Proceedings of the Indiana Academy of Science
(1992) Volume 101 p. 309-317



# MOVEMENTS OF FEMALE WHITE-TAILED DEER IN SOUTHERN INDIANA

Gary J.Wiles[1] and Harmon P. Weeks, Jr.
Department of Forestry and Natural Resources
Purdue University
West Lafayette, Indiana 47907

ABSTRACT: Movements and habitat use by female white-tailed deer (*Odocoileus virginianus*) in southern Indiana during 1979-1981 revealed that home ranges averaged 70 ± 4 ha (±SE) in spring, 50 ± 5 ha in summer, and 55 ± 13 ha in autumn. Fidelity to seasonal and lifetime home ranges appeared to be high. Most deer selected bottomlands over uplands in summer. During this season, does were most active near dusk (from 1800 - 2200 h) and traveled an average of 1,890 ± 67 m per day. Deer infrequently left their home ranges temporarily to make exploratory trips and to flee from disturbances; permanent dispersals by does were not recorded.

## INTRODUCTION

Despite the importance of white-tailed deer as a game animal, few published accounts describe the movements and habitat use of this species in the forested, hilly regions of the central States of the Mississippi River Basin. Prior investigations in Missouri (Progulske and Baskett, 1958), southern Indiana (Hamilton, 1962), and Illinois (Hawkins, *et al.,* 1971) examined limited aspects of deer movements without the benefits of radio-telemetry. During an investigation of the movements and use patterns of white-tailed deer visiting mineral licks in southern Indiana (Wiles and Weeks, 1986), data were gathered for female deer on 1) home range, 2) habitat use, 3) activity patterns, and 4) movements outside normal home ranges.

## STUDY AREA

The study was conducted on a 3,200-ha portion of the Crane Naval Weapons Support Center (NWSCC) in Martin County in south-central Indiana (38°49,N, 86°50,W). Ridges running through the area are moderately-to-steeply (15%-35%) sloped and reach elevations of 250 m. Flat alluvial bottomlands occur along streams at elevations of 150 m. Kirkpatrick, *et al.* (1976) described the plant communities at NWSCC. Oak-hickory (*Quercus* and *Carya* spp.) forest is the most common habitat in the study area and occupies most hillsides and ridges. Old fields on abandoned farmlands are present within tracts of upland forest and are composed primarily of broomsedge (*Andropogon* spp.) and invading woody species. In bottomlands, where flooding periodically occurs, hardwood forests with sycamore (*Plantanus occidentalis*), river birch (*Betula nigra*), and pin oak (*Q. palustris*) are interspersed with brushy fields.

## METHODS

Field work was carried out from February 1979 to December 1980 and from

[1] Present address: Division of Aquatic and Wildlife Resources, P.O. Box 24471 MPO, Guam, GU 96921, U.S.A.

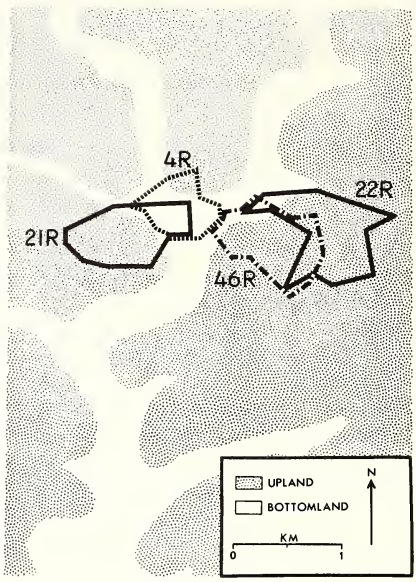


Figure 1. Summer home ranges of four radio-collared females at NWSCC, Indiana, in 1980. Does 4R and 46R were adults, and Does 21R and 22R were yearlings.

November to December 1981. Seasons were designated as: spring (1 March to 15 May, the initial date of fawning; Kirkpatrick, *et al.,* 1976); summer (16 May to 31 August); autumn (1 September, the time when mast crops became available for consumption, to 15 December); and winter (16 December to 29 February).

