Effects of Urban Sprawl on Hunting Participation in the Southeastern United States

Neelam C. Poudyal, Seong-Hoon Cho, and Donald G. Hodges

ABSTRACT

Hunting is an important but declining activity in the Southeastern United States. Although our understanding of what causes this decline is incomplete, the period of decline coincided with rapid urbanization in the region. Urban sprawl, which is changing sociocultural traditions and leisure patterns, may be a driver in declines in hunting. Therefore, using county-level data for the Southeastern United States, we developed a log-linear demand model of hunting to estimate effects of urban sprawl on hunting. Results suggest that an increase in urban population and dispersal of low-density residential development in the wildland reduced hunting participation in the region. This implies that feasibility and effectiveness of hunting as a wildlife management tool may decrease if the current urbanization trend persists in the region. Results also suggest a need to promote hunting within urban populations and for maintaining hunting opportunities by promoting tighter management of urban sprawl to conserve huntable areas, increasing public hunting land, and possibly increasing public access to private lands.

Keywords: hunting, urban sprawl, land use change, log-linear demand, Southeastern United States, human dimensions

In the United States, over 13 million people participated in hunting and related activities in 2001, which accounted for more than $20 billion in direct expenditures (US Department of the Interior [USDI] Fish and Wildlife Service 2002). Hunters' expenditures on license fees, various equipment, transportation, and accommodations have a multiplier effect on local and regional economies (USDI Fish and Wildlife Service 2002). For example, economic impact of hunting in 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 control wildlife populations (Mehmood et al. 2003, Bhandari et al. 2006). Despite these benefits, participation in hunting has declined in recent decades (Cordell and Super 2000, Mozumder et al. 2007).

During this period of decline in hunting participation, many regions in North America have experienced dispersed land development patterns and suburban housing growth, typically referred as "urban sprawl" (Rodrigue 2006). Urban sprawl has widespread ramifications for habitat conservation and human safety. Sprawl expands land development toward suburban and rural territories, increasing wildland–urban interfaces (WUI) (USDA and USDI 2001, Alavalapati et al. 2005, Radeloff et al. 2005) and increasing human–wildlife conflict (Johnson 2001, Hussain et al. 2007). In addition, urban sprawl can affect hunting and other outdoor recreation opportunities. Sprawl, e.g., changes the sociodemographics and cultural characteristics of rural communities (Katz 2002) and introduces modern indoor recreational opportunities that can eventually replace traditional outdoor activities (Brown et al. 2000). In addition, urbanization causes ownership fragmentation that results in smaller tracts of land, in which hunting potential may be limited. Similarly, hunters may need to travel farther to find hunting areas, thereby adding to their hunting costs.

A number of studies have assessed demand for hunting licenses (Heberlein and Thomson 1996, Teisl et al. 1999, Floyd and Lee 2002) and have revealed that declining hunting participation is related to demographic changes within the US population (i.e., "aging" and "browning") and losing accessibility to hunting areas (Mehmood et al. 2003, Mozumder et al. 2007, Poudyal et al. 2008). Heberlein and Ericsson (2005) found that ties to the "countryside" are major to attitudes toward hunting. Although decreased access to hunting areas is directly associated with urbanization, decline in hunting activity relative to urban sprawl has not been a focus of previous studies.

Understanding factors behind declines in hunting is important because of the ecological and economic impact that the decline could cause. Hunting serves as a management tool to maintain wildlife populations within ecological and social carrying capacities. Sales of hunting license generate substantial revenue for conservation agencies (Floyd and Lee 2002). In addition, hunting-related business has a multiplier effect in rural local economies (International Association of Fish and Wildlife Agencies 2002). Therefore, our objective was to analyze effects of urban sprawl on hunting activity in the Southeastern United States, using a data set of county-level license sales for the year 2000. Our primary purpose was to isolate and estimate the effect of urban sprawl on hunting demand. The Southeastern United States was selected for the study because (1) hunting is one of the major consumptive outdoor recreation activities in this region (Lamar and Donnell 1987), (2) the region is one of the fastest growing areas in the nation in terms of urban development (Reynolds 2001), and (3) 8 of the nation's 20 most

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Table 1. Variables used to understand impact of urban sprawl on hunting participation in 2000 in the Southeastern United States.

