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White-Tailed Deer Use of a Suburban Environment in Southern Illinois

Louis Cornicelli[1], Alan Woolf, and John L. Roseberry
Cooperative Wildlife Research Laboratory
Southern Illinois University at Carbondale
Carbondale, Illinois 62901

[1] Present address: Department of Natural Resources, 553 E. Miller Dr., Bloomington, IN 47401.

ABSTRACT

Female white-tailed deer (*Odocoileus virginianus*) were studied in a suburban setting to determine whether they altered their behavior to adapt to living in close proximity to humans and human-associated disturbances. Although deer had opportunity for egress, a marked animal was never detected leaving the study area. Study animals were predominantly crepuscular and used woodlots as primary diurnal bedding sites. Woodlots provided the most secure cover, and their distribution generally dictated deer distribution throughout the study area. Activity budgets did not differ from published data, which suggests suburban deer met life requisites in their small home ranges without additional effort. Origin of the suburban herd apparently coincided with a rapidly expanding county deer population in the early-mid 1980's. Once established however, reproduction was the primary mode of population recruitment. Suburban habitats may serve as refuges that buffer efforts to regulate deer numbers by hunting in surrounding areas. Suburban herds should be identified and managed in association with surrounding rural populations.

INTRODUCTION

White-tailed deer use many natural and human-created habitats (Marchinton and Hirth 1984). One such habitat is the suburban interface between urban and rural landscapes. Use of these areas by white-tailed deer is a relatively recent, but increasingly common phenomenon that has created new challenges for deer managers (Roseberry and Woolf 1991, Curtis and Richmond 1992). Several studies have focused on the human dimensions of suburban deer management (Decker and Gavin 1985, 1987; Connelly et al. 1987; Witham and Jones 1987, 1989; Cornicelli et al. 1993), but little research has been conducted on the basic ecology of deer in these habitats. For example, it is not clear whether deer alter their patterns of habitat use, social behavior, or activity to exploit suburban habitats. Such information is necessary to identify management issues and select appropriate management options (Decker 1987).

Radio telemetry and visual observations were used to study white-tailed deer in a suburban habitat in southern Illinois. The objective was to determine whether home range, movements, and activity of the suburban deer differed from animals in rural Midwestern habitats.

STUDY AREA

The study was conducted October 1990 through May 1992 on a 41.6 km^2 area that comprised the community of Carbondale, Southern Illinois University at Carbondale (SIUC), and some adjacent areas in Jackson County, southern Illinois. Carbondale is a moderately-sized community (17.6 km^2, 27,000 people) in a rural setting that has experienced a dramatic deer population increase during the past decade (Ill. Dept. Conserv., unpubl. data). Carbondale is essentially an island of developed land surrounded by high-quality rural deer habitat. Sufficient undeveloped land remains within Carbondale to support a resident deer population.

METHODS

Distribution and Abundance

All wooded and oldfield habitats were searched for sign of deer use (e.g., trails, beds, pellet groups) to assess general distribution of deer on the Carbondale study area (CSA). To supplement ground searches, a 55-km roadside survey was conducted twice weekly near sunset from 5 to 25 June 1990. Incidental sightings by research personnel, local cooperators, and the Carbondale and SIUC Police departments also were solicited and recorded.

Capture and Radio Telemetry

Deer were baited into open fields and captured with rocket nets or projectile syringes (Hawkins et al. 1968). A combination of 6.7 mg/kg ketamine hydrochloride (HCL) and 1.7 mg/kg xylazine HCL was used for immobilization. Captured deer were sexed, aged by tooth replacement and wear (Severinghaus 1949) as fawn (≤1 yr), yearling (>1 but <2 yrs), or adult (≥2 yrs), and eleven females were affixed with motion-sensitive radio-collars (Wildlife Materials, Carbondale, IL). Effects of the chemical immobilization were reversed with a 0.3 mg/kg intravenous injection of yohimbine HCL (Mech et al. 1985).