Although 48 deer were immobilized and fitted with numbered neck collars or radio-transmitters, only 6 does were radio-tracked for sufficient time to allow home range and seasonal movement assessment. Ages were determined by tooth wear and replacement. The six animals with radio collars were located either visually or by ground triangulation with a portable 3-element yagi antenna. Most bearings were taken at locations 250-750 m from the animal's position and were plotted on topographic maps (1:24,000) with tracking grids. Generally, radio locations fell within 75 m of the animal's actual location as determined visually by observers. "Fixes" were taken at 2-hour intervals at all times of day but particularly from 1800 to 0100 h, the period when deer visit mineral licks most frequently. In addition, each deer was tracked for two or three 24-hour periods in each summer month.

The modified minimum area method (Harvey and Barbour, 1965) was used to determine home ranges, considering outlying points as not being part of the normal home range and eliminating them from data analysis. Range boundaries contained 90%-100% of the fixes recorded for an animal. Areas were plotted on maps, and their sizes were measured with a polar planimeter. The minimum total distance moved per day was defined as the sum of the straight-line distances between sequential locations of an indi-

Table 1. Seasonal home range sizes for six radio-collared female white-tailed deer at NWSCC, 1979-1980.

| Deer Number | Age (yrs.) | Age Home Range Area[a] (ha) Spring | Summer | Autumn |
|---|---|---|---|---|
| 4R | adult | | 28 (154) | |
| 21R | 1 | | 47 (217) | |
| 22R | 1 | | 53 (140) | |
| 32R | 2 | 74 (84) | 68 (181) | 68 (60) |
| | 3 | 51 (229) | | |
| 35R | 10 | 66 (76) | 48 (196) | 42 (61) |
| 46R | 2 | 56 (152) | | |
| Average | | 70 | 50 | 55 |

[a] Number in parentheses represents the number of locations used to determine each home range.

vidual deer during a 24-hour period (Laundre, *et al.*, 1987).

Resightings made incidental to routine research travel of collared but non-radioed deer along roadsides provided additional data on home range and movement patterns. Because these locations were fewer in number and restricted to roadsides, the information they supplied about the ranges of nonradioed animals was not included for statistical analysis. Marked animals killed by hunters (n = 20) or in highway accidents (n = 2) supplied a limited number of locations.

Habitat use was determined from radio-locations of transmittered deer. Each deer was captured within 500 m of an upland-bottomland interface; thus, each animal had a clear choice in the habitat that it used. Although home ranges of these deer overlapped to some degree, all were members of different social groups, and the observations are independent. Habitat types were delineated for an 880-ha area encompassing the home ranges of these animals, with uplands comprising 76.3% of this area and bottomlands the remaining 23.7%; percentages of both habitat types within each home range were compared with these values. Because deer were strongly attracted to mineral licks that occur only in bottomlands, locations made within 1 hour of known visits to licks were deleted from habitat use analysis to avoid possible bias associated with lick use.

## RESULTS AND DISCUSSION

**Home range sizes.** Home ranges of does averaged 70 ± 4 ha (±SE) in spring (n =

Table 2. Monthly variation in home range sizes for six radio- collared female white-tailed deer during the summer at NWSCC, 1979-1980.[a]

| Deer Number | Age (yrs.) | Home Range Area (ha) | | |
|---|---|---|---|---|
| | | Mid-May To June | July | August |
| 4R | adult | 27 | | |
| 21R | 1 | 36 | 22 | 21 |
| 22R | 1 | | 33 | 33 |
| 32R | 2 | 45 | 37 | |
| | 3 | 18 | 33 | 22 |
| 35R | 10 | 37 | 22 | |
| 46R | 2 | | 44 | 40 |
| Average | | 33 | 34 | 29 |

[a] Number of locations per home range varied from 66 to 110 locations/month ($\bar{x}$ = 78.3 locations/month).

