Use of Mississippi Bottomland Hardwoods by White-tailed Deer

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Abstract: Nine white-tailed deer (*Odocoileus virginianus*) outfitted with radio collars were observed for 9 months or longer to monitor seasonal movements and habitat utilization. Estimates of seasonal home-range size, using a multivariate method, varied from 176 ha to 1245 ha, and annual home range size varied from 455 ha to 2216 ha. Average annual home ranges of 4 females (737 ha ± 219 SD) was about half the average home range of 5 males (1511 ha ± 571 SD). Habitat utilization/availability analysis demonstrated significantly greater ($P < 0.05$) utilization of dense bottomland hardwood sawtimber than expected on an annual basis by 5 of the deer, and all deer used this habitat type in greater proportion than expected from its availability. Of 19 habitat types tested, only dense hardwood sawtimber showed a consistent use preference by deer. However, 3 deer showed geometric shifts in home range activity centers in the summer toward soybean fields, suggesting greater utilization of this habitat type than indicated by utilization/availability analysis.

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Hardwood forests once covered extensive areas of river bottom environments throughout the Southeast. These forests have generally supported high densities of white-tailed deer (Moore et al. 1960, Moore 1967, Murphy and Noble 1972), and Stransky (1969) believed that they produced more deer food per unit area than any other Southeastern forest type. Since 1960 much of this habitat has been converted

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to uses other than forests (Stransky and Halls 1967, Holder 1970). The U.S. Department of Agriculture (1971) reported that from 1950–69 up to 81,000 ha of bottomlands in the lower Mississippi valley were converted to agriculture each year.

It has been generally assumed that deer in the Southeast are sedentary, with home ranges of < 300 ha (Marchington and Jeter 1966, Byford 1969, Tucker 1981). Although some variability in home range due to changes in food supplies has been documented (Marchinton and Jeter 1966, Michael 1965, Byford 1969, Downing and McGinnes 1975), reports of major home range shifts in response to changing food supplies have been limited. Various investigators have documented deer use of agricultural fields and adjacent bottomlands (Murphy and Noble 1972, Moore and Folk 1978, Zwank et al. 1979), but it is unknown whether deer merely use soybeans and other crops as a supplemental food and/or cover source, or whether the deer have become dependent on these areas in the absence of natural vegetation. The management and economic implications of this question become more important as remaining areas of bottomlands are converted to agriculture and as deer damage to crops increases.

If the effects of bottomland forest conversion to agriculture on deer populations are to be understood, knowledge of deer movements and habitat preferences in areas where croplands, bottomland hardwoods and other vegetation are juxtaposed is needed. This study examined deer use of bottomlands and adjacent habitat types with the objective of determining the utilization of bottomland hardwood forests by white-tailed deer relative to other habitat types including agricultural crops.

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Methods

The study area, located in east-central Mississippi, at the junction of the Black-belt Prairie and the Tombigbee River flood plain was a 2,025-ha private holding with limited, well-controlled access. Climate is characterized by hot summers and cool, moist winters. Winter temperature average 13.5° C, while summer temperatures average 26.5° C. Average annual precipitation is 139 cm (Brent 1979). Food plots (corn, ryegrass, wheat and turnips) were interspersed along an extensive road system. Adjoining lands were used primarily for soybean and cattle production. The forested portion of the area was managed for wildlife and timber resources. The area had a dense deer population, supporting an annual harvest of about 61 deer/km^2. Vegetation types of the area were pine (*Pinus taeda*) (10%), mixed pine-hardwoods (*Pinus* spp., *Quercus* spp., *Liquidambar styraciflua*) (6%), bottomland hardwoods (*Quercus* spp., *Carya* spp.) (44%), tupelo-cypress (*Nyssa* spp., *Taxodium distichum*) (1%), pasture (17%), and row crops (11%). Nonvegetative land cover (11%) included residential sites, roads and open water.

