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Demand for Resident Hunting in the Southeastern United States

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We modeled hunting demand among resident hunters in the Southeastern United States. Our model revealed that future hunting demand will likely decline in this region. Population growth in the region will increase demand, but structural change in the region's demography (e.g., "browning" and "aging"), along with declining forestland access will decrease hunting demand. The results suggested that programs encouraging younger and non-white populations to participate in hunting could mitigate a forecast hunting decline in the region. Increasing license fees, while politically risky, should increase agency revenues due to price-inelastic demand. The model developed here can be applied to understand and project hunting demand in the Southeast and adapted to other regions.

Keywords hunting, license sales, demand forecasting, price elasticity, Southeastern U.S.

Introduction

Hunting is an activity of great economic significance in the United States. In 2001, 13 million people participated in hunting and related activities, which contributed the nationwide expenditure over $20 billion (USDI Fish and Wildlife Service, 2002). The average annual expenditure of a hunter including license fee and expenses for various equipment, transportation, and accommodation in 2001 dollar was about $1,896 (USDI Fish and Wildlife Service, 2002). Such expenses have a multiplier effect on local and regional economies. For example, the economic impact of hunting in some of the Southern states such as Georgia is estimated to be higher than that of peanuts, one of Georgia's major crops (International Association of Fish and Wildlife Agencies, 2002). In addition to its economic impact, hunting helps to maintain and to control the population of deer and other game species (Bhandari, Stedman, Luloff, Finley, & Diefenbach, 2006; Mehmood, Zhang, & Armstrong, 2003).

In spite of the great economic significance of hunting in the United States, hunting is declining. Hunters grow older and people's participation in hunting has been declining

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(Mozumder, Starbuck, Berrens, & Alexander, 2007; Cordell & Super, 2000; Duda, Bissell, & Young, 1998; Floyd & Lee, 2002). The number of licensed hunters in the nation has declined by about 20% in the last two decades (Figure 1). The International Association of Fish and Wildlife Agencies (2005) reported that the number of hunters in the nation decreased from 15 million in 2002 to 14.7 million in 2003 based on license sales records. The US Fish and Wildlife Service found a decline in small game hunters by 29% between 1991 and 2001 (USDI Fish and Wildlife Service, 2002). Growing concern about the declining popularity of hunting is compounded by findings that policy instruments are unlikely to motivate hunters to return once they stop hunting (Mehmood et al., 2003).

As a result of the decline in hunting license sales, wildlife agencies can experience revenue loss (Sun, Van Kooten, & Voss, 2005; Anderson, Reiling, & Criner, 1985). Hunting license sales are a major source of revenue for the state conservation agencies that face the challenge to meet the growing demand of nature conservation with limited funds (Anderson et al., 1985; Teisl, Boyle, & Record, 1999; Floyd & Lee, 2002). The drop in license sales can have twofold effects: (1) it diminishes operating budgets for conservation agencies and (2) it can lead to increased human–wildlife conflicts around rural–urban interfaces due to overpopulation of game species.

It is important to retain hunting as a tool for game management and a recreation opportunity. In order to maintain and manage hunting demand, it is essential to understand the factors influencing hunting demand. Understanding the factors associated with hunting participation has many implications. For example, it can help establishing grounds for social support for hunter recruitment and retention. Furthermore, there is a need to develop a hunting demand model to project future demand for licenses and revenue generated by that demand. The projected number of licensed hunters is of interest to state conservation agencies, specifically because the amount of funds each state receives through federal aid for wildlife restoration and sports programs is partly determined by hunting demand of each state (Floyd & Lee, 2002).

A number of studies have examined the demand for hunting licenses (Anderson et al., 1985; Bissell, Duda, & Young, 1998; Brown & Connelly, 1994; Floyd & Lee, 2002; Heberlein & Thomson, 1996; Mehmood et al., 2003; Miller & Hay 1981; Sun et al., 2005; Walsh, John, McKean, & Hof, 1992; Ziemer, Musser, & Hill, 1980). These studies produced models that explained the number of licenses sold as a function of license fee, demographic variables, and sometimes-other variables related to availability of hunting

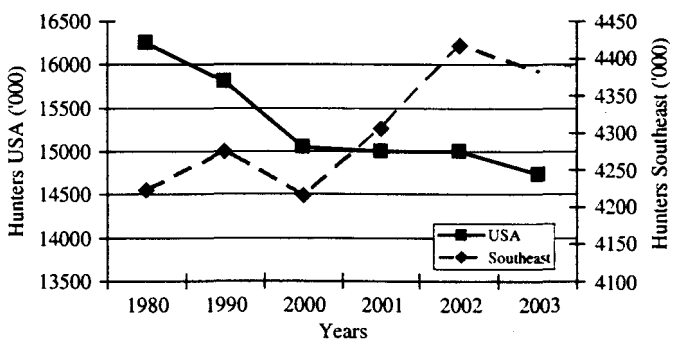

Figure 1. Certified resident hunting license holders in United States and Southeast (Source: NSSF, 2005).

resources. One of the common findings is that resident hunting demand is typically unresponsive to hunting license fees (Teisl et al., 1999). This could be because of the relatively small share of license fee in the total cost of hunting activities. Alternatively, it could be due to the lack of dispersion in license fees both geographically and temporally. In contrast, demographic factors, for example, age, gender, and race are found to have more pronounced effects on hunting demand (Bissell et al., 1998).