Radio-marked deer were located by triangulation ≤10 times/week using a directional 2-element antenna, portable receiver-scanner, and compass. The network of roads on the CSA afforded opportunity to obtain 2 bearings that were approximately 90° apart at distances ≤300 m. Because of the close proximity between the observer and deer and frequent visual observations, estimates of error polygons were not calculated.
Habitat Composition and Use

A high-altitude, color-infrared photograph (27 Mar 1988, 1:14,000) and ground surveys were used to identify 18 land-use types, which were then condensed into 5 classes: urban, residential, woodland/oldfield, agriculture/grassland, and water (Table 1). A transparency of the infrared photograph was digitally scanned into a computerized file and converted into a raster image. Map and Image Processing System software (MIPS; MicroImages Inc., Lincoln, NE.; Skrdla 1992) was used to outline and classify the image to determine total area and relative proportion of each habitat type.

Home Range

Home ranges for autumn (Sep-Nov), winter (Dec-Feb), spring (Mar-May), and summer (Jun-Aug) were computed for each study year. Two non-parametric home range estimators, the harmonic mean (Dixon and Chipman 1980) and Fourier (Anderson 1982), and one non-statistical estimator, the modified minimum area polygon (Harvey and Barber 1965) were tested to see which provided the most realistic fit for the data. Due to heterogeneity of the CSA, both non-parametric estimators produced home ranges that did not accurately reflect deer use of the suburban situation. For example, the harmonic mean estimator frequently generated circular home ranges that encompassed large urban areas that deer did not use. Therefore, the modified minimum area polygon was used in all home range calculations.

Behavior

Diel activity patterns were determined using motion-sensitive features of the radio-collars. Three 4-hour intervals (e.g., 0001-0400, 0401-0800, . . . ,2001-2400) were sampled each week, which yielded complete coverage of one 24-hour period every two weeks. Activity levels for all collared deer were assessed during each 4-hour interval. Individuals were sampled for 6 minutes (Beier and McCullough 1988) after which the scanner would move to the next frequency. If the transmitter pulse rate was constant for the entire period, activity was coded as 0 (inactive); otherwise it was coded as 1 (active).

Statistical Analyses

Analysis of Variance (ANOVA) and Tukey's multiple range test were used to compare seasonal home range sizes. ANOVA was also used to evaluate seasonal differences in activity. Differences were considered significant at $\underline{P} < 0.05$.

RESULTS

Distribution and Abundance

Deer on the CSA formed six distinct groups containing from 9 to 50 animals; the estimated total population was 125 to 150. Other deer occupied the area, but they were not studied because they did not represent a suburban situation (Fig. 1).

Habitat Composition and Use

Habitat composition and degree of development varied within the study area and accounted for both deer distribution (the group units) and abundance. The CSA consisted of 48% developed lands, 27% woodland/oldfield, 24% agriculture/grassland, and 1% water. Potential habitat for deer consisted mainly of small patches of woods and fields bordered or surrounded by developed areas (Fig. 1). These areas were remnants of farmland converted to residential and commercial expansion during the early 1970's.

As indicated by telemetry, wooded areas were a critical habitat component of the study area because they served as primary diurnal bedding sites. Of the 574 wooded hectares on the CSA, 95% were within the core of at least one animal’s home range. Oldfields also served as bedding sites, especially if they included a woody component. Agricultural fields and grasslands served as the primary foraging areas.

Home Range

Seasonal.--Seasonal home ranges were calculated for 11 does tracked ≤ 20 months. Winter and spring home ranges were 60% larger than those in summer and fall ($F = 3.73$; $P = 0.018$; Table 2). Average home range increased during late winter 1991 when several does used a newly-emergent winter wheat field (*Triticum aestivum*). During summer, average home range decreased with the onset of fawning and several weeks post-partum.

Annual.--Average annual home range ($n = 7$) averaged 50.8 ± 23 ha and did not differ among does ($P = 0.169$). There was a strong correlation ($r = 0.77$) between available habitat (patch size that the deer inhabited) and annual home range, which indicated deer used all available areas within their respective group location. There was no evidence that deer used areas outside their identified group locations for periods longer than 1 to 2 days. Unlike other deer telemetry studies, the characteristic "wanderings" that are the basis for exclusion of 5% of telemetry locations typically did not occur. None of four does monitored ≥ 15 months were observed leaving the study area.