2), 50 ± 5 ha in summer (n = 7) (Figure 1), and 55 ± 13 ha in autumn (n = 2) (Table 1). Ranges varied in size from 28 to 74 ha during these seasons. These home ranges are comparable in size to those reported elsewhere for nonmigratory female white-tailed deer (Progulske and Baskett, 1958; Michael, 1965; Marchington and Jeter, 1966; Byford, 1970; Bartush and Lewis, 1978; Larson, *et al.,* 1978; Inglis, *et al.,* 1979; Ivey and Causey, 1984; Holzenbein and Schwede, 1989; Beier and McCullough, 1990).

Comparisons of summer home ranges on a monthly basis indicated no restrictions in adult doe movements during the last half of May and June after fawning (Table 2). No significant difference appeared in range size (1-way ANOVA, $P > 0.70$) among the mid-May to June, July, and August periods. Range sizes averaged 34 ± 3 ha for individual summer months. Ranges of yearling does without fawns were slightly longer and narrower but otherwise similar to those of adult females (Table 2), a further indication that caring for fawns had little effect on adult female home ranges. In contrast, some authors have reported reductions in home range sizes of does after fawning (Bartush and Lewis, 1978; Nelson and Mech, 1981; Ozoga, *et al.,* 1982; Beier and McCullough, 1990).

Wiles and Weeks (1986) found that mineral lick locations appeared to influence home range positioning; licks may have influenced home range size during the spring/summer period as well. Doe 4R (the letter "R" designates a radio-equipped animal) was the only radio-collared female with a lick in the center of her home range. Her summer range was the smallest (28 ha) of any animal (Figure 1). Two licks were easily acces-

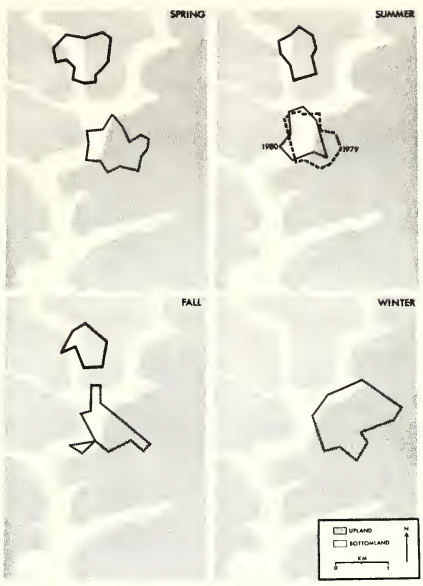


Figure 2. Seasonal home ranges of two radio-collared adult does, 32R (broken lines) and 35R (solid lines), at NWSCC, Indiana, 1979-1980.

sible from any point in her range and eliminated the need to make longer trips to licks. Four deer (Does 21R, 22R, 32R, and 46R) with licks present near their home range boundaries had larger summer areas ($\bar{x}$ = 55 ha, range = 47 - 68 ha) than Doe 4R. Three of these deer had licks located in corners of their home ranges but made little use of regions adjacent to these licks except preceding or following lick visits. Because these areas were used for feeding and resting and not simply as part of a travel route to a lick, they were considered to be inside the animal's home range. No seasonal shifting of home ranges was noted in two deer, Does 32R and 35R, tracked during spring, summer, and autumn in 1979 (Figure 2). Ranges retained a sizable core area that was used each season. Nonetheless, changes in range shape, occurring mostly along range boundaries, were evident over time.

Limited evidence suggests that females at NWSCC may use essentially the same home ranges throughout their adult lives (but see Movements Outside Home Ranges). Doe 32R was radio-tracked during summers of both study years; her ranges were similar during both summers. Sightings of Does 25, 29, and 31 indicated that 1980 home ranges were similar to those of 1979. The most convincing evidence of home range fidelity was exhibited by Doe 35R. This deer was originally tagged in August 1970 as a yearling (F.A. Stormer, pers. comm.) at a point located in the center of her 1979 spring, summer, and autumn home ranges. Another female, Doe 0, was seen consistently in one area during 1979 and 1980 and was resighted in the same locality in October 1986. Except for minor perimeter fluxes, no doe is known to have shifted her home range either

