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Deer–human conflict and hunter access in an exurban landscape

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Abstract: Exurban development (non-metropolitan, residential development) poses unique challenges for wildlife managers through increases in human–wildlife interactions. However, little is known about hunting activity and human attitudes toward white-tailed deer (*Odocoileus virginianus*) in exurban areas. In 2004, we surveyed exurbanites near Carbondale, Illinois, regarding their experiences with and attitudes toward deer, whose population in the study area was at or above cultural carrying capacity. Deer–vehicle collisions (DVC) were common and a concern for most respondents (84%). However, DVCs were less influential than plant damage in determining landowner tolerance of deer. Only 19% of respondents allowed hunting on their property, and this reluctance resulted in substantial amounts of habitat acting as a *de facto* refuge for deer. Due to the closure of land to hunting, traditional deer management alone is not likely to control deer populations in exurban areas without significant outreach and education programs aimed at both increasing hunter recruitment and retention and encouraging more landowners to allow hunting.

Key words: deer–human conflict, deer–vehicle collision, exurban development, human–wildlife conflicts, hunter access, *Odocoileus virginianus*, white-tailed deer

Mediating human–wildlife conflicts has become an integral component of contemporary wildlife management, and much of that conflict in the United States has involved white-tailed deer (*Odocoileus virginianus*) due to their ability to thrive in human-dominated landscapes, economic importance, damage and disease concerns, high visibility, and charisma (Conover 1997). Deer management is often contentious, as stakeholder groups with diametrically opposed viewpoints demand recognition. Managers must have reliable information regarding human attitudes towards deer and deer management to properly manage deer, and much research has been conducted to this end in both suburban (Decker and Gavin 1987; Cornicelli et al. 1993; Stout et al. 1997*a*, 1997*b*) and rural (Brown et al. 1978, West and Parkhurst 2002) areas. However, we know little about the attitudes of inhabitants of exurbia, a type of residential development with a rate of human population increase that exceeds all other development types (Nelson and Sanchez 2005).

Exurbia is a residential land-use that occurs outside city limits and situated among working farms or undeveloped land where human population density and average property size are intermediate between the suburbs and rural areas (Nelson 1992). There is some disagreement about how to define exurban areas; some researchers in the field of urban planning have done so at the county scale, designating counties as exurban if they fall within commuting distance of major metropolitan areas (Morrill 1992). Others define exurbia in terms of population density and property size (Theobald 2004). Property size within exurbia varies considerably from 1 unit/4–16 ha (Theobald 2001).

An estimated 10 million people were added to exurbia in the United States during the 1990s, more than that of urban, suburban, or rural landscapes (Nelson and Sanchez 2005). The expansion of exurbia has largely resulted from increased human populations and a desire by many people to live in a more rural setting (Nelson 1992). Exurban development has been facilitated by improved transportation infrastructure and modern technology that have

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allowed people to live farther away from urban centers without sacrificing amenities (Nelson 1992). Exurbanites tend to be former urbanites and suburbanites who have moved to the exurbs to escape the noise, crowding, and crime found in cities (Davis et al. 1994). Exurbanites and suburbanites share many similarities including average household income levels and the tendency to work in metropolitan areas (Davis et al. 1994, Crump 2003). However, exurbanites differ most from suburbanites in their desire for large lot sizes and a rural environment and their greater willingness to commute to work (Davis et al. 1994, Crump 2003). Newcomers to exurbia are more likely to be younger and more educated than those in farm households (Smith and Sharp 2005).

Although exurbanites and suburbanites have much in common, differences in housing location preferences between exurbanites and suburbanites may be accompanied by differences in wildlife-related values, attitudes, and beliefs. Even if no such differences exist between exurbanites and suburbanites, they may have different expectations for wildlife populations in their respective areas. For instance, suburbanites might not necessarily dislike deer, but they believe that deer do not belong in the city. Conversely, exurbanites often consider themselves rural citizens and may think it natural and desirable to have deer on their property. Because of the potential differences between exurbanites and suburbanites, predictions made about the beliefs and attitudes of exurbanites towards deer and deer management based on studies conducted on suburban and rural residents may not be warranted.

