

MOVEMENT PATTERNS OF WHITE-TAILED DEER IN A VIRGINIA ENCLOSURE¹

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ABSTRACT

Approximately 10,500 locations of 234 individually marked white-tailed deer (*Odocoileus virginianus*) in an 826-ha enclosure at Radford Army Ammunition Plant in Dublin, Virginia, were analyzed to determine when and why deer wander and disperse from their home range. For the first 10 months after birth, over 95 percent of all locations were within 0.8km of each deer's center of activity, but of those which lived past 15 months of age, 30 percent of the does and 53 percent of the bucks are known to have wandered beyond 1.6km, considered the limit of normal activity, sometime during their lives. The tendency for long movements by does was greatest during spring and summer, especially following temporary breakup of family groups at 1 year of age, and when does were preparing to bear their first fawn at 2 years of age. Bucks moved much more frequently than does, and 19 bucks made 25 changes in range, mostly between the ages of 12 and 21 months. The disturbance of chasing by dogs and archery hunting caused many deer to make long movements, but so far as is known, all permanent changes in range were made while the deer were undisturbed. Ten of the 25 changes in range were to areas the deer were known to have visited previously. Breeding season activities caused little irregular movement by does, but nine bucks, most of them yearlings, dispersed immediately before, during, or after the rut. Food, because it was generally plentiful everywhere, and water, because it was used very little, did not appear to be important incentives for dispersal.

INTRODUCTION

In spite of numerous studies showing that the activities of white-tailed deer are usually confined to a small area, there is ample proof that under some conditions long movements and even permanent changes in range take place. Indeed, deer in virtually every state in the southeastern United States have gradually dispersed from small nucleus herds to reoccupy much of their former range. When and why deer disperse have not been adequately determined because such movements may occur only once or twice in the lifetime of a deer. The expense of telemetry equipment and the difficulty in replacing batteries have limited such studies to small numbers of deer for short periods of time. Direct observation of free-ranging, individually marked deer has been used with greater success, but there is considerable opportunity for bias in such studies because it frequently cannot be determined whether a deer which disappears has died, lost its markers, or dispersed completely off the study area.

Our research conditions were also less than ideal. The 826-ha (2,040-acre) enclosure afforded plenty of room for a large, easily captured, easily observed sample of deer. However, the relatively small size of the enclosure meant that there was little opportunity for a deer to move more than 2 or 3km from its home range and there was no unoccupied territory available to attract dispersing individuals. Nevertheless, during their day-to-day activities, these deer seemed unaware of the fact that they were confined within an enclosure, and this fact became apparent to them only *after* they had left their home ranges. Since the extent of deer movements was obviously limited, we limited our study to when and why deer *leave* their home ranges, not how far they go. Nearly 400 deer were marked during the study, and 234 were observed almost every month for a year or more of their lives. The movements observed, when related to sex, age, season, disturbance, and the distribution of food and water, have provided insight as to when and why deer wander and disperse.

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STUDY AREA AND METHODS

A 2.4-m-high chain-link fence surmounted by barbed wire forms the 826-ha enclosure. The habitat is rolling grassland with small isolated stands of mature hardwoods and scattered cedars (*Juniperus virginianus*). About 80 ha have been planted to shortleaf pines (*Pinus echinata*), but few deer use these for cover. The area is traversed by more than 40km of paved roads which facilitate excellent long-range observation over practically the entire enclosure. Observations were made only in daylight, usually early morning and late afternoon.

From 1965 to 1971 352 fawns were captured, marked, and released by the techniques described by Downing and McGinnes (1969). Of those tagged as fawns, 104 bucks and 93 does were observed practically every month for at least 1 year and provided most of the data. In addition, 6 bucks and 31 does captured as adults were included because they had also been observed for at least 1 year. Fall herd size ranged from 330 to 475 deer during the study.

A center of activity was determined for each deer based on all locations recorded during the first year it was observed. This activity center was defined as the intersection of north-south and east-west lines, each of which equally divided the number of plotted locations. Because we were mainly interested in movements outside the normal range, we analyzed only the longest movement of each deer each month; 4,228 observations were analyzed out of the total of more than 10,500. When a deer was seen exclusively outside its home range for 2 or more months, it was considered to have dispersed and only the first observation in the new range was measured from the original center of activity. Subsequent locations were measured from a new center of activity established from the new observation points.

RESULTS AND DISCUSSION

Long-distance movements were not possible in the Radford enclosure, which measured about 3.2×4.4 km, but we feel that it is not necessary for a deer to move a great distance to demonstrate its willingness to do so. "Normal" home range size was considered to be that area which contained the movements of most deer most of the time. For instance, during their first 10 months, 95 percent of the locations of the 197 fawns were less than 0.8km (0.5 mi) from their center of activity. Yearling (1- to 2-year-old) and adult (2+-year-old) does normally spent most of their time within 8.0km of their center of activity; during any month, 75 to 100 percent (mean 89) stayed within this distance. Yearling and adult bucks normally used a larger area than does, but 73 to 100 percent (mean 91) stayed within a 1.6-km (1-mi) radius each month. For both sexes, we considered only those movements beyond 1.6km as likely to result in dispersal.