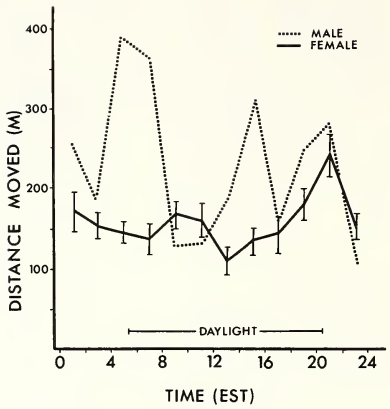


Figure 3. Mean summer movements during 2-hour intervals for six radio-collared female white-tailed deer (n = 38) and one radio-collared male deer (n = 4) at NWSCC, Indiana, 1979-1980.

seasonally or annually. These data on long-term home range stability among females support the findings of others (Tierson, *et al.,* 1985; Beier and McCullough, 1990).

**Summer habitat use.** During summer, four of the six females used bottomland habitat in greater proportion than its relative abundance, while the other two exhibited no habitat preference (Table 3). Concealment qualities of thick vegetation in wooded bottomlands make them a preferred fawning site (Kirkpatrick, *et al.,* 1976). Day and night habitat use patterns were similar for most animals during the summer.

**Activity patterns within home ranges.** The six females were monitored during 38 24-hour tracking periods from June to August. A 3-way ANOVA indicated that there were no significant differences in movements (meters traveled per 2-hour period) among months ($P > 0.75$) or between adults and yearlings ($P > 0.40$); however, movements did vary among the different times of the day ($P < 0.05$). Again, there was no indication that fawning reduced movements of adult does during the first month postpartum. Does were most active near dusk (from 1800-2200 h) with smaller peaks in movement from midnight to 0200 h and from 0800-1200 h (Figure 3). Movements from 2000-2200 h were significantly greater than those of most other periods (Newman-Keuls sequential range test, $P < 0.05$) with the exception of 1800-2000 h, midnight to 0200 h,and 0800-1000 h. Previous studies have shown deer activity in the summer to be high near dusk with other peaks occurring just after midnight (Nelson, 1979), near dawn (Kammermeyer and Marchington, 1977; Beier and McCullough, 1990), and at mid-day (Drolet, 1976). Distances traveled by deer at NWSCC varied considerably within these 2-hour intervals; movements ranged from 0 to at least 410 m in each period. Thus, deer can occasionally be expected not to follow these general activity patterns and may move long distances or remain stationary at any time of the day.

Minimum total distances traveled daily by does averaged 1,890 ± 67 m (range = 1,010-2,640 m). The longest straight-line distance traveled in a 2-hour time period was

Table 3. Summer habitat use patterns as determined by radio locations for six female white-tailed deer at NWSCC, 1979-1980. Percentage of location values marked with asterisk indicate significant habitat selection (Chi-square test, $P < 0.001$).

| Habitat Type | Percentage Available | Percentage of Locations | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 4R | 21R | 22R | 32R[a] | 35R | 46R | Total |
| Upland | 76.3 | 17.0 | 35.7 | 85.5 | 30.6 | 58.4 | 77.1 | 49.9 |
| Bottomland | 23.7 | 83.0* | 64.3* | 14.5 | 69.4* | 41.6* | 22.9 | 50.1* |

[a] Summer habitat use patterns of Doe 32R were pooled for 1979 and 1980.

845 m from midnight to 0200 h. It is generally concluded that males move greater distances than females; for contrast in this area, the only buck that was tracked long enough for comparison moved considerably more than females during 24-hour tracking sessions. He traveled an average of 2,710 ± 250 m per day (n = 4). Peaks in activity occurred near dawn from 0400-0800 h and near dusk from 2000-2200 h (Figure 3). A mid-afternoon peak from 1400-1600 h was most likely an artifact of a single large movement made during that time period.

**Movements outside home ranges.** White-tailed deer at NWSCC made four types of movements from their normal home ranges. Trips to mineral licks were most common and were described by Wiles and Weeks (1986). Other categories of movements included 1) exploratory trips, 2) temporary flights from disturbances, and 3) permanent dispersals.