Variable	Impact on hunting demand	Statistical significance (*P*-value)
Urban sprawl variables		
Urban population: Proportion of urban population in the total population of county in 2000	−	0.01
Mean travel time to work: Average commute time to work in minutes in county in 2000	−	<0.01
WUI: Percentage of county land classified as WUI in 2000	−	<0.01
Private forest ownership size: Average size of private forestlands in 100 ac in county in 2000	NS	0.17
Sociodemographic, ecological, and institutional variables		
License fee: Per hunter capita expenditure in dollars on license fee in the state in 2000	NS	0.90
Population: County total population in 2000	+	<0.01
Age 16—65 yr: Percentage of county population aged 16 to 65 yr in 2000	NS	0.88
Below high school: People with less than 9 yr of schooling as a percentage of county population in 2000	+	0.02
College graduate: College graduates as a percentage of county population in 2000	−	<0.01
Caucasian: White population as a percentage of county total in 2000	+	<0.01
Employment: Percentage of people in the county holding full-time jobs in 2000	−	<0.01
Per capita income: Median per capita income in dollars of the county residents in 2000	+	<0.01
Single parent households: Households with underage children but single parent as a percentage of total county households in 2000	NS	0.43
Public forest: Public forest area within 100-mi radius buffer around county as a percentage of total in-state area within the buffer in 1998	+	0.00
Private forest: Private forest area within100-mi radius buffer around the county as a percentage of total in-state area within the buffer in 1998	+	0.00
Wetland: Wetland area within100-mi radius buffer around county as a percentage of total in-state area within the buffer in 1998	−	0.02
Gun club dummy: Binary variable, 1 if county has gun club in 1998, 0 otherwise	+	0.00
Amusement: Number of outdoor amusement and sports attractions in the county in 1998	NS	0.06

NS, not significant effect; −, negative effect; +, positive effect.

sprawling metropolitan areas in 2000 were located in this region (Yin and Sun 2007).

Methods

Model

Extending the hunting demand model by Teisl et al. (1999) and Sun et al. (2005), demand for hunting can be expressed as

$$\ln Y = \beta_0 + \sum_k \beta_k X + \varepsilon, \quad (1)$$

where, ln Y is an $N \times 1$ vector of the natural logarithm of number of licenses sold in counties and X is an $N \times K$ matrix of variables explaining sociodemographic, ecological, and urbanization characteristics of the county. The last term ε is an $N \times 1$ vector of random errors. Because our focus was effect of urban sprawl on overall hunting demand, we included all types of resident licenses sold in the county to obtain number of hunting licenses sold.

Because our model had heteroscedasticity ($\chi^2_{169} = 416.1$; $P \leq 0.001$), a feasible generalized least square (FGLS) method (Greene 2003) was adopted. Using FGLS, we estimated parameters with the equation,

$$\hat{\beta} = (X'\hat{\Omega}^{-1}X)^{-1}X'\hat{\Omega}^{-1} \ln Y, \quad (2)$$

where Ω is an $N \times N$ diagonal matrix of error terms. The estimated error variance and detailed specification of the FGLS model are discussed by Greene (2003, p. 209). Variance inflation factors were estimated to detect multicollinearity (Greene 2003) among variables included in the model.

Data Sources, Variables, and Study Area

The model assumed that log of quantity of hunting licenses issued in a county is a function of sociodemographic, ecological, and institutional variables (Table 1) that have been used in previous studies (Heberlein and Thomson 1996, Floyd and Lee 2002, Mehmood et al. 2003). State offices responsible for hunting license sales maintain license sales records at the county level. We summed county-level sales data for all types of resident hunting permits in 2000 and calculated the natural logarithm to derive dependent variables (i.e., natural log of resident license sold in the county). Details on explanatory variables are presented later.

