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Journal
Proceedings of the Vertebrate Pest Conference, 19(19)

ISSN
0507-6773

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Publication Date
2000

DOI
10.5070/V419110020

HOME RANGES AND HABITAT SELECTION OF WHITE-TAILED DEER IN A SUBURBAN NATURE AREA IN EASTERN NEBRASKA

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ABSTRACT: We evaluated the movements of 59 radio-collared female white-tailed deer (*Odocoileus virginianus*) at the Gifford Point Wildlife Management Area (GP) and Fontenelle Forest Nature Area (FF) in eastern Nebraska from 1994 to 1997. Annual home ranges averaged 276 ha (CI=166 ha). Forty-four of the deer maintained relatively small home ranges (*0*=129 ha) and resided in the GP lowlands (*n*=14), FF lowlands (*n*=11), and FF uplands-Bellevue residential area (BR) (*n*=19). Deer in the latter area were frequently observed in backyards, at deer feeders, and on city streets. Seven of the deer were transients, maintaining seasonal home ranges that varied in size and did not overlap in location. The centers of these seasonal home ranges were on average 2,430 m apart. No consistent patterns of dispersal or seasonal migration were detected. Deer response to hunter activity was highly variable. Most deer maintained relatively static home ranges before, during, and after the hunting seasons, but three deer moved over 2,000 m and established non-overlapping home ranges after the hunting seasons. Since no migration patterns were observed, we suggest that regulated hunting seasons continue in both the upland and lowland areas of GPFF, and in the open space areas of Bellevue where conditions are conducive to hunting.

KEY WORDS: habitat selection, home range, hunting, (*Odocoileus virginianus*), migration, suburban, white-tailed deer, wildlife damage management

(March 6-9, 2000, San Diego, California) Proc. 19th Vertebr. Pest Conf. (T.P. Salmon & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. 2000.

INTRODUCTION

Little is known about the behavior and spatial dynamics of deer in urban-suburban environments. The occurrence of populations of deer in these areas is a relatively new and increasingly frequent phenomenon. Overabundant deer populations in urban areas can lead to significant problems including: damage to personal property, degradation of plant communities, deer-vehicle collisions, and disease transmission. Residents of Omaha and Bellevue, Nebraska experienced such problems in the 1990s, because of a deer population increase that occurred primarily on two adjacent properties—Gifford Point Wildlife Management Area (GP), a state-owned area managed for wildlife and hunter recreation, and Fontenelle Forest (FF), a privately-owned nature area and conservation education facility that prohibited hunting for 35 years. Aerial censuses of the GPFF area in the 1960s indicated that deer were primarily distributed in the GP lowlands during winter. Local managers believed that deer migrated from the FF upland in fall and overwintered in the GP lowland areas. It appears that the deer population increased dramatically in the late 1980s, or deer shifted their movements into the wooded hills of FF and adjacent residential areas, or both. In January 1995, we estimated that the local population density was 28 deer/km^2 (VerCauteren and Hygnstrom 2000). The GP Habitat Management Preliminary Action Plan (Nebraska Game and Parks Commission (NGPC), unpubl. doc., 1990) identified a need for research to determine if deer that spend spring and summer in the previously unhunted FF uplands are available for harvest in the GP lowlands during the fall GP archery and muzzleloader seasons. Our objective was to analyze the movements and habitat selection of deer in and around GPFF, relative to seasonal change, vegetation parameters, hunting, and other human activities. Information on these factors will enable agencies and organizations to improve the timing and spatial application of deer management practices. Given the current harvest restrictions, as well as real and perceived problems caused by an overabundant deer herd, it will be necessary for associated agencies and organizations to coordinate management programs.

STUDY AREA

The study area was adjacent to the Missouri River in northeastern Sarpy County, Nebraska, bounded to the north and west by Omaha and Bellevue, Nebraska. It consisted of seven group- or publicly-owned parcels and several individually-owned residential tracts. The NGPC manages the 567 ha GP Wildlife Management Area, which is located in the forested Missouri River floodplain. A 162 ha agricultural area known as Gifford Farm (GF) is located between GP and FF. It is managed by the Educational Services Unit #3 and serves as a center for agricultural education. Corn, soybeans, and alfalfa are the primary crops raised on the area. The FF area is a 526 ha nature preserve that consists of equal proportions of forested floodplain and wooded uplands. The area is traversed by 27 km of hiking trails. Public recreation and environmental education are the primary activities on the area. Several Bellevue residential developments, individual homes, acreages, and a golf course are interspersed with the upland forest and occupy about 400 ha. The Bellevue residential (BR) area slopes westward into an urban business-industrial area that bounds the study area. In addition, we included the western edges of

Mills and Potawattamie Counties, Iowa in the study area. The primary land uses in Iowa were high-intensity agriculture and scattered municipal and residential developments.