Fidelity

Fidelity was expressed as the percentage of overlap between home range among consecutive seasons (e.g., spring-summer) and between years (e.g., winter 1991, 1992). In all but three cases marked deer ($n = 11$) displayed strong site-specific fidelity between season and between years; one deer had only 1% overlap between winter 1991 and winter 1992, while a second deer had no overlap between fall 1991 and winter 1992, and between winter 1991 and winter 1992. When these were removed from the analysis, mean overlap averaged 40% (range = 10.8% to 75.3%) between seasons and 28.2% (range = 14.4% to 48.4%) between years. Differences in degree of overlap between females were attributed to seasonal changes in vegetative composition and annual changes in agricultural practices. To illustrate, the relocations of one doe were concentrated toward north during summer (the area of heaviest cover within her home range) and south in winter (the portion of her home range that contained agricultural crops). Conversely, a doe who inhabited an area that remained constant throughout the study period exhibited little deviation in overlap (Fig. 2).

Movements

Marked deer were sedentary and remained within 1 km of their capture sites. Average daily distances traveled increased with increases in home range (e.g., winter/spring vs. summer/fall), although only marginally ($P = 0.06$) (Table 2). Although deer altered use patterns seasonally depending on changing food supplies, they basically inhabited the same areas throughout the year (see Fidelity, above).

Mean distance from the geometric center of activity (GCA) to the outermost edge of the home range averaged 528.6 m (range = 194.7 to 1,145.7 m). The GCA moved an average of 238.8 m between winter and summer (the largest and smallest average home ranges, respectively). These movements represented a shift from communal bedding and feeding groups in winter to individualism exhibited during summer parturition. Distance between seasonal GCA averaged 151.8 m (range 3.6 to 481.5) and did not vary during consecutive seasons ($P = 0.428$).

Activity

Marked deer maintained a predominantly crepuscular activity schedule throughout the study period. Greatest activity (percent of time active ± SE) occurred in early morning (68.4% ± 2.6%; 0400 - 0800 hrs) and around dusk (60.4% ± 3.3%; 1600 - 2000 hrs in winter-spring and 2000 - 2400 hrs in summer) (P = 0.019). There was no difference in activity levels (hours of activity ± SE) between winter (12.7 ± 0.04), spring (11.9 ± 0.05), or summer (11.7 ± 0.05) (P = 0.926).

DISCUSSION

Emerging Phenomena of Suburban Deer

The habitation of deer on the CSA is a relatively recent occurrence. An urban wildlife inventory conducted in Carbondale during 1978-79 reported only two deer sightings in 2 years (Jenkusky 1979). One lifetime resident indicated that deer were not common until 1985 (R. Parrish, pers. comm.). Additionally, deer-vehicle collisions on the CSA showed a 200% increase in the number of reported accidents during the period 1981-1989, with the greatest increase occurring in 1987 (Cornicelli 1992).

Factors contributing to the establishment and growth of the suburban deer herd inhabiting the CSA are likely related to a rapid increase in the Jackson County deer population as evidenced by harvest data (Ill. Dep. Conserv., unpubl. data). Increasing deer densities in rural habitats most likely resulted in higher dispersal rates and an increased probability that dispersing deer would find vacant, suitable habitats such as offered by the CSA. Once immigrants became established on the CSA, resident herds formed that appeared to have strong fidelity to their home ranges. The availability of travel corridors suggests that herds on the CSA are not trapped in isolated habitats, yet we found no indications that they would attempt to emigrate.

The herd clearly is not a "sink"; rather, it may well be a "source" population for surrounding areas. If true, the CSA and similar suburban habitats serve as refuges and source populations that, depending on size, may buffer the effects of exploitation on surrounding hunted herds.

Behavior and Ecology of Suburban Deer

Telemetry data indicated that deer on the CSA had smaller home ranges than a herd in rural habitat. Hawkins (1967), working on Crab Orchard National Wildlife Refuge less than 10 km east of the CSA, reported home ranges for females up to 10 times larger than was observed during the present study. Smaller home ranges indicate that suburban areas, such as the CSA, can provide the necessary resources for deer in relatively small areas. Although development has removed larger expanses of contiguous habitat (Cornicelli 1992), high interspersion within smaller patches allow deer to obtain such resources without excessive travel between areas.