Urban Sprawl Variables

We used the county proportion of urban population, mean travel time to work, percentage of WUI area, and average ownership size of private forestland to measure aspects of urban sprawl. County share of urban population is commonly used to estimate degree of urbanization (e.g., Applegate et al. 1984, Brown et al. 2000). Urban and total population of each county was obtained from US Census data set (US Census Bureau 2000). Also obtained from this source was mean travel time to work, which defines accessibility to economic opportunities for county residents. We included this because it determines spatial pattern of employment and intensity of development (Gordon et al. 1989, Song 1996, Bento et al. 2005). Land with a housing density of 6.17 or more per square kilometer and with 50% or less area covered by wildland vegetation has been classified as WUI (USDA and USDI 2001). We obtained proportion of county land in the WUI from Wildland Urban Interface Project 2000 (Radeloff et al. 2005). WIU data are readily available at the county level and have already been used by Haight et al. (2004), Hammer et al. (2005), and Stewart et al. (2007). We obtained mean size of private forestland from the National Agriculture Census of 2002 (National Agricultural Statistical Service 2002), which maintains the number of forest owners and total forestland under private ownership. We included this because urban sprawl can cause ownership fragmentation, which leads to smaller forest tract size in which hunting may no longer be feasible.

Socioeconomic, Ecological, and Institutional Variables

There is no unitary hunting license fee available because different states issue various types of licenses. Because license fees are fixed at

the state level, we used state fees to estimate effect of license fees on hunting demand at the county level. The US Fish and Wildlife Service (2003) maintains state level annual uniform records of certified hunters and their expenditures on license fees. Using this data set, we represented license fees by per capita hunter expenditure on licenses, which was statewide resident license sales divided by number of resident hunters. This is not an exact measure of license price but it does capture variation in license prices among states and is likely the best proxy available. We included the license fee variable because price is an essential component of a recreation demand model (Walsh et al. 1992).

We obtained data on sociodemographic and economic variables from the US Census Bureau (2000). We used total population, age, education, race, employment, per capita income, and family status to control for tastes and preferences of people. We used the natural log of county population to minimize outlier effects of large variations in county population (Teisl et al. 1999). We created an age 16- to 65-year variable to represent percentage of total county population comprised of residents between the ages of 16 and 65 years. We selected this particular age group because most of the hunters begin hunting at the age of 16 years (Heberlein and Thomson 1996) whereas people in age cohort of 65 years and older are less likely to hunt (Schole 1973, Manfredo and Zinn 1996). We also included percent of county residents with less than a high school education and percent of those with at least a college degree. We included percentage of white people in the total county population in the model based on Floyd and Lee (2002). We included percentage of full-time employed individuals to capture effect of employment status, and we used the median per capita income to estimate effect of economic prosperity on hunting. We hypothesized that counties with larger percentages of people with full-time employment or higher education would be less likely to hunt, but those with higher incomes would be more likely. We also included percentage of single-parent households to allow for differing parental responsibilities, which can affect time available for hunting (Mehmood et al. 2003).

Ecological and institutional variables included percentage of public and private forests, percentage of wetland, presence of a gun club, and number of outdoor amusement and sports attractions. We obtained data for those variables from the National Outdoor Recreation Supply Information System (NORSIS; Cordell and Betz 1997). Using these data, we created a 100-mi radius buffer around the county and measured availability of public forest, private forest, and wetland as a percentage of total in-state area within that buffer. We limited the buffer to within the state only because resident hunting permits are not valid outside the state of residence. We hypothesized that the larger the percentage of these land cover types within the buffer, the more hunting opportunities there are in a reasonable travel distance from the county. We created a dummy variable to indicate whether or not a gun club was present in the county. Including presence/absence of gun clubs within a county allows for possible effect that sports shooting may have on hunting. Number of amusement and sports attraction at the county level was available in the NORSIS data set and we included this variable in our demand model to control for possible substitute/complementary effects for hunting.

We included counties from 10 Southeastern States (Alabama, Georgia, North Carolina, South Carolina, Tennessee, Virginia, Kentucky, Arkansas, Louisiana, and Texas). We excluded three counties in Georgia and Texas because of no sales records. We also excluded all counties in Florida and Mississippi because these states did not have county-level sales records available for 2000. We used 1,066 counties and excluded 197.

Results and Discussion

Estimates from the FGLS model reveal that 14 of 18 variables were statistically significant ($P \leq 0.05$) and consistent with the extant literature (Table 1). Details of regression results are shown in the Appendix (Table A1). The adjusted R^2 of 0.84 reveals that the hunting demand model provided a reasonably good fit of the data.