The predominant plant communities in the study area include mature floodplain forest, forested river bluffs, upland suburban forest, and cultured turfgrass. The area also includes floodplain agricultural fields, successional grassland savannas, and old-channel wetlands. Dominant tree species in the forest communities include cottonwood (*Populus deltoides*), silver maple (*Acer saccharinum*), sycamore (*Platanus occidentalis*), and burr oak (*Quercus macrocarpa*). Predominant understory species include American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), hackberry (*Celtis occidentalis*), and ironwood (*Ostrya americana*). The ground layer is occupied by over 350 species of forbs, grasses, and sedges.

White-tailed deer were uncommon in the study area prior to 1960, but the population density reached a high of 28 deer/km^2 in 1995 (VerCauteren and Hygnstrom 2000). The overabundance of deer was largely due to high fecundity, the prohibition of hunting in FF and the adjacent BR area, the availability of agricultural crops on GF, and widespread deer feeding in the BR area. Annual deer hunting seasons were initiated on FF during fall 1996. They consist of a nine-day archery season in the FF upland area and a coinciding nine-day muzzleloader season in the FF lowland area. Deer hunting on GP was initiated in 1973, and typically consists of an annual fall 107-day archery season and a nine-day muzzleloader season. Details regarding the study area are available in Hygnstrom and VerCauteren (1999).

METHODS

We captured 99 deer from March 1995 through March 1996 with netted-cage traps, rocket nets, and remote chemical immobilization. Fifty-nine female white-tailed deer (23 adults, >12 months old; 36 juveniles, 8 to 12 months old) were equipped with radio-collars (Advanced Telemetry Systems, Isanti, Minnesota; and Wildlife Materials, Carbondale, Illinois). We located radio-marked females up to four times/week from 1 January 1995 to 31 March 1997. For each deer location, we collected two to four receiver bearings from mapped receiving sites (n=90). Bearing accuracy was ±1.9°. The mean distance from the receiver to the deer was 600 m. The average time span between bearings was 5 minutes. We omitted all locations in which bearings were taken >10 minutes apart or error polygons exceeded 2.0 ha. Fifty-six percent (n=3,665) of all deer locations were confirmed by visual observation. All methods were approved by the University of Nebraska Institutional Animal Care and Use Committee (#95-02-007).

We used Excel 5.0 (Microsoft Corporation 1997) and the Spatial Ecology Analysis System (SEAS; J. R. Cary, University of Wisconsin-Madison) to generate deer locations from the telemetry data. A covermap and deer location overlays were developed using the MIPPS Geographic Information System (Map and Image Processing System; MicroImages, Lincoln, Nebraska). We used a harmonic mean method (Dixon and Chapman 1980) to generate home range estimates from the deer locations. The mean number of locations per deer was 140 (range=40 to 234). The 95% isopleth delineated the boundary of each home range (White and Garrot 1990). We used 95% confidence intervals (CI) to report home ranges sizes and distances moved (Zar 1984).

We used the annual home ranges of the radio-marked deer to determine their general use of the study area. In addition, we subdivided the deer location data by phonological seasons (spring, summer, fall, winter) and before, during, and after hunting seasons to determine their effects on deer movements and habitat use. For each of the periods, we measured four home range characteristics: size, distance of home range center shifts, and area and percentage of home range overlap. We used adjusted t-tests without assuming equal variances to determine differences in the home range characteristics among the seasons and hunting periods. The data were independent and normally distributed, but the sample variances were not homogeneous ($F_{\text{Max } 0.05(14,11)}=7.8$). This assumption can be violated without serious risks, provided the number of cases in each treatment is the same (Hays 1963).

RESULTS AND DISCUSSION

Home Ranges

We generated 6,525 usable locations on 59 radio-marked female deer in the GPFF area. The mean annual home range size was 276 ha (range=18 to 4,265 ha, CI=166 ha). Forty-four (75%) of the 59 deer maintained relatively small ($\bar{x}$=129 ha, CI=27 ha), static home ranges, indicating that sufficient resources were available to support individual deer, at least during the short term. The home ranges of these "residents" appear to be slightly smaller at GPFF than in nearby agricultural areas in Nebraska (170 ha, VerCauteren 1993), Missouri (162 ha, Progulske and Baskett 1958), and Iowa (162 ha, Gladfelter 1978). Cornecelli (1992) and Grund (1998) have reported that the behaviors of urban and rural deer are similar, but urban deer establish much smaller home ranges. Other researchers have speculated that female white-tailed deer will not leave established home ranges even if higher quality areas are available, because of fidelity to the area and social interactions with nearby deer (Nelson and Mech 1984, 1992; Mathews and Porter 1993; McNulty et al. 1995).

Fourteen of the GPFF residents inhabited the GP lowlands, 11 occupied the FF lowlands, and 19 resided in the FF uplands and BR area. Deer in the GP lowlands were predominantly located in wooded areas, but they also frequented small openings and the GF cropland before construction of a woven-wire fence around the perimeter of the fields was completed in April 1996. Deer occupied the wooded areas of the FF lowland and frequented the adjacent grass pastures of GF. In the FF upland, deer frequented the ridges and valleys of the more remote areas, as well as areas interlaced with boardwalks and wooded hills adjacent to the BR area. Deer were frequently observed on city streets, in backyards, and at deer feeders in the BR area. Nine of the female deer used feeders daily at times that coincided with the placement of feed.