Although deer habitat on the CSA was limited and often close to human developments, their predominantly crepuscular activity rhythms were consistent with other studies of deer activity (Montgomery 1963, Kammermeyer and Marchinton 1977, Beier and McCullough 1990). This is interesting because it has been suggested that the behavioral flexibility of deer should enable them to modify activity periods to avoid humans (Marchinton and Hirth 1984). This apparently was not the case on this study area.

MANAGEMENT IMPLICATIONS

The emerging phenomena of suburban deer populations present two basic problems for wildlife managers. The most immediate of these is control of the size and growth of these non-traditional herds. Deer in suburban habitats are generally not amenable to conventional management strategies (Jones and Witham 1990). Historical control methods involving hunter harvests are usually not a viable option due to safety considerations and opposition by urban/suburban residents. In the Carbondale area, 82% of survey respondents wanted the deer population stabilized or decreased, yet only 46% supported some type of lethal control (Cornicelli et al. 1993). Clearly, suburban deer populations present wildlife management with a challenge to develop proactive, innovative strategies to balance public needs and concerns with the ultimate welfare of the resource (Curtis et al. 1993).

The second problem involves harvest management of the rural segment of the deer population. Essentially immune from harvest and natural predation, suburban herds can be expected to increase rapidly and, if suitable corridors exist, may act as effective source populations for surrounding areas via annual dispersal of juveniles. Depending on the relative size and number of suburban sanctuaries, normal harvest strategies may be compromised. When planning future harvests to attain population goals, we recommend that predictive models and other management planning tools take into account the potential refuging effects of suburban areas.

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Table 1. Aggregated land-use types.

Category	Includes
Urban	Business/commercial properties, apartment complexes, roadways
Residential	Residential sub-divisions (single-family housing)
Woodland/Oldfield	Woodland, hedgerow, oldfield
Agriculture/Grassland	Row crops, hay/alfalfa, pasture, orchards, other grasslands
Water	Lake, pond, stream

Table 2. Seasonal home range size (ha) and average distance (m) between geometric center and outermost edge of the home range for radio-collared white-tailed deer in Carbondale, IL, 1990-92.

			Home Range		Movements		
Season	n[1]	N[2]	Mean	SE	Mean	Min	Max
Autumn	11	11	16.7	10.3	404.3	147.9	651.9
Winter	11	17	37.1	24.0	602.1	316.5	935.4
Spring	9	15	40.1	30.2	592.6	230.4	1,145.7
Summer	7	9	16.5	9.2	408.1	274.6	781.7

[1] Number of female deer radio-collared during that season.

[2] Number of home ranges used in analysis (several deer were monitored during consecutive years).

Figure 1. Map of the Carbondale, Illinois study area showing distribution of cover types. Enclosed solid lines indicate primary deer herds. Areas outside dashed lines indicate property within city limits, but not representative of a suburban setting.