Although hunting is generally legal in exurbia, exurban development reduces deer harvest efficiency (defined as the proportion of the deer population harvest per permit issued) at the county level in Illinois (Harden et al. 2005). This reduction in harvest efficiency may be due to hunter exclusion zones, which preclude hunting within a certain distance of an occupied dwelling without the occupants' permission (Harden et al. 2005). In Illinois, exclusion zones have radii of 274 m and 91 m for firearm and archery deer hunting, respectively (Illinois Department of Natural Resources 2002), and 31% of Illinois (excluding the 4 Chicago metropolitan counties) falls within the 274-m exclusion zone. Exclusion zones may provide refuge to deer during the hunting season. It is unknown, however, to what extent exclusion zones are enforced or what proportion of landowners is even aware of them. Alternatively, the county level reduction in harvest efficiency (Harden et al. 2005) could also be due to the closure of land to hunting, regardless of hunter exclusion zones. Knowing the extent to which exurban development reduces hunting is critical to wildlife managers, given that hunter harvest is the primary means of deer population management.

The juxtaposition of wildlife habitat and human development in exurbia facilitates frequent contact between wildlife and humans. Given exurban growth rates and an increasing potential for human–wildlife conflict, exurbanites will be an increasingly important stakeholder group. Lack of adequate information on human–wildlife conflict (e.g., rates of deer–vehicle collisions [DVCs] and plant damage) in exurbia may limit the ability of wildlife managers to meet the challenges that exurban development may pose. The goal of our study was to understand attitudes and beliefs of exurbanites toward deer near Carbondale, Illinois. These data, along with knowledge of hunting activity in the exurbs, will help prepare wildlife managers to anticipate and proactively address deer–human conflict in exurbia.

Study area

Our study was conducted immediately southeast of Carbondale, Illinois, in Jackson and Williamson counties. The study area boundary was established by using a buffered (200 m) minimum convex polygon (Mohr 1947) derived from telemetry locations of 37 radiocollared deer (Storm 2005). The study area was comprised of 6 cover types: forest (59%), grassland (25%), cropland (11%), old field (3%), wetland (1%), and urban (1%). Dwellings within the study area had a clumped distribution and a density of approximately 20 dwellings/km^2. Property sizes were highly variable (range <0.5 ha to >120 ha) with most properties <10 ha.

Methods

This survey was part of a larger project that examined deer space-use and vulnerability to harvest in an exurban landscape (Storm 2005). Therefore, we attempted to survey every household that was visited by radio-collared deer to determine the hunting status (e.g., whether hunting was allowed and which type of harvest) of each property. Study area residents (n = 159) were generally identified by plat map. We used a modification of the Total Design Method (Dillman 1978) to survey inhabitants of the study area. Surveys were mailed with a cover letter that explained project goals. Nonrespondents were sent a postcard reminder after 2 weeks, and a second survey was sent 4 weeks after the first mailing. Survey methods were approved by the Human Subjects Committee at Southern Illinois University Car-bondale (protocol #04263).

We queried study area residents regarding their exper-iences with deer (i.e., deer sightings, plant damage, DVCs), their attitudes towards deer, concerns about deer, and their preferences for deer population

trends. We included some of the same questions Cornicelli et al. (1993) used in their survey of Carbondale, Illinois, residents to allow comparison between sub-urbanites and exurbanites who reside in the same region. We also asked residents questions regarding deer hunting on their property and their awareness and enforcement of the 274-m (firearm) and 91-m (archery) hunter exclusion zones (Illinois Department of Natural Resour-ces 2002).

Percent response for each question was calculated. We used the likelihood ratio test (Zar 1996) to determine: (1) if those who had someone in their household involved in a DVC were more likely to desire a deer population reduction than people who had no one in their household in-volved in a DVC, (2) whether people with concerns about deer damaging their plants and DVCs differed from others in their desire for a particular deer population trend, and (3) whether people were more aware of the 274-m versus 91-m hunter exclusion zones. We considered differences significant when $P < 0.05$.

Results

The survey response rate was 76% (121 out of 159). Respondents resided on the study area an average of 12.4 years (SE = 1.2). Most respondents (77%) observed deer on their property often, 22% saw deer on their property occasionally, and 1% never observed deer. Fifty-eight percent of respondents believed the deer population had increased since they moved to the property, 31% believed deer numbers had remained the same, 5% thought the population had declined, and 6% were unsure. Ninety-eight percent of respondents had ≥1 type of vegetation planting: 86% had flowers, 79% shrubs, 40% vegetable garden, 38% fruit trees, and 7% cash crops. Eighty-two percent of respondents who grew plants believed they had incurred damage from deer, although only 11% considered it intolerable. Fifty-two percent of respondents indicated that either they or an immediate family member had been in a DVC. Deer–vehicle collisions were chief among concerns that study area residents had about deer (82%; Figure 1).