Deer were captured using modified Stephenson box traps (Masters 1978) and drop nets (Ramsey 1968) during February and March 1980–82. Deer were outfitted with radio collars and numbered tags were placed in both ears. Adult deer were fitted with a 500-g package consisting of a radio transmitter mounted on a butyl-rubber collar. Some units employed for 6-month-old juvenile deer weighed 330 g and were designed by the manufacturer as break-away collars. Use of these units was discontinued after early failures; instead, 500-g units were subsequently applied with collars pre-set for adult size but folded and tightly taping with plastic electricians' tape to fit a small neck circumference. The tape weathered rapidly, deteriorated within a few months and the units expanded to adult size before growth caused the collars to become too tight. Both units operated in the 164–166 MHz range and were powered with lithium batteries.

Biotelemetry Procedures

Animals collared prior to February 1981 were monitored for a continuous 12-hour period every 5 days for 1 year beginning 2 April 1980. The start of the 12-hour observation period was alternated between 0000 hours and 1200 hours to monitor evenly all time periods. Deer radio-collared in 1982 were monitored monthly from April 1982 through September 1982. Continuous, diurnal 12-hour observations were made at 10-day intervals for these deer during the period 1 October 1982 to 1 February 1983. The 1982–83 monitoring design was different because deer radio-collared after 1981 were captured for a study on buck movements (Kagel 1984). These later data are presented to supplement to the original 1980 data base.

A network of 25 receiving stations was established to monitor telemetered deer. A radio fix was determined by obtaining an azimuth from at least 2 receiving stations. An attempt was made to obtain 1 fix per deer every 2 hours during the observation periods. A hand-held, 2-element, yagi antenna was used for readings. Locations were determined by triangulation with each azimuth having an error arc of $\pm 7.5°$. At a range of 500 m between transmitter and receiver, the area of the error polygon produced by 2 15° arcs was 1.78 ha when the observed azimuths intersected at a 90° angle.

On occasion, it was necessary to use light aircraft to help locate deer that had left the study area. Ground inspections were conducted as soon as possible after these flights to confirm the aerial locations.

Home Range and Movements

Analysis of telemetry data was conducted by combining computer software employed for habitat description by the Mississippi Remote Sensing Center (MRSC) with TELEPRO, a program developed at the MRSC to determine deer locations from raw telemetry data and calculate home-range and movement statistics. TELEM (Koeln 1979) and HOMEST (Dunn 1978) were incorporated as subroutines of TELEPRO to calculate home range estimates by convex-polygon (Mohr 1947), non-circular (Jennrich and Turner 1969) and multivariate Ornstein-Uhlenbeck (MOU) (Dunn and Gipson 1977) methods, and geometric center of use (Hayne 1949). For the MOU method, home-range was defined as the area that included 95% of an animals' activities (Jennrich and Turner 1969).

Habitat Utilization

Habitat analysis was conducted utilizing a digital land resource data base prepared by the MRSC The data base, describing 19,000 ha centered on the study area, was created using photogrametric methods and color infrared imagery (scale 1: 15,870) flown 25 May 1979. Each 0.404-ha unit, called a pixel, was classified as row crops, pasture, pine forest, hardwood forest, cypress-tupelo gum forest or mixed forest. Forest habitat types were further classified as dense (>60% crown closure) or sparse (<60% crown closure) and as sawtimber (ave. dbh>26.7 cm), immature (ave. dbh 5–26.7 cm) or sapling (ave. dbh <5 cm).

Map coordinates of deer locations were converted to digitized data base coordinates using operational software at the MRSC. Individual deer locations were sorted by 4 seasons: spring (Mar–May), summer (Jun–Aug), fall (Sep–Nov), and winter (Dec–Feb).

Goodness of fit tests (Zar 1974) were used to determine if vegetative type availability within a convex polygon home range was different from vegetative type utilization by deer (H_o: Deer use each various vegetative type in proportion to its occurrence within its home range). The convex polygon home range was used to determine availability of habitat because we believed it reasonable to assume the animal was aware of the habitat types within the area encompassed by its travels. Goodness of fit tests were also used to examine vegetative type utilization by season. Only vegetative types with ≥ 1 expected locations were included in the test. All goodness of fit tests were conducted using the G statistic (Sokal and Rohlf 1969).