Escape from Hunting

Sex and age apparently have some bearing on the degree of movement during hunting. Autry (1967:22-27) noted during a hunt at Crab Orchard National Wildlife Refuge in Illinois that bucks were killed approximately twice as far from their normal ranges as were does. Does killed more than 1 mile (1.6km) from their normal centers of activity were virtually the same average age as those killed within 1 mile, but bucks killed beyond 1 mile averaged only 1.7 years while those killed less than 1 mile distant averaged 2.8 years. This can be interpreted as a tendency for yearling bucks to move longer distances than other sex or age classes. However, movement is normal for yearling bucks at this time of year, and the movements reported may not have been entirely due to hunting. Cattle roundups, which are similar in some ways to intensive hunting, are reported by Hood and Inglis (1974:490) to cause bucks to take flight into adjacent pastures, while does take circuitous escape routes and return to their home ranges within a few hours.

Movements of Radford Arsenal deer during the hunts of 1965 and 1966 were reported previously by Downing et al. (1969:22). During those hunts, more than two-thirds of the marked fawns moved outside their normal ranges, many of them going as far as the enclosure fence would allow. There were no older deer conspicuously marked during the 1966 hunts, so no comparison of movement with age was possible.

Hunting dogs were introduced into the Radford enclosure on 1 weekend in September 1969 and on 6 weekends in April and May 1972. Virtually every deer was chased out of a 245-ha watershed each weekend. Most deer returned home by the following day. One crippled buck that had been chased repeatedly in September 1969 was seen the next day near the far side of the enclosure over 3km away, but he returned to his normal home range shortly thereafter. A few marked does were also seen outside the watershed the following day, but none took up permanent residence there.

The fact that long movements take place during hunting makes us wonder how well hunter returns of tagged animals represent normal dispersals and migrations, and how much of this movement is taking place only to escape hunters. We have not shown that permanent changes in range occur as a result of hunting, but we do know that hunter returns of tagged deer do not necessarily indicate their normal range.

Breeding Season Movements

At Radford Arsenal, 3 percent or less of the does (Fig. 1) were observed 1.6km or more from their centers of activity during November, the peak month of the rut (McGinnes and Downing 1972), and no permanent changes were observed. On the other hand, November and December were months of considerable movement for bucks (Fig. 2), especially after they reached 2.5 years of age. Twenty percent or more were observed 1.6km or more from their centers of activity during their third and fourth Novembers and during their fourth December. The last 12 months in Figs. 1 and 2 are a composite of all subsequent years, thus the fourth November and December contain deer up to 6.5 years of age.

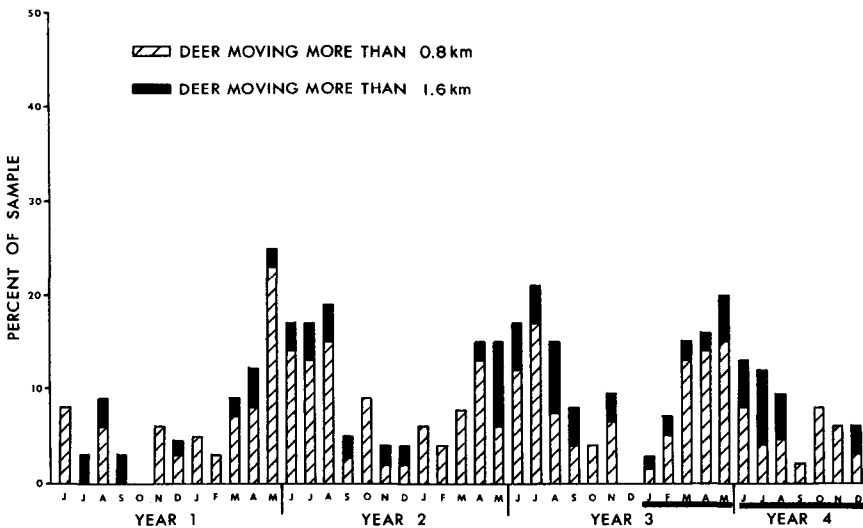


Fig. 1. Percent of does moving more than 0.8km from their center of activity during each month of their lives. Radford Army Ammunition Plant, Virginia, 1965-1972. Last 12 months (underlined) include all does older than 2.5 years (see Table 1 for sample sizes).