Thirty-nine percent of survey respondents listed DVCs as their only concern. Damage to plantings (35%) was also a common concern of respondents. Concerns about zoonotic diseases caused by deer and ornamental plant damage by deer were less common (23% and 11%, respectively). Ninety-five percent of respondents either enjoyed having deer in their area or enjoyed deer but had concerns about them (Figure 3). Forty percent of respondents wanted a decrease in deer numbers, 47% wanted no change, and 13% wanted the deer population to increase (Figure 2).

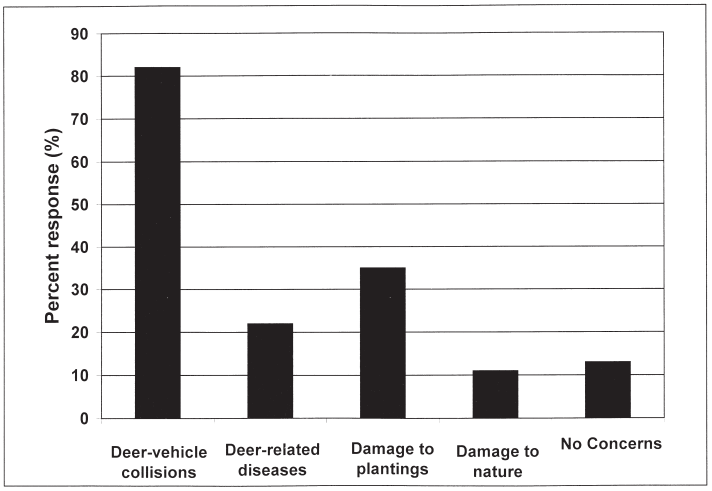

Figure 1. Deer-related concerns of exurbanites near Carbondale, Illinois, taken from a 2004 survey of exurbanite attitudes about deer and preferences for deer population trend.

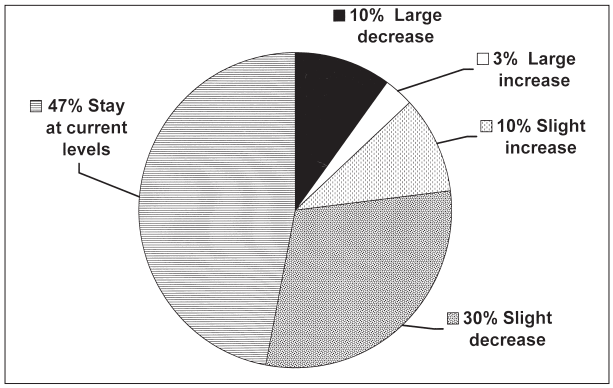

Figure 2. Desired deer population trend of exurbanites near Carbondale, Illinois, taken from a 2004 survey of exurbanite attitudes about deer and preferences for deer population trend.

Respondents who had plant damage concerns were more likely to prefer a decrease in the deer population than those whose only concern was DVCs (65% vs. 25%; $G = 15.3$, $P < 0.001$). Respondents who had someone in their household involved in a DVC were no more likely to desire a population decrease than those who had not (48% vs. 38%; $G = 1.4$, $P = 0.499$).

Only 19% of respondents allowed deer hunting on their property. Of those who did, 87%

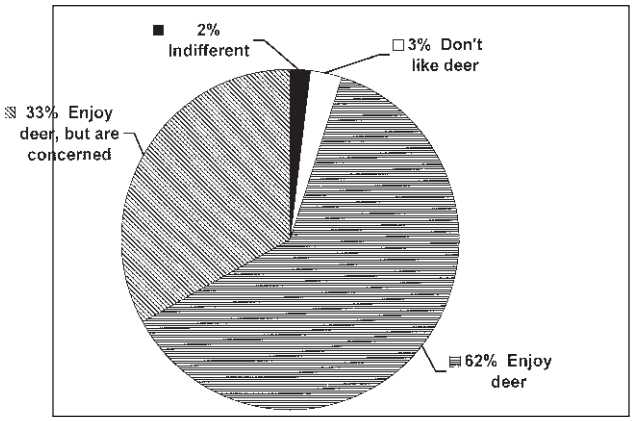

Figure 2. Percent response to the question, "How do you feel about having deer in your area?" by study area residents in exurban Carbondale, Illinois, taken from a 2004 survey of exurbanite attitudes about deer and preferences for deer population trend.

allowed bow hunting, 52% shotgun hunting, 9% muzzleloader hunting, and 4% handgun hunting. On 30% of hunted properties, 1 bow hunter constituted all of the hunting that took place. More people were aware of the 274-m hunter exclusion zone than the 91-m hunter exclusion zone (41% vs. 24%; $G = 8.5$, $P = 0.004$).