Urban Sprawl Variables

All urban sprawl variables were significant ($P \leq 0.05$), indicating importance of sprawl factors on hunting demand. An increase of 1% in proportion of urban population by itself decreased hunting demand by 12% at the county level. This relatively large elasticity is consistent with results of Applegate et al. (1984) and Brown et al. (2000) that urbanization is the greatest demographic threat constraining participation in hunting in the United States. These results also corroborate the finding by Heberlein and Ericson (2005) that an individual's demand for hunting greatly depends on whether or not he or she grew up in a rural setting. The negative coefficient of urban population is consistent with previous studies and indicates that the urban share of total county population significantly reduces demand for hunting (Manfredo and Zinn 1996, Heberlein and Thomson 1996, Brown et al. 2000). Exposure to alternative modern indoor leisure activities, such as school sports, television shows, theaters, and electronic media, might have reduced public interest on hunting in urban areas (Brown et al. 2000). Another reason for the negative effect of the urban population share may be that increasing civil and animal rights advocacy could convince more urban than rural residents not to hunt (Brown et al. 2000, Campbell and Mackay 2003, Heberlein and Ericson 2005). Additionally, individuals who moved to urban areas may no longer hunt and therefore are not passing on hunting to their children (Purdy et al. 1989, Brown et al. 2000).

The coefficient of commute time was negative ($P \leq 0.01$), with an estimated marginal effect that a 1-minute increase in average commute time to work decreases demand for hunting in the county by 1.02%. This is consistent with Willett (2002), who concluded longer commute times substantially reduced time spent with family and in other leisure activities. To the extent that increased commuting time is associated with increased travel time to any location, this variable incorporates an additional impact that discourages hunting. This implies that availability of time adversely impacts popularity of consumptive outdoor recreation in urbanizing landscapes. The WUI coefficient was negative ($P \leq 0.01$), indicating that an increase in urban sprawl significantly decreased participation in hunting. An increase of 1% in the area of WUI is estimated to decrease demand for hunting by 2.6%. This implies that sprawl development constrains hunting demand as a result of the decline of huntable land and habitat fragmentation. This result may be explained in part by "leap-frog" development patterns associated with urban sprawl, leading to increased WUI. This is consistent with studies, which found that suburban development and fragmentation of rural forestlands have substantially decreased the feasible hunting areas (e.g., Brown et al. 2000, Jagnow et al. 2006). Moreover, these factors can sometimes favor habitat for early successional species, in which their population growth, if not hunted, is likely to result in nuisance wildlife problems. Average ownership size of private forestlands did

not have a significant ($P = 0.17$) effect on hunting demand. This might be explained by the fact that ownership size that is based on parcel size may not capture the actual size of the forest tracts in the parcel, which might have more relevance in explaining hunting opportunities. Although data on mean size of private forest tracts are not available at a county level, we believe that our WUI variable and forest variables take into account any effects that average forest tract size may have on hunting.

Socioeconomic, Ecological, and Institutional Variables

License fee was found to have an insignificant effect ($P = 0.90$) on license demand (Table 1), which may be explained by the fact that license fees comprise a negligible share of total expense for hunting. This is consistent with Teisl et al. (1999) and Sun et al. (2005) who concluded that resident hunting demand is price inelastic. The coefficient for the log of total population was positive and significant ($P \leq 0.01$), and the elasticity estimate (Table A1) indicated that a 1% increase in county population increased demand for hunting by 0.81%. As expected, the coefficient for white population was positive ($P \leq 0.01$), which is in agreement with Floyd and Lee (2002). Percentage of the county population between 16 and 65 years was not significant ($P = 0.88$), however. Distribution of this particular age group may not have possessed significant variation in the study area. A test of variance estimate also supported this speculation (F-statistic = 0.01; $P = 0.92$). Counties with higher proportions of their populations with full-time jobs had smaller hunting demand ($P \leq 0.01$). Percentage of households with single parents was not significant ($P = 0.43$). The coefficient of per capita income was positive ($P \leq 0.01$). The estimated income elasticity of 1.03 suggests that a 1% increase in per capita county income increases the demand for hunting by 1%. This income elasticity is similar to income elasticity among Maine residential hunters (Teisl et al. 1999).

