HABITAT UTILIZATION OF WHITE-TAILED DEER
IN SOUTHEASTERN OHIO DETERMINED
BY RADIOTELEMETRY

A THESIS
Presented in Partial Fulfillment of the Requirements for the Degree Master of Science
by
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INTRODUCTION

Deer in Ohio

There is little doubt that the white-tailed deer (Odocoileus virginianus) is one of the most important game animals in Ohio. Widespread abuse of the white-tail and elimination of its habitat caused its extinction in Ohio by 1904, and not until 1943 did hunters enjoy the first modern hunting season in Ohio (Stoll and Donohoe 1973). Since 1961, the deer population has been increasing rapidly; hunter kill increased from 3,831 in 1971, to 23,431 in 1977, and hunters increased from 74,709 to 150,000 for the same period (Stoll 1977, pers. comm.). The economic importance of deer is well understood by a general store owner in southeastern Ohio who stated that deer hunters boost his sales by $600 per day during the deer gun season. In addition to hunters, many people enjoy deer in a non-consumptive way. Landowners boast of deer inhabiting or visiting their property, vacationers enjoy seeing deer when they visit Ohio's parks and forests, and others are satisfied just knowing that deer are present.

On the other hand, some people suffer monetary loss and personal injury from deer. Farmers, fruit growers, and nurserymen suffer losses each year from deer, and motorists receive injuries and property damage as a result of deer on our highways. Deer management must be conducted to satisfy these diametrically opposed groups.
Status and Objectives

Little is known about the habitat requirements of white-tailed deer in the central hardwoods region. This point is substantiated by the few papers available and by comments made by deer experts in a recent symposium (Bookhout 1970). Most technical data concern food habits (Murphy 1970, Nixon et al. 1970), and little information has accumulated concerning Ohio deer (Nixon 1965, Nixon et al. 1970). These workers noted food was probably not limiting to midwestern deer herds, but Murphy (1970) observed that range appraisal was not being applied in midwestern states. Nixon (1970), in Ohio, used sightings of deer, rubbing sites made by antlered bucks, and bed locations to determine habitat preferences.

Virtually no information is available on the effects of weather, season, and time on habitat selection of deer in Ohio. Information on western deer and northern yarding deer, while providing comparable data, would not be indicative of deer in this region. Successful management must start with basic knowledge of the ecological parameters that affect deer habitat utilization. Therefore, the objectives of this study were: (1) to determine the proportion of time spent by deer in different forest successional types; (2) to describe composition, cover, density, and size class of plants in areas used by deer; and, (3) evaluate the effects of weather, season, and time on deer
habitat selection.
MATERIALS AND EQUIPMENT

Study Areas

The first study area (Zaleski) was established in Vinton County and included 1,980 ha within Zaleski State Forest (Fig. 1). The Zaleski study area was chosen because deer are abundant, road systems are extensive, and botanical descriptions were available (Nixon 1965, Moser 1972). Proximity to the Waterloo Wildlife Experiment Station of the Ohio Division of Wildlife, 13 km east, was also an important factor in choice of the Zaleski area (Francis 1975). A second study area (Union Furnace) of 260 ha in Hocking County (Fig. 2) became necessary when an experimental animal shifted its range 18.5 km from the original study area.

Hocking and Vinton counties are in the unglaciated portion of southeastern Ohio; as a result, the relief in these counties is greatly dissected (Goldwait et al. 1961). Elevation in the Zaleski area ranges from 204-311 m above sea level. Steep ridges typically rise from numerous narrow valleys. Union Furnace area ranges from 244-314 m above sea level and is topographically similar to the Zaleski area.