Floyd and Lee (2002) used a telephone survey to find the demographic characteristics of individuals who purchased hunting licenses. They found age and race as the major predictors of hunting and fishing participation. Sun et al. (2005) examined demand for wildlife hunting in British Columbia focusing on the effect of license price. Bhandari et al. (2006) explored the effect of hunters' background and field characteristics on harvest success. Mozumder et al. (2007) reviewed the legal and economic issue of lease hunting on private lands. Zhang, Hussain, and Armstrong (2006) studied the supply of hunting leases in private forestlands. Gender-wise participation in hunting was scrutinized in the survey studies by Heberlein and Thompson (1996) and Bissell et al. (1998).

The earlier studies used a single city, province, or state as study areas and have not focused on projection of future hunting demand (Sun et al., 2005; Miller & Vaske, 2003; Floyd & Lee, 2002; Teisl et al., 1999; Brown & Connelly, 1994), thus limiting regional generalizations and implications for the projection. This article attempts to address these two gaps in the literature by examining the determinants of hunting demand among residents in the Southeastern United States using a dataset of county-level license sales in 2000. The Southeastern United States is chosen as the study area because hunting is an important economic activity in the South and many Southerners view hunting as a way of life. For instance, 3 out of the top 10 states ranked by hunting-related retail sales are in South (International Association of Fish and Wildlife Agencies, 2002). The focus of this study is to identify socioeconomic, land use change, and institutional factors associated with the demand for hunting licenses and to forecast hunting demand in the region over the next few decades.

Following Anderson et al. (1985), Brown and Connelly (1994), and Sun et al. (2005), a hunting license demand equation is estimated on cross-sectional data at the county level. County level data are chosen because the county is the smallest unit at which license sales data are recorded by state agencies. Despite the use of aggregate data, this approach is known to be less costly, less time consuming, and less intrusive than using personal interviews or survey data (Heberlein & Thomson, 1996).

Empirical Model

The hunting license demand equation is specified as:

$$\ln Y = \beta_0 + \sum_k \beta_k X + \varepsilon \tag{1}$$

where, ln Y is a N by 1 vector of the natural logarithm of the number of licenses sold in counties, X is a N by K matrix of the explanatory variables, β_0 is an intercept parameter, and β_k is a K by 1 vector of slope parameters. The last term ε is N by 1 vector of independent and identically distributed random errors. A log-linear model is applied because: (1) the quantity of licenses sold varies greatly among counties and taking the natural log of the dependent variable minimizes the possible issue of heteroskedasticity

(Wooldridge, 2003, p. 268), and (2) the log-linear functional form in hunting demand models has consistently performed better than linear, log-log, or lin-log models (Sun et al., 2005; Ziemer et al., 1980).

The detailed definition and description of the explanatory variables are presented in Table 1. Because the license fee is fixed at the state level, the license fee at the state level is used to capture the proxy effect of license fee on hunting demand at the county level.

Table 1
Variable definition and descriptive statistics

Variable	Description	Mean	Standard deviation
Dependent Variable			
License	Total of all kinds of residential hunting permits sold at the county in year 2000	3,912.60	5,168.45
Independent Variables			
License fee	Per hunter capita hunter expenditure on license fee in the state	13.763	2.922
Personal income	Average personal income of county in millions	1774.715	6068.661
Employment	Percentage of people in the county holding full-time jobs	43.709	6.975
Commute	Average commute time in minutes to work	25.773	5.223
Below high school	People with less than 9 years of schooling as a percentage of county population	7.338	3.381
College graduate	College graduates as a percentage of county population	12.203	4.957
Population	County population	62754.54	167914.70
Age 16–34	Percentage of county population between 16 and 34 years	21.975	3.986
Age 35–65	Percentage of county population between 35 and 65 years	38.661	2.969
Single male parent households	Households with children under 16 but no wife as a percentage of county total	3.152	1.008
White	White population as a percentage of county total	77.981	16.886
Public forest	Public forest within 100 mile distance from county centroid but within the state, as a percentage of total area	5.722	4.620
Private forest	Private forest within 100 mile distance from county centroid but within the state, as a percentage of total area	39.538	20.008
Gun clubs	Equals 1 if county has a gun club, 0 otherwise	0.024	0.154
Amusement	Number of outdoor amusement and sports attractions	0.163	1.090

Whereas different states issue various types of licenses, there is no uniform license fee data available. For example, Tennessee issues hunting permits for waterfowl, annual big game gun, annual big game archery, annual big game muzzleloader, and various combinations while Georgia issues alligator and dog deer hunting permits that Tennessee does not issue. Because of the inconsistent types of issued permits, average state license fee, estimated by dividing the total revenue of statewide resident license sales by total number of resident hunters, is used as a proxy for the license fee.