Our results indicate that education level of residents also affects demand for hunting, with people with less education being more likely to hunt. This may be explained by the fact that hunting is a part of culture and tradition in rural areas in the Southeast, where the average level of education is lower than in urban areas. The negative effect of higher education level may be also attributed to the larger opportunity cost of time for physical and time-consuming outdoor trips. Variables capturing proportion of public and private forests were positive and significant ($P \leq 0.01$). Thus, proximity and availability of forest areas increased demand for hunting. Comparing estimated marginal effects of two different forest types revealed that availability of public forestland could have a larger effect than private forestland. This may be caused by the fact that hunting in private forests often involves an extra cost of leasing, potential liability, and other legal costs (Mozumder et al. 2007). Effect of wetland availability was significant ($P \leq 0.05$) but had unexpected sign. However, the effect of wetland availability could be positive for other consumptive outdoor recreation such as fishing and boating. As expected, presence of gun clubs in the county had a positive effect ($P \leq 0.01$), supporting the argument of Green et al. (2004) that membership in such clubs generates social capital and increases hunters' welfare. Availability of alternative outdoor amusement activities did not have a significant effect ($P = 0.06$) on demand for hunting.

Conclusions

Our results reveal that sprawl development and associated urban influences constrain hunting demand. In particular, urbanization of the population and loss of habitat and hunting ground due to increase in WUI area is deterring hunting in the region. An implication for forest and wildlife managers is that feasibility and effectiveness of hunting as a wildlife management tool may decrease in the future, if the current urbanization trend persists. If hunting participation decreases, one of the most significant nontimber benefits from forestlands (i.e., lease hunting) may be limited. Moreover, loss of license revenue will further constrain operating budgets and conservation efforts of state agencies. As the urban proportion of the US population is likely to grow further in the future, efforts could be directed toward encouraging hunting among urban residents. Also, because decline in hunting is likely to be mitigated by sprawl management, conserving natural areas and discouraging sprawl-like development may be needed to maintain hunting.

Forestland needs to be protected from urban sprawl because rural areas and forest in the region are being converted to WUI zones at unprecedented rates (Cordell and Macie 2002), and our analysis shows that an increase in WUI areas and loss of hunting ground in forestland can significantly affect hunting demand, regardless of landownership. Although local governments are unlikely to support policies that discourage development, providing landowners compensation for easements would motivate some to resist market demand for their property to be developed. Specifically, promoting smart growth efforts to increase housing density and decrease forest fragmentation may help preserve hunting opportunities in urbanizing neighborhoods. Comprehensive land-use plans, along with incentives that reduce landowners' property tax burdens, might be needed to slow down sprawl and preserve habitat, where opportunities may exist for hunting and other outdoor activities. Forest managers and planners working in WUI areas could encourage and assist nonindustrial private forest landowners to pursue lease hunting, which could be helpful in increasing public access to private lands that currently are unavailable. State agencies may see benefits in increasing public hunting land, because our model indicates a far greater effect of public land on license sales compared with private land.

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Appendix

Table A1. Results of feasible generalized least square regression of demand for resident wildlife hunting against urban sprawl, socio-economic, ecological, and institutional factors in the Southeastern United States, 2000.

Variable	Parameters	VIF[a]
Intercept	−10.549[b] (1.901)	—
Urban sprawl variables		
Urban population	−0.145[c] (0.061)	1.139
Mean travel time to work	−0.010[b] (0.003)	1.399
Wildland–urban interface	−0.026[b] (0.006)	3.485
Private forest ownership size	−0.022 (0.016)	1.393
Sociodemographic, ecological, and institutional variables		
License fee	−0.000 (0.007)	1.241
ln (population)	0.813[b] (0.019)	3.048
Age 16–65 yr	−0.000 (0.006)	2.400
Below high school	0.017[b] (0.007)	3.229
College graduate	−0.045[b] (0.006)	5.076
White population	0.011[b] (0.001)	3.308
Employment	−0.012[b] (0.003)	3.059
ln (per capita income)	1.047[b] (0.202)	7.143
Single-parent households	0.002 (0.002)	1.323
Public forest	0.023[b] (0.005)	4.383
Private forest	0.005[b] (0.001)	1.949
Wetland	−0.014[c] (0.006)	2.775
Gun club dummy	0.483[b] (0.074)	1.628
Amusement	0.004 (0.002)	4.999
Adj. R^2	0.84	
F-statistic	318.52[b]	
Number of observations	1,066	

[a]Variables with variance inflation factor values exceeding 10 induce multicollinearity.
[b]Significance of parameters at 1% level. The numbers in parentheses are the standard errors.
[c]Significance of the parameters at 5. The numbers in parenthesis are the standard errors.