Dispersals by bucks are discussed under the following section. However, of the 25 recorded dispersals, 5 (all by yearlings) are known to have taken place during November and December and may have been related to the breeding season. Dispersals by four additional bucks may also belong to this class: a yearling and a 4.5-year-old which changed range during October, and a yearling and a 2.5-year-old which changed range sometime between September and December.

In more northern states, deer movements into yards each winter may be difficult to distinguish from breeding season movements. And since many states set hunting seasons to coincide with the rut, movements to escape hunters may also be a confounding factor.

Other Movements

Sparrowe and Springer (1970:423-427) reported considerable movement of deer at times other than the hunting season in South Dakota. A yearling doe moved 20 miles (32.2km) from its winter trap site by late June but returned by September. An adult doe moved 8 miles (12.9km) upriver from her summer range in September and returned by October. Overall, no significant difference in annual

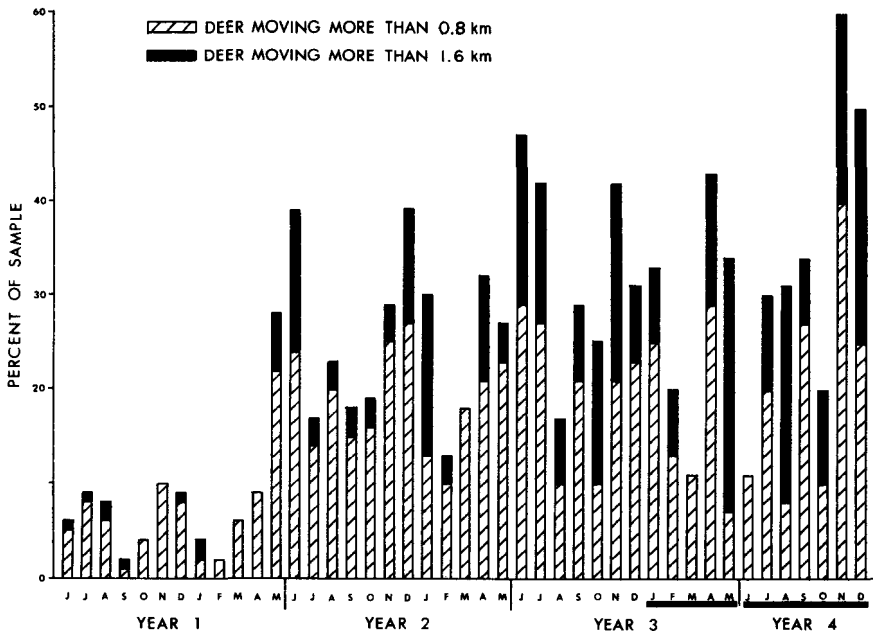


Fig. 2. Percent of bucks moving more than 0.8km from their center of activity during each month of their lives. Radford Army Ammunition Plant, Virginia, 1965-1972. Last 12 months (underlined) include all bucks older than 2.5 years (see Table 1 for sample sizes).

linear ranges was noted between 9 males, whose ranges averaged 12.0 miles (19.3km), and 12 females, whose ranges averaged 11.1 miles (17.9km). Hawkins and Klimstra (1970:414) in Illinois believed that 10 of 79 yearling females (13 percent) dispersed; 6 were killed by hunters or automobiles 1.8 to 6.3 miles (2.9 to 10.1km) from their capture sites. They also believed that after 2 years of age, most does were permanent residents.

At Radford Arsenal, 30 percent of the 76 does observed past 15 months of age wandered beyond the 1.6-km radius sometime during their lives. No permanent dispersals were observed for does, and the 1.6-km distance was exceeded by 5 percent or more of the does only during three periods, their second May (24th month), third August (27th month), and fourth July (which includes subsequent July) (Fig. 1). The greatest percentage of movement beyond 1.6km (9 percent) occurred during the doe's second May when most were preparing to bear their first fawn. In the 15 instances where does had tagged mothers, their ranges were almost identical.

Although this study did not demonstrate that does disperse, the obvious spread of populations from nucleus herds proves that dispersal by does is a normal, though probably not universal, behavioral pattern. The stimulus which causes these dispersals apparently was not present during this study and thus remains poorly known.

Of the 66 bucks observed past 15 months of age, 53 percent wandered beyond the 1.6-km radius sometime during their lives. The seasonal pattern is not pronounced (Fig. 2), and only in September, February, and March of each year did we fail to observe at least 10 percent of the bucks 1.6km from their center of activity. Our small sample of older bucks (Table 1) may partly explain this lack of a seasonal pattern in longer movements.

Nineteen bucks changed range 25 times during the study. Since the enclosure was small, most moved only 2 to 3km but probably would have moved much farther (and perhaps more often) in an unenclosed area. In many cases, several months elapsed between the last observation in the old home range and the first observation in the new one, making it impossible to determine when the actual

Table 1. Numbers of bucks and does whose observed movements each month are illustrated in Figs. 1 and 2. Radford Army Ammunition Plant, Virginia, 1965-1972.