Socioeconomic, ecological, and institutional variables are included as explanatory variables in the hunting license demand equation. Mehmood et al. (2003) found that childcare responsibilities influence the time for participation in hunting. Accordingly, percentage of single male parent households is used as a variable reflecting family status. Percentage of people in the county with full time employment is used to capture the effect of employment status. Based on the literature (Heberlein & Thomson, 1996; Mehmood et al., 2003; Floyd & Lee, 2002; Bissell et al., 1998), we hypothesize that the counties dominated by white populations have higher hunting demand. It is expected that individuals with higher levels of economic prosperity are more likely to participate in hunting.

Following Shulstad and Stoevener (1978), total population in the county is included to capture the effect of absolute population on hunting demand. A positive effect of this variable on license demand is expected. Given the fact that the total population greatly varies among the counties in the Southeast, the natural log of total population is used in the equation to minimize the heteroskedasticity. The percentage of population with less than a high school education and percentage of population with college degree or higher level are included to examine whether individuals with higher levels of education are more likely to participate in hunting activities. Likewise, two sub-categories of age measures, the percentages of populations between 16 and 35 years and between 35 and 65, are included to examine age-wise preference for hunting demand. Average commute time to work is included to examine the effects of time availability for the hunting trips.

Mehmood et al. (2003) found that lack of public hunting access was a major reason for quitting hunting among Alabama residents. Miller and Vaske (2003) found that hunters in Illinois were 106 times more likely to decrease participation if they perceived a lack of land available for hunting than those who did not perceive this constraint. Duda et al. (2004) and Jagnow, Stedman, Luloff, San Jullian, and Finley (2006) argued that more private landowners have been closing or limiting access to their land for hunting than ever before. Availability of forest land under different ownerships (e.g., private and public ownerships) is included to capture the hunting opportunities in the region. Given that hunters often travel outside the county to hunt, a buffer of 100 miles is drawn around the county centroid within each state. As it is not clear how far hunters travel for hunting activities, identifying a distance for the buffer is arbitrary. Nevertheless, the 100-mile buffer within the state boundary is used because most resident hunting is assumed to be done within reasonable daily traveling distance. Availability of such hunting grounds is expected to positively affect the demand for hunting (Mozumder et al., 2007) and other wildlife related consumption demand (Zawacki, Marsinko, & Bowker, 2000). For this reason, the 100-mile buffers for public and private forest are included in the model. Similar buffer variables for pasture and wetland were created but not included in the final model because both of the variables are significantly and positively correlated with the public forest variable.

A binary variable indicating whether or not the county contains gun clubs is included to test the hypothesis that institutional platforms have positive effects on hunting demand. A variable capturing the number of alternative outdoor amusement and sports attractions is included to control for substitute effects. This type of variable has not been previously used in the literature.

Data

Study data were obtained from a variety of sources. The state offices responsible for hunting license sales provide the county level sales record for all resident hunting permits in 2000. The numbers of all types of resident license sold were added to obtain the total quantity of license sold to reflect total resident hunting demand. Counties from 10 Southern states including Alabama, Georgia, North Carolina, South Carolina, Tennessee, Virginia, Kentucky, Arkansas, Texas, and Louisiana (parishes) are included. A few counties in Georgia and Texas and several independent cities in Virginia are dropped because these counties did not sell any licenses in 2000. Counties in Florida and Mississippi are missing because sales records were not available at the county level for 2000. The total number of counties used in the analysis is 1,066 and 197 are excluded or missing.

Data on demographic and economic variables including population density, age, education, race, employment, commute time, and single male parent households were obtained from the 2000 U.S. Census, and the USDA Economic Research Service. Per capita hunter expenditure on license fee was obtained from the National Shooting Sports Foundation (NSSF). NSSF keeps the record of resident and non-resident hunting license sales by state that are obtained from the US Fish and Wildlife Services.

Another dataset used in this study is ecological information capturing the availability of hunting grounds. The percentages of forest area under public and private ownership were obtained from the national outdoor recreation supply information system (NORSIS). This database system compiles the county level database of outdoor recreation resources in the United States under the Renewable Resources Planning Act (RPA) assessment of recreation and wilderness (Cordell & Betz 1997). The variables for the 100-mile buffers for public and private forests within state boundaries were calculated in ArcGIS using NORSIS and ESRI datasets. Two boundary criteria are combined to create the 100-mile buffers: within 100-mile radius circle from the centroid of each county, and inside of state boundary. The state boundary was needed because resident hunting license is permitted only within the state that issued the permit. Data on whether or not the county has a gun club, and availability of amusement and sports in the county were also obtained from NORSIS. It should be noted that the NORSIS dataset and the Census data differ by two years, however, the status of ecological and institutional variables are unlikely to change appreciably in such a short time period.