Confidence intervals (95%) were used for testing significance of utilization by vegetation type within seasons and annually (Neu et al. 1974). Confidence intervals were not calculated when N (number of observations) or p_i (proportion observed) were not sufficiently large; i.e., when Np_i or $N(1 - p_i) < 5$ (Hayes and Winkler 1970).

Each deer location was treated as a data base cell corresponding to 0.404 ha. Because cell size was smaller than the error polygon of 1.78 ha that depicted the observed accuracy of the telemetry system, a habitat proximity analysis also was conducted using a composite of 9 cells centered by the observed cell for a total cell size of 3.63 ha.

Results and Discussion

Deer Capture and Monitoring Period

Six adult or yearling deer were captured and outfitted with radio collars in February–March 1980. These deer were observed for at least 1 year, including 3 females aged at greater than 2.5 years at capture (deer numbers 120, 160 and 220), a female that was aged at 1.5 years of age at capture (deer number 260), a male aged at greater than 2.5 years of age at capture (deer number 140), and a male aged at 1.5 years of age at capture (deer number 200). Three males, a yearling and 2 6-month-old fawns were captured and radio collared in February and March 1982. The 2 fawns (deer numbers 491 and 891) were observed until January 1983 when both were killed by hunters. The yearling (deer number 266) was monitored until January when it was killed by hunters.

Habitat Utilization

The hypothesis that deer used each vegetative type in proportion to its occurrence was rejected for all deer except 491. Except for dense hardwood sawtimber, there was no clear pattern of utilization by deer. Dense hardwood sawtimber was used more than expected by all deer and significantly ($P<0.05$) more by 5 deer.

Seasonally, dense hardwood sawtimber was consistently used more than expected. Deer 160 used this habitat type more than expected in all seasons and significantly ($P<0.05$) more in spring, fall, and winter. Deer 260 used this habitat type significantly ($P<0.05$) more than expected in spring; deer 891 used it significantly more than expected in summer and fall; deer 140 used it significantly more than expected in winter. The year-round attractiveness for this type is unclear but perhaps is influenced by ambient temperatures and food resources. Ockenfels (1980) and Tucker (1981) reported an increase in utilization of riparian areas during high ($>30^{\circ}$ C) summer temperatures. Mast would be expected to attract deer in fall and winter, and it has been reported that well-watered hardwood bottoms contain deer forage superior to other sites (Moore et al. 1960, Moore 1967, Segelquest and Green 1968).

There was no clear preference for any pine cover type, although deer 220 did use dense immature pine in significantly ($P<0.05$) greater proportion than its availability, while deer 260 used sparse pine sawtimber significantly more than expected.

Row crops, principally soybeans, were used significantly ($P < 0.05$) less than expected by 3 deer and consistently less than expected by all others. Although expected, summer use of soybeans relative to availability did not increase. However, home ranges of most deer shifted during this period to include more of this habitat type.

Pastures were used significantly ($P <0.05$) less than expected by deer 160 and 260. Seasonally, deer 120 used pastures significantly ($P<0.05$) more than expected during summer, while deer 160 used pastures significantly less ($P <0.05$) than expected in spring, summer, and fall.

Home Range

The 3 calculation methods produced annual home range estimates that varied from 455 to 2,935 ha (Table 1). In general, home ranges were smallest during the winter with no other apparent seasonal trends. However, the largest home range of deer 120 occurred during winter. Average home range of males using the MOU model (1511 ha ± 571 SD) was twice as large as females (737 ha ± 219 SD).

Summer home range increases of deer 220 and 260 may be related to increased utilization of soybeans during the summer months. Home range size increased concurrently with a spring-summer shift of geometric centers of use toward these fields

Table 1. Estimates of home-range (ha) by season for 9 white-tailed deer, Bigbee Valley, Mississippi (1980–82) using the multivariate Ornstein-Uhlenbeck (MOU), non-circular (NC) and convex-polygon (CP) methods.