Month	Number of does/month				Number of bucks/month			
	Year of age				Year of age			
	0-1	1-2	2-3	3-4	0-1	1-2	2-3	3-4
June	93	63	42	92	104	68	28	9
July	66	53	23	48	76	71	26	10
August	69	48	27	64	83	76	29	13
September	68	40	25	65	90	61	24	15
October	73	35	25	48	91	58	20	10
November	69	44	31	54	71	53	24	15
December	65	45	29	65	87	52	13	12
January	43	31	71		60	30	12	
February	70	43	91		86	39	15	
March	58	40	94		72	22	9	
April	53	39	94		58	28	14	
May	56	34	98		69	26	15	

dispersal took place. However, 10 of the 19 bucks definitely changed range between the 12th and 21st month of their lives, and 4 others may have changed during this period, so yearlings seemed the most inclined to disperse. Hawkins and Klimstra (1970:414) reported that 80 percent of the 58 intensively studied yearling bucks at Crab Orchard National Wildlife Refuge in Illinois emigrated, mostly during October and November. Interestingly, movements of these Illinois yearlings stabilized by February, their 21st month, and only 7 percent of 44 older bucks were known to have made permanent changes in range.

Ten of the 25 moves at Radford were to areas the bucks were known to have visited before the permanent move, suggesting that the familiarity obtained during temporary long-distance wanderings may result in permanent moves to these areas at some later date. Only 1 of the 19 bucks is known to have obtained any of this familiarity under disturbance conditions.

During the summer of 1970, over 20 ha of the enclosure were plowed and planted to fertilized agricultural crops, including alfalfa, and groups of up to 90 deer were seen there almost every day in August and September. Thirteen of the bucks which subsequently changed range were alive at that time, but only four of them moved to the agricultural plantings. Six of the remaining nine possibly did not know about the plantings, since they were never seen there, but the other three used them repeatedly, yet eventually moved from these fields to other areas. One returned to the fields a year later. Two additional bucks extended their range more than 0.8km to reach these fields, but since they continued to use part of the original range, they were not considered to have emigrated. Sandt (1969), working at Radford Arsenal, noted no movements of marked deer to reach a 22-acre (10-ha) hardwood clearcutting.

Use of Water

Although considerable research has been done on the drinking habits of deer in the arid West, this subject has been largely ignored in the humid East. Chapman (1939:265) reported that deer in Ohio were never observed drinking fresh water but that a large number were seen drinking from muddy saline licks, suggesting that salt was being sought rather than water. Hosley (1956:211) cited several workers as saying that deer were unable to obtain water during winter but presumably secured moisture from snow. Michael (1967:54) reported that deer on the Welder Refuge in south Texas drink more frequently with increasing air temperature. Pregnant does seem to drink more often than other deer, and individual marked does have been observed drinking five times in 1 day. Michael stated that watering sites were frequently the centers of home ranges and that the presence or absence of water noticeably affects their daily activities. Nevertheless, some deer did not appear to drink water at all, and Michael reported eight occasions when he saw deer licking leaves of yucca plants (*Yucca treculeana*) to obtain accumulations of dew.

Among the estimated 50,000 deer observations made during this study, we recall fewer than a dozen times when we saw deer drinking water. The area contains about 5.4km of permanent

spring-fed streams distributed so that more than 90 percent of the area is within 0.8km of water. Water was seemingly within easy reach of almost every deer, yet at least 35 percent had home ranges in upland areas which did not include these streams and thus had no opportunity to drink except after heavy rains. We saw no indication that movements were made to reach water, even in summer, and conclude that open water is of little importance to this herd.

The senior author also noted that only 1 of more than 20 deer used water in a 304-ha Georgia enclosure during a 2-month (September-October) drought. Japanese honeysuckle (*Lonicera japonica*), a succulent vine normally used only in winter, was the main source of food during this drought.

CONCLUSIONS

As reported frequently in the literature, deer spend most of their time within 100 to 200 ha, but this study and many others have shown that after the age of 10 months, occasional wanderings of several kilometers may be expected. Does seem inclined to make these movements only in the summer at 1 year of age (following family breakup) and when they are preparing to bear their first fawn. We suggest that the reasons no permanent changes in range were recorded for does in this study are the limited size of the enclosure and the high population levels (approximately one deer per 2 ha = 1 deer/5 ac) in all areas.

Rutting activity apparently did not affect doe movements, but it caused a considerable number of bucks to move beyond their normal range and probably initiated some dispersals. Bucks older than 10 months commonly wandered but often returned to their home range. The seasonal pattern of movement was not pronounced, but wanderings were less frequent during September, February, and March than other months. Buck dispersals were most frequent between the 12th and 21st month of age, and quite often these were to areas previously visited under undisturbed conditions.

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