Discussion

This study is the first to explicitly examine the deer-related attitudes and experiences of exurbanites. Our results differ in some ways from those of Cornicelli et al. (1993), who surveyed residents of the nearby city of Carbondale, Illinois, in 1990. Comparison of raw percentages revealed that perception of deer use of residential property was much greater in the exurban study area than in Carbondale (99% of exurbanites seeing deer on their property versus 36% of suburbanites seeing deer or evidence of deer on their property; Cornicelli et al. 1993). More exurbanites than Carbondale suburbanites reported plant damage (82% of exurbanites with plants on their property sustaining damage versus 50% of suburbanites who observed deer; Cornicelli et al. 1993). Not surprisingly, a greater proportion of exurbanites than suburbanites expressed concern about plant damage (35% vs. 18%, respectively; Cornicelli et al. 1993). Furthermore, a greater percentage of exurbanites in our study reported plant damage than did urbanites and suburbanites in Missouri (4–34%; Stout et al. 1997a) and homeowners in Virginia (36%; West and Parkhurst 2002). Exurbanites were also more likely to report involvement in DVCs (50%) than Missouri urbanites and suburbanites (8–15%; Stout et al. 1997a) and residents of New York State (28%; Stout et al. 1993). The proportion of exurbanites and Carbondale suburbanites concerned with DVCs appeared similar (82% versus 75%; Cornicelli et al. 1993).

Fewer Carbondale suburbanites (78%) than exurbanites (95%) enjoyed deer in their area, and more suburbanites were either indifferent about deer or disliked them (22% versus 5%; Cornicelli et al. 1993). Despite this, suburbanites were somewhat less likely to want a reduction in the deer population than were exurbanites. It may seem counterintuitive that the people who enjoyed deer more would also be more likely to desire a population decrease. However, the proportion of residents with concerns about plant damage was nearly double among exurbanites and may account for the difference. Prior experience with and concerns regarding deer-caused plant damage are major determinants of tolerance of deer (Decker and Gavin 1987, West and Parkhurst 2002). Similar to our study, Decker and Gavin (1987) reported that people who listed plant damage as their primary concern were more likely to desire a population decrease than those who held DVCs as their primary concern. Stout et al. (1997*a*) also reported that those in a community sustaining significant plant damage but with relatively few DVCs were more likely to desire a population decrease than those in a community with less plant damage and higher numbers of DVCs. Stout et al. (1997*a*) proposed that people were more tolerant of DVCs than plant damage because DVCs involve a certain amount of chance, whereas plant damage is seen as an act of invasion by deer. Also, people may consider the vehicle driver to be at least partially at fault in a DVC because they may be driving too fast or not paying attention, whereas few would assign blame to a landowner whose plants are eaten.

The discrepancy in experiences, attitudes, and desired deer population trend between exurbanites and suburbanites could also result from differences in how deer use exurban and suburban areas. In suburban areas, many residential properties represent nonhabitat or foraging habitat (Cornicelli et al. 1993). Thus, deer use of residential property is often a result of deer infiltrating from parks and undeveloped areas into adjacent residential areas to forage (Grund et al. 2002). Exurban properties are generally larger than suburban properties

(Nelson 1992) and often contain higher quality deer habitat; thus, most exurban deer spend their entire lives on private properties and may be a more constant presence. Differences in perception of deer use between suburban and exurban residences could also be due to differences in deer density; however, we lack explicit estimates of deer density data in exurban versus suburban Carbondale.

The lack of hunting on our study area was surprising and, if representative, is likely driving the decrease in county-level harvest efficiency occurring in Illinois counties with high degrees of exurbanization (Harden et al. 2005). Approximately 75% of the study area was within the 274-m exclusion zone, indicating that exclusion zones have the potential to greatly reduce the proportion of land open to hunting in exurban areas. However, hunter exclusion zones preclude hunting only when they are enforced and when they overlap properties that would otherwise be hunted. Given that only 41% of respondents were aware of the hunter exclusion zones and only 19% of properties were hunted, hunter exclusion zones are themselves probably of little consequence to deer harvest efficiency in exurban Illinois.