Empirical Results

Ordinary least squares regression estimation (OLS) of Equation 1 requires the assumption that the variance of the error term is constant. If the error terms do not have constant variance, they are said to be heteroskedastic. Heteroskedasticity can occur if there are subpopulation differences. Because the study area is rather broad with potential subpopulation differences, heteroskedasticity may be expected. OLS estimation in presence of heteroskedasticity is not efficient. Heteroskedasticity was initially detected using a Goldfeldt-Quant (GQ) test wherein the null hypothesis of homoskedasticity was rejected

(F-value of 259.20, 151 df, and $p < 0.0001$). Hence, Equation 1 is re-estimated using the following feasible generalized least square (FGLS) method (Greene, 2003),

$$\beta = (X'\Omega^{-1}X)^{-1}X'\Omega^{-1}y \tag{2}$$

where, the term Ω is an N by N diagonal matrix of error terms. Note that the vector Y in Equation 2 is in logarithmic form as transformed in Equation 1. The estimated coefficients for each of the explanatory variables are presented in the Table 2. Eleven out of 15 explanatory variables are statistically significant ($\alpha = 0.05$). The signs of statistically significant coefficients are consistent with prior expectations and the findings from earlier literature. The adjusted coefficient of determination ($R^2 = 0.73$) reveals a fit comparable to previous literature.

Consistent with consumer theory, the average license fee was found to have a negative and significant effect on license demand. The price coefficient, equivalent to the price elasticity in this functional form, of –0.20 is similar to the findings of previous works that used an aggregate approach. For example, Teisl et al. (1999) found that the price elasticity of hunting demand is –0.32 among resident hunters in Maine. Sun et al. (2005) reported a

Table 2
FGLS regression parameter estimates

Variables	Coefficient
Intercept	–1.710*** (0.626)
ln(License fee)	–0.204* (0.108)
ln(Personal income)	0.312** (0.134)
Employment	–0.014*** (0.003)
Commute	–0.011*** (0.003)
Below high school	0.012* (0.007)
College graduate	–0.037*** (0.006)
ln(Population)	0.516*** (0.140)
Age 16–34	–0.004 (0.006)
Age 35–65	0.019** (0.009)
Single male parent household	–0.041** (0.018)
White	0.013*** (0.001)
Public forest	0.019*** (0.005)
Private forest	0.003*** (0.001)
Hunting clubs	0.254** (0.117)
Amusement	0.008 (0.008)
F-statistic	196.490***
Adj. R^2	0.73
Number of observations	1066

Note: ***, **, and * indicates statistical significance of parameter at $\alpha = .01, .05, .10$ levels, respectively. The numbers in parenthesis are the standard errors.

price elasticity for the basic license fee of –0.22 among resident hunters in British Columbia. As with these other studies, the inelastic price elasticity suggests that states could expect to increase sales revenues by increasing license prices. For example, suppose 1,000 licenses are sold at the price of $20 yielding $20,000 in revenue. Increasing price by 25% to $25 would decrease licenses by 5% to 950, whereas revenue would increase to $23,750 or 18.75%. However, the 5% decline of licenses sold would likely come with a reduction of other hunting related spending and possible political fallout. The decline would also negatively affect the redistribution of federal money to support for conservation education programs and related projects (Floyd & Lee 2002). Alternatively, because of the inelastic price response, decreasing license price as a hunter recruitment strategy would not be effective as revenues would disproportionately plummet.

Of the socioeconomic variables, personal income, employment, education less than high school, college graduate and more, total population, age between 35 and 65, single male headed households, white race, and average commute time to work are found to be statistically significant ($\alpha = 0.05$). The income elasticity of demand for resident hunting license is 0.31. This indicates that 1% increase in personal income increases the demand for hunting by 0.31% and supports the notion that hunting can be considered a normal good.

Counties with higher proportions of residents with full-time jobs are likely to have lower demand for hunting. This finding implies that time is a critical aspect of hunting demand just like other recreational demand (Bockstael, Strand, & Hanemann, 1987). Similarly, the coefficient of average commute time to work was negative and significant. The possible explanation for this is that the people who commute longer distances to work have less discretionary time for outdoor recreation activities, particularly those that require travel to the field.

Counties with higher proportions of population with less than high school education are more likely to have higher hunting demand, whereas the opposite is true for the population of college graduates. The counties with higher proportion of whites are more likely to have higher hunting demand. The positive effects of population with lower education and proportion of white people may be explained by hunting being one of the rural white class cultural traditions in some areas of the South. The reason behind the negative effect of population ratio of college graduates may be similar to the coefficients for the employment and commute time variables, suggesting greater opportunity cost of time for full-time employed and individuals with greater commute time and college degrees. Consistent with Shulstad and Stoevener (1978), the total population has a positive effect that is significant at the 1-percent level. The elasticity of the total population variable suggests that a 1% increase in population in a county increases the hunting license sales by 0.51%. This reveals the fact that the growing population in the Southeast will help to keep the hunting demand in this region alive, assuming other factors remain constant.