Deer	Sex	Age at Capture[a]	Method	Spring (Mar–May)	Summer (Jun–Aug)	Fall (Sep–Nov)	Winter (Dec–Feb)	Annual
			MOU	811	307	873	979	934
120	F	A	NC	830	276	748	1080	851
			CP	447	269	520	736	990
			MOU	742	[b]	[b]	427	728[c]
140	M	A	NC	802			457	741[c]
			CP	436			386	758[c]
			MOU	1113	661	799	192	883
160	F	A	NC	1264	672	650	189	919
			CP	905	619	681	193	1201
			MOU	1245	[d]	959	475	1735
200	M	Y	NC	1258	1575	884	480	1855
			CP	1064	1368	754	415	2935
			MOU	243	586	420	176	455
220	F	A	NC	234	634	423	154	475
			CP	222	525	281	142	651
			MOU	422	885	444	281	677
260	F	Y	NC	371	931	496	293	713
			CP	456	776	636	199	1344
			MOU	[b]	[b]	[b]	[b]	1179
266	M	Y	NC					1229
			CP					825
			MOU	[b]	[b]	[b]	[b]	2216
491	M	F	NC					2140
			CP					1703
			MOU	[b]	[b]	[b]	[b]	1697
891	M	F	NC					1561
			CP					1564

[a]A = adult, Y = yearling, F = fawn.
[b]Sample size considered too small (i.e., <40 observations).
[c]Annual home range does not include summer–fall observations which were off the study area and would expand home range estimates considerably.
[d]No estimate available as process did not appear stationary.

(819 m and 968 m, respectively). Deer 160 also shifted its spring-summer geometric center of use 612 m closer to soybeans, although its home range size did not increase.

Although row crops were not used in greater proportion than expected, the summer shift in home range centers toward soybeans may indicate an abundant food source provided by soybeans during the summer months that would require relatively little foraging time. The animal could spend a small proportion of time in this habitat type and still have soybeans constitute a major proportion of its diet. Almost without exception, deer could be seen feeding on soybeans within the study area during the summer months.

Deer 120 was the only animal whose geometric center of use was located in an agricultural rather than forested area. Accordingly, summer home range for deer 120 was smallest of the 4 seasonal home ranges, while winter home range, which included more forest, was the largest. A shift in center of use from summer, 1,350 m nearer to bottomland habitat, was observed in the winter home range of deer 120. This shift reflected deer 120's apparent strategy for exploiting the available habitat. This strategy centered activity around agricultural areas most of the year, with farther ranging in the winter when food was less plentiful in the fields. Another possible strategy was exhibited by deer 160, 220, and 260. They appeared to center most activity in hardwood areas where mast was plentiful in fall and winter and where succulent new vegetation was available in spring. Deer 140 centered its activity in bottomlands during the winter and in late March made migration-like movements, swimming the Tombigbee River, and locating 7-km distant in a swamp adjoining agricultural lands. Lack of sufficient radio fixes during April–October prohibited summer and fall home range and utilization estimates for deer 140. Deer 200 made a similar shift in center of use (3 km) for summer and winter. However, unlike deer 140, movements between these 2 areas occurred over several weeks. Multiple strategies for habitat exploitation have been observed in deer on the Welder Wildlife Refuge in Texas (Inglis et al. 1979).

Deer utilized bottomland hardwood forests, especially mature stands, extensively throughout the year. Some deer appeared to shift their geometric center of use toward soybean fields during the summer, but most deer still utilized bottomland habitats to a greater extent during this time. The seasonal forage provided by soybeans does not offset the permanent loss of bottomland hardwoods caused by agricultural clearing. Efforts to stem clearing of remaining bottomland hardwood tracts should be pursued.

These data suggest home ranges of deer utilizing diverse bottomland habitats are very large relative to that of deer in other southeastern habitats. Pledger (1975), Ockenfels (1980), and Herriman (1983) also reported home ranges >700 ha for deer inhabiting bottomland hardwoods. Shifting of home range to utilize soybean fields may cause concentrations of deer in agricultural areas, resulting in depredation problems. In areas where depredation is a problem, sportsmen and farmers should be encouraged to increase antlerless harvest over a considerable area surrounding bean fields. Managers should be aware that the minimum area that can be managed effectively for intensive herd management in bottomland habitats, or areas of great habitat diversity, is likely to be large.

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