We recognize that while 19% of respondents allowed hunting on their property this does not necessarily mean that 19% of the land area is being hunted. For example, if the respondents who allowed hunting owned a large proportion of the study area, then hunter harvest may still be substantial enough to control deer populations in exurbia. We did not collect property size information, so we were unable to determine the proportion of the study area that was hunted. However, concurrent research in our study area reported an 87% annual survival rate of deer and only 5 harvest-related mortalities (Storm 2005). This indirectly but clearly indicates that the proportion of land hunted was low on our study area. The survival rate of deer in our study area is high relative to most rural (Nixon et al. 1991, Brinkman et al. 2004) and even suburban (Etter et al. 2002, Porter et al. 2004) areas. The vulnerability of deer to harvest likely varied greatly on a relatively small spatial scale in the study area, and many deer, especially those living near the more heavily developed portions, occupied home ranges that encompassed no hunted properties whatsoever. Therefore, exurbia is conducive to abundant, highly visible deer populations with low annual mortality.

Although respondents overwhelmingly enjoyed having deer on their property, most either wanted the deer population to remain at its current size or decline, suggesting that it is at or above the cultural carrying capacity. It appears, then, that many of the exurbanites in our study area enjoyed having deer on their property while simultaneously desiring no further increase in deer density. The discrepancy between the high proportion of respondents who desire a stable or reduced deer population and the low proportion who allowed hunting is similar to that found in suburban areas wherein many who want fewer deer do not support lethal population reduction (Stout et al. 1997*b*).

Deer entering residential area.

In exurbia, properties can generally be hunted only if the landowner so desires. In our study, small sample size precluded an examination of why most people do not allow hunting on their property. We did find that people who were concerned about damage to plantings were more likely to desire a population reduction. Lauber and Brown (2000) reported that landowners in New York State who experienced deer-related problems were more likely to allow hunting, suggesting that as the deer population grows and more people have negative experiences with deer, they might allow hunting on their property. Because of this, one may be tempted to consider this a self-correcting problem. We would caution against this view because it is unknown whether properties will be opened up to hunting as deer become more of a nuisance. Negative experience with deer is only one of several factors that may influence hunter access decisions; others include liability and safety concerns and beliefs regarding the morality of hunting (Wright et al. 1988, Lauber and Brown 2000).

Research and management implications

Given its explosive growth, exurban development will play an ever-increasing role in deer management through decreases in hunter access and increases in deer–human interactions. Man-

agers must be aware of the exurban development in their state and its potential impact on their ability to manage deer on a landscape scale.

Our research suggests that deer in exurbia cannot be managed as they currently are in rural areas. Traditional management techniques, such as adjusting license availability to meet harvest goals, will not work in exurbia; agencies can issue as many licenses as they like, but if only 20% of the properties is open to hunting, the desired harvest cannot be achieved. Community-based management in which various stakeholders share management responsibility has been advocated as an effective means of resolving suburban deer conflict (Schusler et al. 2000). However, community-based management will not likely solve exurban deer problems because exurbanites do not exist in small, discrete communities. The spatial extent of exurbia is much greater than that of suburbia, and state wildlife agencies do not have the money or manpower to give the same amount of attention to exurban areas as they do to suburban areas. There is also the matter of jurisdiction. In suburbia, problem deer in a municipal park may be dealt with, absent the consent of everyone in the community, if a city council or task force has the authority to make a decision (Curtis and Hauber 1997). In exurbia, deer problems will exist mostly on private lands, and landowners cannot be compelled to allow hunting.

Although our research demonstrates that exurban properties can function as deer refugia and limit hunter harvest, the limited geographic area in this study hinders our ability to extrapolate this result across the landscape. Future research should focus on mapping the extent of exurbia and determining the relationship between nonmetropolitan dwelling density and the proportion of the land closed to hunting on larger scales.

Future research should also assess whether reasons for hunter access decisions made by exurbanites differ from those of rural landowners. For example, it is possible that liability concerns might be more important to farmers, whereas safety concerns might be more important to exurbanites. Knowing these differences could increase the effectiveness of education and outreach programs designed to increase hunter access by emphasizing the primary concerns of the targeted group of landowners. Even if substantial improvements could be made to improve hunter access, it remains to be seen whether hunters could be mobilized to hunt in these areas. Hunter recruitment and retention are declining throughout much of the United States (Enck et al. 1997), and a comprehensive plan to reverse this trend is necessary if hunter harvest is to remain an effective deer management tool.

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Alan Woolf (deceased) was the director of the Cooperative Wildlife Research Laboratory at Southern Illinois University–Carbondale from 1987 to 2004. He received his Ph.D. degree in wildlife science from Cornell University in 1972. During his professional career, he mentored over 75 graduate students and published over 100 scientific papers. His commitment and dedication to excellence was an inspiration to colleagues and students alike, and his lasting contributions to the wildlife profession will long be remembered and appreciated.