.0523)	(0.0012)
Intercept	3.4913***	3.4738***	3.4653***
	(0.3034)	(0.3003)	(0.2990)
Overdispersion	0.4587	0.4520	0.4551
McFadden R^2	0.0491	0.0503	0.0492
Log-likelihood	-996.70	-995.44	-903.38

***, **, and * indicates significance at the 1%, 5%, and 10% levels respectively.

Note: Robust standard errors are reported. 3 observations from the original sample of lease hunting sites were dropped due to missing data.

APPENDIX D

Hedonic model Pearson correlations

Variable	Size	Members	Mixed forest	Planted pine	Natural pine	Hardwood	Recent harvest	Food plots	QDM	Buck county
Size	1.000	-	-	-	-	-	-	-	-	-
Members	0.661	1.000	-	-	-	-	-	-	-	-
Mixed forest	-0.075	-0.060	1.000	-	-	-	-	-	-	-
Planted pine	0.102	0.139	-0.626	1.000	-	-	-	-	-	-
Natural pine	0.060	-0.038	-0.448	-0.194	1.000	-	-	-	-	-
Hardwood	-0.113	-0.095	-0.299	-0.151	-0.053	1.000	-	-	-	-
Recent harvest	0.213	0.224	-0.129	0.258	-0.007	-0.174	1.000	-	-	-
Food plots	0.117	0.126	-0.015	-0.075	0.037	0.106	0.077	1.000	-	-
QDM	0.147	0.044	-0.015	-0.018	0.061	0.015	0.085	0.151	1.000	-
Buck county	-0.017	0.079	-0.099	0.020	0.024	0.086	0.110	0.061	0.191	1.000
Dev. camping	0.304	0.226	-0.046	0.022	0.061	0.049	0.062	0.165	0.194	0.087
Fishing ponds	0.101	0.092	0.038	0.007	-0.012	0.019	-0.074	0.134	0.099	-0.074
Metro distance	0.221	0.060	-0.179	0.140	0.113	-0.027	0.110	0.004	0.140	0.241
Ridge and valley	-0.073	-0.068	0.040	0.018	-0.033	-0.063	-0.014	-0.033	-0.034	-0.149
Piedmont	-0.323	-0.062	0.116	-0.122	-0.081	0.051	0.054	0.010	0.057	-0.029
Upper coastal	0.115	-0.053	-0.152	0.115	0.037	0.053	0.088	0.049	-0.010	0.291
Lower coastal	0.376	0.208	0.002	0.017	0.092	-0.104	-0.028	-0.057	-0.047	-0.243

Hedonic model Pearson correlations continued

Variable	Dev. Camping	Fishing ponds	Metro distance	Ridge valley	Piedmont	Upper coastal	Lower coastal
Size	-	-	-	-	-	-	-
Members	-	-	-	-	-	-	-
Mixed forest	-	-	-	-	-	-	-
Planted pine	-	-	-	-	-	-	-
Natural pine	-	-	-	-	-	-	-
Hardwood	-	-	-	-	-	-	-
Recent harvest	-	-	-	-	-	-	-
Food plots	-	-	-	-	-	-	-
QDM	-	-	-	-	-	-	-
Buck county	-	-	-	-	-	-	-
Dev. camping	1.000	-	-	-	-	-	-
Fishing ponds	0.184	1.000	-	-	-	-	-
Metro distance	0.213	0.055	1.000	-	-	-	-
Ridge and valley	-0.125	0.010	-0.246	1.000	-	-	-
Piedmont	-0.202	-0.134	-0.380	-0.260	1.000	-	-
Upper coastal	0.249	0.093	0.366	-0.143	-0.668	1.000	-
Lower coastal	0.054	0.070	0.243	-0.091	-0.425	-0.234	1.000