**Movements outside home ranges: Exploratory trips.** Inglis, *et al.* (1979) noted that nearly 80% of the radio-monitored deer in a Texas study occasionally left their home ranges to make voluntary exploratory trips lasting from 4 hours to several days. Others have noted similar movements among white-tailed deer (Downing and McGinnes, 1975) and black-tailed deer (*Odocoileus hemionus*; Dasmann and Taber, 1956). At NWSCC, trips of this type were rare. Only five exploratory trips were known to have been made by four of the six radio-tagged does. Four of these excursions were short and extended 300-400 m beyond the delineated boundaries of home ranges. A fifth movement differed greatly. Doe 32R traveled 3.4 km southwest of her normal autumn home range on 8 September 1979 and stayed in a 16-ha area of upland hardwood forest for about 4 weeks. Neither a causal factor in her leaving her home range nor any unique feature of the target woodland could be identified that might have attracted and held her. After a month, she returned to her original home range and remained there the rest of the autumn.

**Movements outside home ranges: Temporary flights from disturbances.** Monitoring of three radio-collared deer during the 1979 autumn "either-sex" hunting season indicated that flights from home ranges occurred during gun but not archery hunts. Does 32R and 35R and Buck 34R were located several times each day of hunting. During 7 deer-days (total days that radio-tagged animals were hunted) of bow hunting in October,

no "abnormal" deer movements were detected. In contrast, four trips from home ranges occurred during 10 deer-days of shotgun hunting in November and December. The lengths of these trips ranged from 200 m to at least 1 km. Differences in the likelihood of deer to flee their home ranges during the two types of hunts were probably related to the amount of protective cover available and to hunter density and behavior. Forested and brushy habitats became more open toward the end of autumn as leaf fall continued. At the same time, hunting pressure increased dramatically with the number of hunters more than doubling during gun hunts from 1.1 hunters/km$^2$ to 2.7 hunters/km$^2$. Further, shotgun hunters were more likely to disturb deer by hunting while walking than were bow hunters, who preferred still hunting from tree stands or the ground. Noise from shotguns also may have frightened deer.

Two other movements by radioed deer outside their home ranges were recorded. Doe 35R moved 400 m west of her home range for 4.5 h while explosive tests were being conducted at a demolition pit in the eastern part of her home range. Doe 32R traveled a minimum distance of 8.3 km in 15 h during a round trip that took her 3.1 km outside her home range. Free-ranging domestic dogs (*Canis familiaris*) were seen in this doe's home range 2 days earlier and may have chased her from the area.

The kill locations of 12 collared does taken during the autumn hunts on NWSCC were compared with the locations they were observed in the preceding spring and summer. They were recovered at sites averaging 1.72 km (range = 0 - 5.2 km; 42% of kills > 2 km) from their known home range areas. Similar movements among deer at NWSCC were summarized by Kirkpatrick, *et al.* (1976). Downing and McGinnes (1975) were highly suspicious of inferences made about autumn movement patterns of deer that were drawn from hunter returns. As previously discussed, such movements probably represent a mixture of attempts to escape hunting, travel associated with mating activity, and/or temporary large-scale shifts in home range similar to that noted in Doe 35R.

## ACKNOWLEDGMENTS

Indiana Division of Fish and Wildlife funds supported this project. The authors especially thank J.C. Olson, D.J. Case, and R.D. Fahlsing for their assistance in fieldwork, and R.E. Mumford and F.H. Montague for reviewing the manuscript. In addition, the authors would like to thank L. Andrews, H. Thomas, R. Bledsoe, V. Adams, D. Arrington, and the administration and security police of NWSCC for providing information, access, and logistical support. J.D. Pesek assisted with the statistical analyses. This is Journal Paper No. 10,561 from the Purdue Agricultural Experiment Station.

## LITERATURE CITED

Bartush, W.S. and J.C. Lewis. 1978. Behavior of whitetail does and fawns during the parturition period. Proc. Southeastern Assoc. Game Fish Comm. 32: 246-255.

Beier, P. and D.R. McCullough. 1990. Factors influencing white-tailed deer activity patterns and habitat use. Wildl. Monogr. 109, 51 pp.