Study area soils are Muskingum silt loam and loam derived principally from sandstone and shale of the Mississippian and Pennsylvanian groups (Beatley 1959,
Fig 1. Location of the Zaleski study area. The study area boundary is defined by the heavy black line and location of the area is noted inside map of Ohio (insert). Map is from Zaleski State Forest, Department of Natural Resources, Columbus, Ohio.
Fig. 2. Location of the Union Furnace study area. The study area boundary is defined by the heavy black line and location of the area is noted inside the map of Ohio (insert). Map is from U.S. Geological Survey topographic map, Union Furnace quadrangle.
Stout 1927). These soils are generally shallow, acidic, and constantly eroded from steep ridges and narrow valleys.

Climate in southeastern Ohio is mild. Temperatures from stations near the study areas range from a mean annual high for 1894-1957 of 19³ C to a mean annual low of 5⁰ C (Beatley 1959). Mean annual temperature is 12⁰ C. The warmest and coldest months are July and January. Mean annual precipitation from 1894-1957 was 104.22 cm with a range of 70.59-145.26 cm, while mean annual snowfall was 59.69 cm, and average percent of precipitation as snow was 11.6%. Average number of frost-free days per year in Hocking and Vinton counties are 163 and 150 respectively (Gordon 1969).

Hocking and Vinton counties were profoundly affected as the iron ore industry went into large-scale production in southeastern Ohio about 1850. Vast areas of timber were cut to provide charcoal for blast furnaces (Beatley 1959). By 1883, 60% of the virgin forest in southeastern counties was cleared and second-growth forests were being utilized (Lord 1884). During the 1930's, these large tracts of even-aged, well-stocked second and third growth furnace lands, of which the Zaleski study area is a part, were acquired by the Federal and State Governments (Beatley 1959). These forests are managed by the U.S. Forest Service and the Ohio Division of Forestry.

Hardwood forests in southeastern Ohio are classified
as mixed mesophytic forest (Braun 1950). In the Zaleski area chestnut and black oak (*Quercus prinus*, *Q. velutina*) and pignut and mockernut hickory (*Carya glabra*, *C. tomentosa*) dominate ridgetops and upper slopes. Understory commonly consists of small oaks and hickories, sassafras (*Sassafras albidum*), flowering dogwood (*Cornus florida*), red maple (*Acer rubrum*), and greenbriar (*Smilax rotundifolia*, *S. glauca*). Dominant ground cover frequently includes greenbriar, poison ivy (*Rhus radicans*), common cinquefoil (*Potentilla simplex*) and lowbush blueberry (*Vaccinium angustifolium*). Middle and lower slopes often contain a mosaic of canopy species such as white and red oak (*Q. alba*, *Q. rubra*), sugar maple (*A. saccharum*), tuliptree (*Liriodendron tulipifera*), white ash (*Fraxinus americana*), and American Beech (*Fagus grandifolia*). Prevalent understory species on the slopes are dogwood, sassafras, American hornbeam (*Carpinus caroliniana*), tuliptree, white ash, blackgum (*Nyssa sylvatica*), sugar and red maple, mapleleaf viburnum (*Viburnum acerfolium*), greenbriar, and grape (*Vitis* spp.). Dominant ground cover, with the addition of Virginia creeper (*Parthenocissus quinquefolia*), is similar to that of the upper slopes. Flood plains and hollows (narrow valley bottoms) support canopy species such as American beech, tuliptree, sycamore (*Platanus occidentalis*), buckeye (*Aesculus* spp.), and river birch (*Betula nigra*); in the understory, white ash, tuliptree,
spice bush, (*Lindera benzoin*), American hornbeam, river birch, blackberries (*Rubus* spp.), and grape are common. Ground cover in the bottoms is most diverse and typically consists of violets (*Viola* spp.), false miterwort (*Fiarella cordifolia*), geum and avens (*Geum virginianum, G. canadense*), spotted jewelweed (*Impatiens capensis*), bedstraw (*Galium boreale*), clearweed (*Pilea pumila*), and poison ivy. White pine (*Pinus strobus*), red (*P. resinosa*), and shortleaf (*P. echinata*) pine plantations make up approximately 20% of the Zaleski timber class and include about 25% of the study area (Stoll et al. 1975).