There is a significant variation in the hunting demand of population age cohorts between ages of 16–34 and 35–65. The coefficient for the age of 35–64 is positive and significant at the level of 5-percent whereas the coefficient for the age of 16–34 is not significant even at 10-percent. It reveals that counties with more population of 35–65 age group are more likely to have greater hunting demand whereas counties with more population of 16–35 age group are less likely to have greater hunting demand. This result is consistent with the conclusion of Brown, Decker, Siemer, and Enck (2000) that the mean age of the hunters has increased somewhat in recent decades. More importantly, this discrepancy among the age groups confirms the declining popularity of hunting among the younger generation (Duda et al., 2003). This result suggests that the state agencies may need to

focus on younger age groups for promotion of hunting. Recruiting younger individuals may help maintain social support for hunting, as there appears a growing protest against hunting in recent years (Campbell & Mackay, 2003).

The single male-headed household has a negative and significant effect ($\alpha = 0.05$). This can be interpreted that the time and resources needed for childcare are likely to adversely affect hunting demand. This is consistent with the finding that the time, money, and energy required rearing children influence individuals' willingness to participate in hunting (Mehmood et al., 2003). The counties with higher proportions of white population are likely to have higher demand for hunting licenses. This result confirms the finding that African American and Hispanics are less likely to purchase hunting license than whites (Floyd & Lee, 2002). This is clear empirical evidence to support the argument that without changes in tastes and preferences, the "browning" of America will be a factor in declining per capita hunting participation and overall hunter numbers.

The higher availability of forest areas within a 100-mile buffer leads to higher hunting demand regardless of ownership of the forest. This relationship can be understood by the fact that forest area is the habitat for various game species. The percentages of public and private forests within a 100-mile radius circle from the county center have significant and positive effects on the hunting demand. These relationships can be explained by the fact that the percentage of forest of both ownerships reflects the availability and access to hunting ground. A closer scrutiny of coefficients between these two forest types reveals that the availability of public forest has a substantially greater marginal effect on hunting demand compared to the private counterpart. This may be because private forests have lease fee and legal liability as barriers to hunting. This finding corroborates the arguments of Miller and Vaske (2003), Duda et al. (2004), and Mozumder et al. (2007) that the accessibility to hunting land may be a major issue in declining hunting numbers. This is also consistent with the conclusion of decreasing hunting demand due to decline of public hunting land in Alabama (Mehmood et al., 2003). Alternatively, some of the difference could be due to the fact that in many states private land owners can hunt their land without a license.

Among the institutional variables, the binary variable for presence of a gun club in the county is found to be significant ($\alpha = 0.05$). Counties with such clubs are expected to have higher demand for licenses. This indicates that the gun clubs could be effective institutions to help retaining and promoting hunting activities. Moreover, hunters may have incentive to join such clubs to share information regarding sport shooting and hunting activities. The availability of ancillary outdoor attractions such as amusement parks and other outdoor sports are found to have no significant effect on hunting demand and hence, are neither substitutes nor complements for hunting activities.

Projection

While the estimated model can be used to examine the factors that influence hunting demand, it can also be used to simulate future hunting demand under a number of assumptions about explanatory variables, for example, demographic, forest land use, and institutional changes in the future. The estimated regression parameters from the structural model are applied to the projected values of the explanatory variables to project future hunting demand for hunting licenses in the Southeast over five-year intervals from 2000–2030.

Assumptions about demographic, land use, and institutional changes at the county level in the future are cumbersome. The projected changes are obtained based on

available literatures and databases. For those variables whose projected changes are not available, the values are estimated using interpolation and extrapolation techniques. The projected values of demographic changes are obtained from a U.S. Census projection report (U.S. Census Bureau, 2005). For example, the projected population of white and total populations at a given county for a given future year is used to calculate percentage of white for the respective county and year. The report projects that the population in the region increases by 46% in the period of 2000 and 2030, whereas the white population share decreases from 78% to 65% during the same period.

To project the license fee, average growth of license fees are obtained from US Fish and Wildlife Service (2002 & 2007), and are extrapolated to year 2030. The real annual growth of the average fee during 2001 to 2006 was 0.5%. Similarly, the personal income growth rate from current years for the Southeast region is obtained from Bureau of Economic Analysis and county level income for future years is extrapolated using the current annual growth rate to extrapolate the future income values (BEA, 2007). The Bureau suggests an annual increase of 4.6% in the average personal income in the Southeast region between 2000 and 2005. However, adjusting for current inflation rate, a real growth of 1.9% is used. Projected means of commute time to work in Southern counties are extrapolated using the annual growth of travel time to work that is obtained from recent commute trend in the region compiled by US Department of Transportation (McGuckin & Srinivasan, 2003).