Seasonal Movements

The remaining seven radio-marked deer at GPFF were identified as "transients," based on their relatively large seasonal shifts in home range centers and low percentage overlap in seasonal home ranges. The mean dates of initiation of spring and fall dispersal were 6 May (n=6) and 11 October (n=4), respectively. Spring and summer home ranges did not overlap (0%) and the mean distance between the home range centers was 4,420 m (range=1,894 to 6,768 m). Summer and fall home ranges did not overlap (0%), and the mean distance between home range centers was 2,430 m (range=1,879 to 3,196 m). Annual home ranges (0=1,117 ha, range = 315 to 4,265 ha) of transients were three to six times larger than the home ranges of resident deer. Spring movements have been reported to occur in <30% of female deer in mid-latitudes (35° to 45°) (Gladfelter 1978; Zwank et al. 1979; Nixon et al. 1991). Transient females dispersed much farther at the DeSoto National Wildlife Refuge (DNWR) in eastern Nebraska, (0=28.5 km, range=3 to 87 km, VerCauteren 1998) than they did at GPFF. It appears that the urban area of Bellevue and Omaha is a more significant barrier to deer movements than the Missouri River or the large agricultural fields adjacent to DNWR.

In the 1960s and 1970s, aerial surveys conducted by NGPC biologists indicated that deer moved out of the upland areas and congregated in stands of cottonwoods on GP lowlands after heavy snowfalls. Deer were rarely seen in the FF lowlands or uplands during winter. For several years NGPC biologists speculated that the deer population in the FF upland could be controlled incidentally by hunts conducted on GP because deer routinely migrated from the FF upland to overwinter in the GP lowland. In the 1980s, however, deer were observed with increasing frequency throughout the year in the FF upland and BR area. More recent deer feeding activities by Bellevue residents led to the speculation that deer had lost their migratory behavior and were staying in the uplands throughout the year. We examined the home ranges of 13 radio-marked deer that occupied the FF upland-BR area during winter and nonwinter periods and found no evidence of a migratory pattern. Seven deer were residents of the FF upland throughout the winters of 1995-96 and 1996-97. Three deer were residents though the winter of 1995-96 and three were captured early in the spring of 1996 and stayed through the winter of 1996-97. The sizes of the winter and non-winter home ranges for the FF upland deer during 1995 and 1996 were similar (P=0.78), as were the distances between centers (P=0.55) and the percentage overlaps (P=0.12) of the seasonal home ranges. Seventy-five percent of the deer in the study area were residents, and thus maintained a high degree of fidelity to their relatively small home ranges in the GP lowland, FF lowland, and FF upland-BR areas. Therefore, hunting in the GP lowland area alone would not be an effective means of controlling the deer population in the FF upland and BR areas.

Effects of Hunting

In general, the effects of hunting activity on deer home ranges were minimal, but highly variable. Most deer (59%, n=34) maintained a high degree of fidelity to their original home ranges, whether exposed to muzzleloader or archery hunting activities. Deer in the GP lowlands appeared to shift greater distances than deer in the FF area (0=667 m versus 0=231 m, respectively), and three GP deer completely abandoned their pre-hunt home ranges. Deer in the GP lowlands experience little interaction with humans until the fall hunting seasons begin, and contacts with hunters are likely to stimulate a significant avoidance response. In contrast, deer in FF are exposed to a high level of human activity (hikers, boardwalk visitors, school groups) and are regularly fed in the BR area. As a result, many of the deer in the FF upland and BR area have acclimated to the presence of nonthreatening humans.

MANAGEMENT IMPLICATIONS

Knowledge of the movements of individual animals can facilitate population management. Seventy-five percent of the radio-marked female deer in this study were residents of the GPFF area. Emigration rates were low, even at relatively high deer densities. Therefore, mortality will likely have to increase to maintain deer at a level that is conducive to land management objectives. Deer used the upland forest and adjacent residential area of Bellevue year-round. No migratory patterns were detected in deer using the FF upland-BR area. Therefore, deer using the upland areas are not susceptible to public hunting activities occurring on GF or the GP lowland area. Recent hunting seasons in GP and FF effectively reduced deer densities from 28 deer/km^2 in 1995 to 14 deer/km^2 in 1998 (VerCauteren and Hygnstrom 2000). We recommend that regulated hunting seasons be continued in the FF upland and expanded to include the adjacent residential open spaces of Bellevue where conditions are conducive to hunting.

ACKNOWLEDGMENTS

We acknowledge the contributions of Jason Ekstein, who conducted nearly all of the fieldwork associated with this project. We also thank Mark Dietz, Becky Ekstein, Chris Kearns, and several volunteers who assisted with fieldwork. Ken Finch, Gary Garabrandt, Randy Gleason, and Kurt Lunstra provided access to the study area, documents, and logistic support. Kevin Church, Gary Garabrandt, Kurt Lunstra, and Karl Menzel reviewed the manuscript. Funding for the project was provided by the FF Association, Gifford Foundation, NGPC, Papio-Missouri Natural Resources District, Sarpy County, and University of Nebraska-Lincoln.

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