The Union Furnace area is privately owned, was extensively stripped for coal about 1946, and was not reclaimed. The stripped areas are bare with few trees, severely eroded, and contain many ponds. Black locust (*Robinia pseudoacacia*), red elm (*Ulmus rubra*), and bigtooth aspen (*Populus grandidentata*) are trees most frequently encountered in the stripped area. Hollows that were not disturbed contain vegetation similar to that of the Zaleski area.

Capture

Modified clover traps (Clover 1954) were used to capture deer and were described by Francis (1975). Further modifications included raising the trip-line to avoid accidental springing by small mammals and installing a mechanism that secured the drop-bars once the trap was sprung.
(Schriver 1976). A Cap-Chur gun delivering a dart containing succinylcholine chloride (Appendix A) was used to immobilize deer. Dart size was either 1, 2, or 3 cc and darts were loaded with a dose for fawns (age < 1 year) of 7.2 mg (0.04 mg/kg). This load was used because fawns were most frequently seen, were least frightened by autos, and showed the smallest variation in weight.

Tracking System

Each transmitter (Appendix A) weighed about 600 g and was sealed with dental acrylic to withstand environmental stresses. The transmitter was mounted on an adjustable nylon collar 5 cm wide and 57 cm long, and was attached to the deer by securing four bolts, lockwashers, and nuts through holes in each end of the collar. Transmitters were powered by mercury batteries, and the signal was pulsed to increase battery life to 24 months. Collars were fitted with whip antennas made of spring steel that were sealed inside the collar. The antenna extended from the collar dorsal to the spine and protruded 7.6-20.3 cm. Each receiver (Appendix A) was inside an aluminum case for protection and was fitted with a handle or shoulder strap for portability. An 8-element yagi antenna (Appendix A) was permanently mounted on both a Ford Bronco and a military jeep. Nearly all radio-tracking was done in these vehicles. The antenna passed through the roof of a vehicle, through a
compass chart and was then anchored to the floor or seat. The chart was a plywood circle 25.4 cm in diameter that was scribed with 360 degrees. An azimuth indicator (pointer) was attached to the mast just above the compass chart. A 3-element hand-held yagi was used to investigate the location of a deer when no movement was noted for conspicuously long periods of time. The small yagi also was used with aircraft when signals could not be detected from the ground.

Meteorological Equipment

Meteorological equipment (Appendix A) consisted of: (1) a pyranograph for recording solar radiation; (2) hygrothermograph for recording temperature and relative humidity; and, (3) a rain/snow gauge. All of the equipment, except the rain/snow gauge, was located at the Waterloo Wildlife Experiment Station. The station afforded more security than the study area, and the pyranograph was mounted on top of one of the station buildings. The hygrothermograph was housed inside a well-ventilated (louvered) box that was mounted on a post. The post was driven into the ground until the box was 30.48 cm above the ground. Charts were changed on the equipment weekly. The rain/snow gauge was installed at my home in Zaleski which was adjacent to the study area. The gauge was read daily at midnight.
METHODS

Capture and Handling

Areas of heavy deer use were first ascertained from tracks, trails, and signs of browsing. These areas were baited with apples for one week, then abandoned or equipped with a trap. Apples were placed inside traps, and traps were checked twice a day. When a deer was captured, it was first subdued inside the trap. A burlap bag was placed over the head to quiet the deer, and the animal was carried outside the trap for ease of handling. Age, sex, and physical condition were recorded, and a transmitter was fastened around the neck. Chest girth was measured to estimate weight from a regression equation (Townsend 1973).

A Cap-Chur gun was employed as a second method of capture and soon became the primary technique. Two people drove slowly through the study area at any time of day, and when deer were observed on or near the road, the driver advanced the vehicle cautiously until the shooter had a relatively unobstructed shot at the hip of the animal. A distance of 18-36 m was estimated to be a safe, effective range. After a shot that appeared to hit the deer, personnel remained inside the vehicle for 10 minutes. An attempt was then made to find the barbless dart to determine if it had discharged. If the dart fired, a swift and thorough search for the drugged deer was launched. If the deer
was found, it was immediately positioned on its left side with its head and body uphill. Heartbeat and respiration were checked, and the mouth and throat were checked for rumen contents to assure that the deer would not choke. Then, the same procedure was followed for the drugged deer as was used for a trapped animal. After the animal was collared, personnel watched from a distance until the drugged animal moved away.