Byford, J.L. 1970. Telemetrically determined movements of two white-tailed deer fawns in southeastern Alabama. Proc. Southeastern Assoc. Game Fish Comm. 24: 57-63.

Dasmann, R.F. and R.D. Taber. 1956. Behavior of Columbian black-tailed deer with reference to population ecology. J. Mammal. 37: 143-164.

Downing, R.L. and B.S. McGinnes. 1975. Movement patterns of white-tailed deer in a Virginia enclosure. Proc. Southeastern Assoc. Game Fish Comm. 29: 454-459.

Drolet, C.A. 1976. Distribution and movements of white-tailed deer in southern New Brunswick in relation to

environmental factors. Can. Field-Natur. 90: 123-136.
Hamilton, R. 1962. Factors affecting dispersal of deer released in Indiana. J. Wildl. Manage. 26: 79-85.
Harvey, M.J. and R.W. Barbour. 1965. Home range of *Microtus ochrogaster* as determined by a modified minimum area method. J. Mammal. 46: 398-402.
Hawkins, R.E., W.D. Klimstra, and D.C. Autry. 1971. Dispersal of deer from Crab Orchard National Wildlife Refuge. J. Wildl. Manage. 35: 216-220.
Holzenbein, S. and G. Schwede. 1989. Activity and movements of female white-tailed deer during the rut. J. Wildl. Manag. 53: 219-223.
Inglis, J.M., R.E. Hood, B.A. Brown, and C.A. DeYoung. 1979. Home range of white-tailed deer in Texas coastal prairie brushland. J. Mammal. 60: 377-389.
Ivey, T.L. and M.K. Causey. 1984. Movements and activity patterns of female white-tailed deer during rut. Proc. Southeastern Assoc. Game Fish Comm. 35: 149-166.
Kammermeyer, K.E. and R.L. Marchington. 1977. Seasonal change in circadian activity of radio-monitored deer. J. Wildl. Manage. 41: 315-317.
Kirkpatrick, C.M., C.M. White, T.W. Hoekstra, F.A. Stormer, and H.P. Weeks, Jr. 1976. White-tailed deer on Crane Naval Ammunition Depot, Indiana. Purdue Univ. Agr. Exp. Sta. Bull. 932, 42 pp.
Larson, J.J., O.J. Rongstad, and F.W. Terbilcox. 1978. Movement and habitat use of white-tailed deer in southcentral Wisconsin. J. Wildl. Manage. 42: 113-117.
Laundre, J.W., T.D. Reynolds, S.T. Knick, and I.J. Ball. 1987. Accuracy of daily point relocations in assessing real movements of radio-marked animals. J. Wildl. Manage. 51: 937-940.
Marchington, R.L. and L.K. Jeter. 1966. Telemetric study of deer movement ecology in the Southeast. Proc. Southeastern Assoc. Game Fish Comm. 20: 189-206.
Michael, E.D. 1965. Movements of white-tailed deer on the Welder Wildlife Refuge. J. Wildl. Manage. 29: 44-52.
Nelson, M.E. 1979. Home range location of white-tailed deer. U.S. Dep. Agr. Forest. Serv., Res. Pap. NC-173, 10 pp.
_____ and L.D. Mech. 1981. Deer social organization and wolf predation in northeastern Minnesota. Wildl. Monogr. 77, 53 pp.
Ozoga, J.J., L.J. Verme, and C.S. Bienz. 1982. Parturition behavior and territoriality in white-tailed deer: Impact on neonatal mortality. J. Wildl. Manage. 46: 1-11.
Progulske, D.R. and T.S. Baskett. 1958. Mobility of Missouri deer and their harassment by dogs. J. Wildl. Manage. 22: 184-192.
Tierson, W.C., G.F. Mattfeld, R.W. Sage, Jr., and D.F. Behrend. 1985. Seasonal movements and home ranges of white-tailed deer in the Adirondacks. J. Wildl. Manage. 49: 760-769.
Wiles, G.J. and H.P. Weeks, Jr. 1986. Movements and use patterns of white-tailed deer visiting natural licks. J. Wildl. Manage. 50: 487-496.