Because the employment, age-cohorts, and population by education level projection are not available for the Southeast region, the projection rates for the entire nation are used as proxies. The employment projection is due to Bureau of Labor Statistics (Saunders, 2005) and suggests 1.3% as an annual growth rate of employment from 2004 and 2014, beyond which the county level employment is extrapolated assuming this growth rate. Similarly, the age-cohorts projection is obtained from Day (1996) who projected the age-wise population growth rate up to 2050 for the U.S. Census Bureau. This projection suggests a significant aging of population and decline in share of population that belongs to the age group of likely hunters in the Southeast as suggested by our regression results, that is, 39% of 35–65 age group in 2000 to 30% of the same age group in 2030. The projected populations of below high school and college graduate are obtained from Hussar and Bailey (2006) who projected the population by different level of education up to 2015 for US Department of Education. Using their growth rate, the populations of respective education levels at counties are extrapolated for subsequent years. The projection suggests an increase in share of population with college degrees and a decrease in share of population with less than a high school degree.

The projected values of public forest and private forest share are created using the forestland change projection report for the Southeast region, obtained from the USDA Forest Service (Alig, Platinga, Ahn, & Kline, 2003). The report projects on average a 6% decrease of private forest area in the Southeast region from 1997 to 2050. The percentages for the share of private forest in intermediate years are obtained by linear interpolation. The means of projected explanatory variables are reported in Table 3. Similarly, Alig et al. (2003) reported that the public forest in the Southeast will remain constant during next few decades. Due to the data limitations, the percentage of households with single male parents with children, the information on whether or not the county has gun clubs, and number of alternative outdoor amusement are assumed to be constant over the projection period. The already discussed scenario is the base-line case, which will later be compared with scenarios of alternative assumptions.

Table 3
Mean value of projected explanatory variables for base-line alternative

Variable	2005	2010	2015	2020	2025	2035
License fee	14.14	14.53	14.92	15.33	15.75	16.18
Personal income	1950.10	2142.54	2353.96	2586.25	2841.46	3121.86
Employment	43.21	42.70	42.20	41.70	41.21	40.72
Commute	27.90	30.20	32.70	35.40	38.32	41.49
Below high school	6.76	6.22	5.73	5.27	4.85	4.47
College graduate	12.39	12.40	12.49	12.59	12.69	12.79
Population	67704	73084	78892	85161	91928	99232
Age 16–34	20.29	18.73	17.29	15.96	14.71	13.60
Age 35–65	37.21	35.80	34.44	33.14	31.88	30.67
White	75.70	73.45	71.27	69.15	67.09	65.10
Public forest	5.70	5.70	5.70	5.70	5.70	5.70
Private forest	38.96	38.74	38.52	38.30	38.09	37.87

The projected value of each variable is simulated for each county in the study area. Then, the projected values of explanatory variables and regression parameters are plugged into the estimated demand equation to predict the value of dependent variable for a given county in a given future year. Because the model is log-linear, it needs transformation and correction of the predicted dependent variable, which is in logarithmic form. Following Wooldridge (2003, p. 205), the predicted dependent variable is transformed and corrected to yield the actual number of hunting licenses. The projected demands at county level for a particular future year are then summed up to yield the estimation for the region for that year. For the projected demand in counties with missing observations, the projected mean demand from included counties is applied. For the projection purpose, we explicitly assume that these counties share similar characteristics and may not have dramatically different demand from the projected average of all the other counties in the same region.

The predicted values using the demand model and projected means of explanatory variables is 12.4% less than the actual license sales for 2000. This means the model and the projected explanatory variables slightly under-predict the demand. Consistent with the nationwide trend, projection results indicate that the region will experience a slight decrease in hunting demand from 2000 to 2030. The total demand in 2030 would be 5.36 million in the region, which is about 9% less than that of 2000. This projection is consistent with most existing literature, which suggests a declining participation in consumptive outdoor recreation such as hunting (Brown et al., 2000; Kelly & Warnick, 1999). Brown et al. (2000) reported that people's participation in hunting nationally reached a peak in 1983 and substantially and consistently declined thereafter. Cordell et al. (2004) claimed that since 1960 hunting participation has declined nationally from 16% to 12% of the general population. Bowker, English, and Cordell (1999) forecasted national hunting participation to decline by 11% from 1995 to 2050, with the hunting trips in the South declining 22% during the same period.

A ten-year period comparison of projection suggests that the demand would decrease by about 3% between 2000 and 2010. The actual sales record during the previous ten-year

period of 1990–2000 revealed a 4.4% decline. Similarly, the actual sales record also shows a 5.45% decline from 1995 to 2005. Based on the actual decline of sales record in the periods of 1990–2000 and 1995–2005 and predicted decline in the period of 2000–2010, our forecasts may be conservative.