Monitoring Deer

Each collared deer was followed twice each month during a 24-hour interval by both tracking vehicles. Methods for monitoring deer are described by Francis (1975). Triangulation of azimuths obtained simultaneously by each monitoring vehicle was used to locate radio-equipped deer (Marshall and Kupa 1963). An azimuth was obtained by bisecting the compass readings between two signal nulls, or points where the signal became inaudible (Anderson and De Moor 1971). Wind, cloud cover, precipitation, light condition, and signal fluctuation were noted in conjunction with each deer location and were recorded as follows: wind as calm (0), breezy (1), or windy (2); cloud cover as clear (0), partly cloudy (1), overcast (2), haze (3), fog (4); light condition as dawn (0), day (1), dusk (2), dark (3); precipitation as none (0), drizzle (1), rain (2), sleet (3), snow (4), hail (5); and signal as
nonfluctuating (0) or fluctuating (1). Numerical representation of variables was used to simplify computer analyses. Each tracking unit exchanged azimuth readings every 30 minutes, a procedure that allowed both operators to maintain on maps a current record of location of an animal. This allowed each operator to adjust his position to maintain optimal tracking stations.

Botanical Sampling

An accurate estimate of error in locating radio-collared deer was not available for the study area. Therefore, transmitters were placed on a ridgetop and a valley bottom for tests. Radio-locations were then taken from tracking stations surrounding the transmitters. Test data were examined to discover variance of sample locations from the true location of the transmitter. The mean error plus two standard errors (n=57, SE=10.67 m) from a true location was determined to be 21.34 m. This resulting value was used as the radius of a circle containing the true location of a radio-collared deer in 95% of the radio-locations (0.14 ha). The area of error around a radio-location (1,430.91 sq m) was converted to quadrats (eighteen 4x20 m) to facilitate random sampling (Fig. 3).

Deer locations were randomly selected from each monitoring period for habitat plots. A period was separated into six 4-hour time groups. Numbered beans corresponding
Fig. 3. Botanical sampling scheme showing positions and dimensions of quadrats used at randomly selected deer locations. Figure is not drawn to scale.
to the number of radio-locations obtained during a 4-hour period (16 maximum) were placed in a container. A bean was randomly drawn for each 4-hour period to determine which deer location would be sampled for that period. If one location was obtained for a 4-hour period, then that location was sampled. The same method of random selection was used to determine location of vegetational quadrats within a 0.14-hectare sample location.

Procedure for each vegetational sample included: (1) a random selection of one 4x20 m overstory quadrat (Francis 1975); (2) a random selection of one 2x10 m understory quadrat within the chosen overstory quadrat (Moser 1972, Francis 1975); and, (3) a systematic sample of one segmented belt transect 10 m long where 25 alternate units 10x20 cm were sampled for ground cover species (Oosting 1956). A clinometer built in the compass was used to measure the slope at each sample. Stem counts were made in the quadrats according to the following criteria: overstory included trees > 10 cm diameter breast height (dbh); understory included trees < 10 cm dbh and > 61 cm in height, and shrubs and woody vines > 61 cm in height; and, ground cover included all herbaceous plants regardless of size, and woody plants and vines < 61 cm in height (Moser 1972, Francis 1975). Sample locations and quadrats to be sampled were ascertained and transcribed onto vegetation data sheets prior to going into the field. This technique
conserved time and allowed for maximum sampling effort once personnel were in the field. A compass and 7.5-minute topographic map was used to locate sample plots in the field.