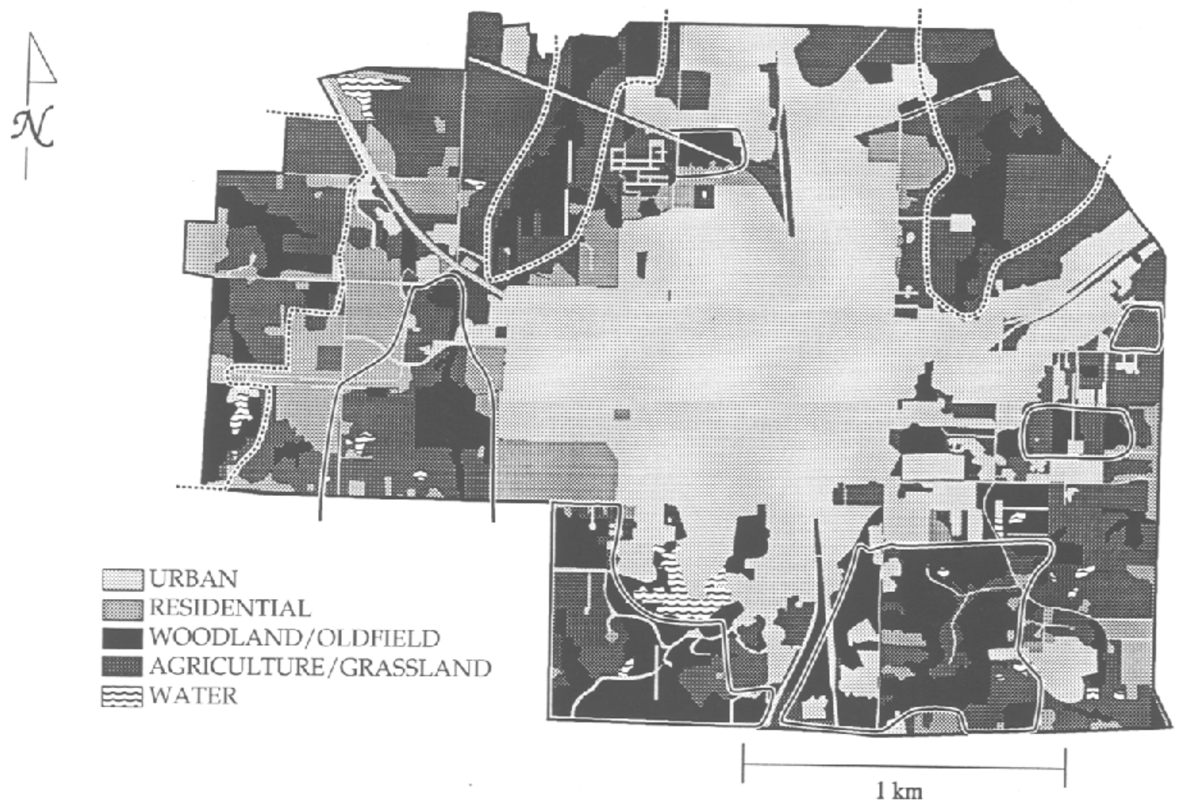

Figure 2. Differences in degree of seasonal home range overlap between a doe that inhabited changing vegetation (A) and one whose habitat did not vary (B).

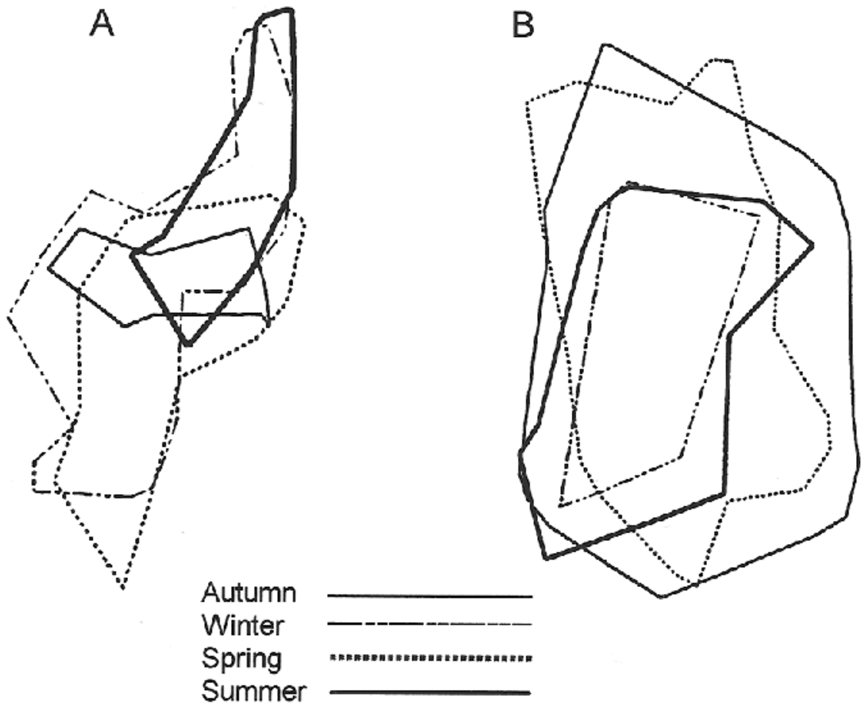

Figure 3. Percent of time active (± 95%) for radio-collared white-tailed deer in Carbondale, Illinois, Nov. 1990 - June 1991.