The expected decline in hunting demand can be attributed primarily to the structural change in demographics and to some extent the expected decrease in forestland in the area. It was reasonable to expect an increased hunting demand due to expected population growth in the region during 2000 to 2030. However, a significant change in demographic structures and loss of forest areas—particularly those under private ownership—will slow down any expected growth in hunting. Following Bowker et al. (2006), indices are developed to compare and better explain the future trends of population growth, hunting demand, and per capita hunting demand. Figure 2 presents each index for each five year interval up to 2030. As reported, the per capita demand for hunting will decline by 37% out to 2030. The projected decline in demand in Figure 2 seems slightly different from the number of certified license holders for this region as shown in Figure 1. However, the possible explanation behind this is that the number of certified license holders in the region increased slightly during 2000–02, due to overall population growth, but the total licenses purchased decreased slightly. Even though the annual breakdown shows some randomness, the overall trend is declining. The total population in the region will increase by about 46%, which will compensate the decline in per capita demand for hunting and result in an overall decrease in hunting demand by about 9%. This result is in line with Bowker et al. (2006), who found that growth in total population can dominate the decline in per capita demand.

As the trend lines in Figure 2 indicate, hunting demand does not mimic the total population growth trend. This is because the share of population that positively influences hunting demand in the region will decrease in coming decades. For instance, the population belonging to age cohort 35 to 65 years, that our current regression analysis suggests to be positively correlated with license sales, is projected to decrease by 18% over the period of 2000–2030. That will lead into the percentage share of this age cohort in county population to decrease from 38% in 2000 to 30-percent in 2030. Further, by 2030, about 45% of population is projected to belong in the age group of 65 years or older and notably this cohort (65 and older) is less likely to hunt (Schole, 1973; Manfredo & Zinn, 1996). Also, the population share of young age class (below 20 years) at which most of the likely

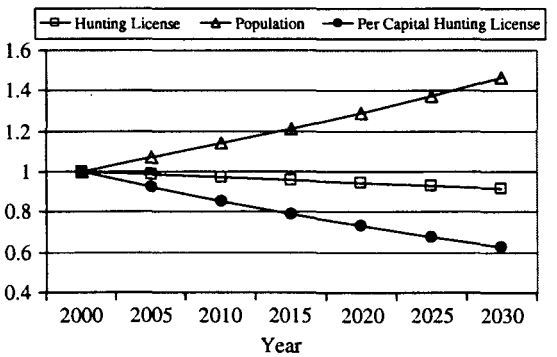

Figure 2. Projected hunting demand index in Southeast region.

hunters start hunting (Duda et al., 2003) is projected to continuously decline during the same period.

Another structural shift that is likely to drive down the hunting demand in the Southeast is racial composition change. The U.S. Census Bureau projects that the share of white population, which is positively correlated with hunting, will decline substantially in the region from 78% in 2000 to 65% in 2030. This racial transition commonly known in the media as "browning" will likely be key to declining hunting demand. Further, the share of population with college degree, which is negatively correlated with license demand, will increase while those with less than a high school level education, which is positively correlated with license demand will decrease during the same period shifting down hunting activities in the future, albeit to a lesser extent than age and race.

Similarly, because the region is projected to face a continuous decline in private forestland and no increase in public forestland, the declining availability of hunting opportunities will be another issue. Although, the share of pastureland and wetland are not included in the model due to their positive correlation with forestland, it is reasonable to expect a bigger cumulative effect from the increasing loss of forestland, wetland and other open space on hunting activities in the area.

In addition to the aforementioned base-line projection, we assumed alternative rates of change for some of the explanatory variables in simulated alternative scenarios. The base-line is a best guess based on projected reports and literature. The first alternative, Higher Population Growth (HPG), assumes a population growth rate that is 1.33 times the rate in the base-line. Proportionate changes in other variables are also assumed. As in the base case, public forest is assumed to be constant, however a one-third higher rate of decline is assumed in case of private forest. While this may not perfectly reflect the population growth and forest loss scenario, it will approximate the anticipated decline of more open spaces in a higher HPG scenario.

The second alternative, Increased Minority Population Share (IMPS), assumes a higher proportion of non-whites in the region in future. GMPG assumes the white population growth rate that is half of base case rate, so that the mean county level share of white population will be 56% by 2030 instead of 65% in base case.

The third alternative, Faster Forest Loss Rate (FFLR) assumes everything else the same as in base-line, but makes an additional assumption about the land use change. Unlike the forest loss projected by Alig et al. (2003) in base-line, a projection from the Southeast Natural Resources Leadership Institute (2006) is adopted for FFLR. The institute projects an annual forest decline rate of 0.43% in the southeast region for the period of 1992 and 2040. In addition, our forestland loss assumption in the base-line fails to take into account for the loss of hunting access due to closure of forest by private landowners. Cordell and Betz (2000) mentioned that the private forestland with access for outsiders is recently decreasing at an annual rate of 1%, as increasing numbers of landowners restrict their property. So, this scenario could approximate the effect of both of these factors (increasing conversion and restriction rates).

The final alternative, Increased Youth and Elderly (IYE) assumes a smaller growth rate among the population of age cohort that is currently positively correlated with hunting demand. Keeping everything else the same as in base-line, IYE assumes that the population of age cohort 34 to 65 would grow by half the rate in base case. The projected demand under each alternative assumption has been reported in Table 4 and compared with the projection trend from base-line in Figure 3.

Examination of projected statistics and trend line for each scenario reveals declines in hunting demand through 2030 of anywhere from less than 10% in the HPG case to almost

Table 4
Number of hunting licenses (in millions)

	2000	2005	2010	2015	2020	2025	2030
Base-line alternative	5.87	5.77	5.70	5.62	5.53	5.45	5.36
Higher population growth	5.87	5.87	5.77	5.70	5.64	5.59	5.56
Incr. minority pop. share	5.87	5.64	5.45	5.28	5.11	4.96	4.81
Faster forest loss rate	5.87	5.73	5.61	5.50	5.39	5.28	5.17
Increased youth and elderly	5.87	5.70	5.55	5.41	5.28	5.16	5.03

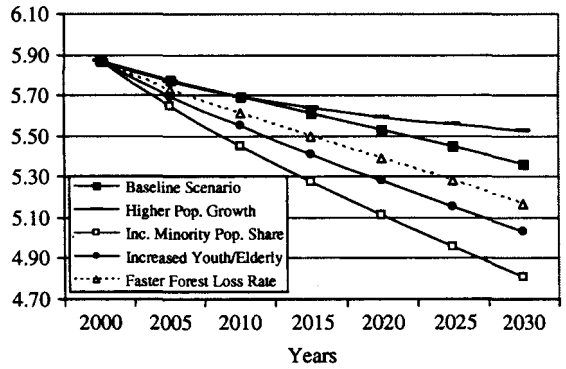

Figure 3. Demand for hunting license in millions projected under various assumptions.

20% in the IMPS alternative. The HPG scenario will decrease the region's hunting demand by about 5.3%, or about 3.7 percentage points less than the base-line drop of 9%. Under the IMPS scenario, hunting demand in the region will decrease by 18%, which is about double of the decline rate under the base-line scenario. This indicates that the demand for hunting would be sensitive to a relative decrease in white population. Importantly, this may have serious implication in the Southeast region where the Hispanic population is increasing rapidly. However, it should also be noted that this effect could be mitigated through acculturation over time.

The FFLR alternative shows a decrease in hunting demand by about 12%, which is about 4 percentage points more than the base-line scenario. This indicates that the availability and the access to the forestland will be a key issue in hunting in the Southeast. The last scenario, IYE with a slowed growth of active age cohorts (35–65) indicates that the demand for hunting will decline by about 14% out to 2030. This decline rate is 5% higher than in the base case. This is intuitive because the share of this age cohort will decline from 38% in 2000 to 27% in 2030 under this scenario, in contrast to only 30%.

Conclusion

In this article, a log-linear demand model for wildlife hunting among resident hunters of the Southeastern United States was estimated using county level data. Findings show that the sociodemographic data aggregated at county level can be combined with land use

information such as forest acres, to explain the demand for hunting. Our base-line findings indicate a likely decline in the demand for hunting licenses across the Southeast of about 9% through 2030. The results are driven by an expected per capita decline in hunting demand off-setting the projected increase in population growth. The most import factors for the per capita decline appear to be structural shifts in the population, particularly increased non-whites and an age shift.

Further, the results from this study suggest a few policy implications. First, the age and race cohorts most positively correlated with hunting participation are declining. Hence, if state agencies feel it is important to maintain hunting demand and support in the public, they will likely need to devise programs and marketing campaigns to promote awareness and encourage both younger and non-white participation.

Second, any revision of license fees should recognize the very price inelastic structure of demand among Southeastern hunters. This implies that an increase in price induces a less than proportionate decline in sales and most importantly, an increase in revenue. However, there could be spin-off effects and political ramifications involved that should be considered. More importantly, decreasing the license fee will only increase demand and participation by a less than proportional amount.

Third, agencies may consider programs that increase public hunting land. Results from our model indicate that the availability of public hunting land has a far greater impact on license sales than private land. Therefore, programs that increase public land or possibly increase public access to private land could mitigate some of the forecast decline in hunting demand. Also, promotion of gun clubs or shooting clubs may provide existing hunters a social linkage to keep up hunting companionship or to collectively bargain the lease rate for bigger private acres.

Finally, although our projections give a general picture for the region, state agencies might find the model useful to project the region-specific license demand or forecasting revenue because the model uses periodically updated census data and land resource information. In addition, the model can be extended to understand and project demand for hunting and similar consumptive outdoor activities in the South and other regions.

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