Habitat (overstory) type at a deer location was determined by criteria set forth in Moser (1972:46-48). The overstory consists of eleven generalized plant associations:

- Mixed mesophytic
- Beech-maple
- Bottomland hardwoods
- Mixed oaks
- Oak-hickory
- Chestnut oak-hickory
- Shortleaf pine
- Red-other pines
- Successional hardwoods
- Grass-forbs

**Mixed Mesophytic.** Mixed mesophytic is a mature forest type that occurs in cool, moist, but well-drained sites, such as lower slopes, north and east facing slopes, coves, and some valley bottoms. Red and black oaks predominate over white oaks (excluding chestnut oak). An abundance of tuliptree commonly with basswood (*Tilia americana*) and the aforementioned black oaks are characteristic of this habitat type.

**Beech-Maple.** Beech-maple is mature forest which occupies similar areas as mixed mesophytic. The main differences with mixed mesophytic are the composition of the oaks and abundance of beech and sugar maples.

**Bottomland Hardwoods.** The bottomland hardwoods occupy
the poorly drained, flat, valley bottoms. The canopy is sparse and characteristic trees are river birch, elm, buckeye, and sycamore.

**Mixed Oaks.** Mixed oaks are on the wider and wetter ridgetops, the slowly sloping north-facing hillsides, and some of the low places on the drier ridges. The canopy is a mixture of oaks with no apparent dominants.

**Oak-Hickory.** Oak-hickory occurs on the upper slopes, ridgetops, south-facing slopes, and the drier east and west-facing slopes. Hickories and oaks dominate the canopy.

**Chestnut Oak-Hickory.** Chestnut oak-hickory occupies the dry ridgetops and occasionally low places on the ridge and dry upper slopes. Chestnut oak and hickory dominate the canopy.

**Shortleaf Pine.** Shortleaf pine occurs in plantations commonly found on upper slopes or ridgetops. They are often sparsely planted, with well developed understories.

**Red-Other Pines.** Red and other pines are plantations of red pine and often mixtures of red, white, or shortleaf pine. The plantations are located on a variety of sites, except the steep slopes, from the valleys to the ridgetops.

**White Pine.** The white pine type is almost pure plantations of white pine and occurred from the valleys to the ridgetops. Typically, white pine has a dense canopy and little or no understory.
**Successional Hardwoods.** Successional hardwood type exists in sites that appear to have been farmed or cut-over 5 to 25 years ago. It exists on the full range of slopes. Typical species include aspen, black locust, hickories, tuliptree, hawthorns, sourwood, dogwood, and briers.

**Grass-Ferbs.** Grass-forbs usually occur on the upper slopes and ridgetops. The sites were cultivated or grazed at one time and now are only slowly being reinvaded by woody species. The soils appear to be poor in nutrients and shallow.

**Data Analyses**

Data from botanical sampling forms were tabulated and key-punched for statistical analyses. Chi² and one-way analysis of variance (ANOVA1) programs were obtained from the Statistics Laboratory, Statistics Department, The Ohio State University, Columbus. To facilitate comparisons with other data from the study area, classification of variables are those used by Moser (1972) and Francis (1975). The term 'climatic variables' includes temperature, humidity, barometric pressure, and solar radiation. Seasons, as used hereafter, are defined as spring (March 1-May 31), summer (June 1-August 31), and fall (September 1-November 30). Only two categories of time were considered: day (0800-2000) and night (2000-0800). Smaller time categories were not possible because of a small sample size.
Habitat preference and avoidance were determined by a Z-test (Freund et al. 1960), using control data that were collected by Moser (1972) for the Zaleski study area. No control data existed for Deer 8 at Union Furnace; therefore, Zaleski area control data were assumed to represent the Union Furnace study area, and results from Deer 8 throughout this study were compared with Zaleski data.
RESULTS

Capture

Traps

Probable trap sites were baited January 6, 1974, in the Zaleski study area. Apples were consumed daily by deer at seven bait sites. After a week of baiting, four clover traps were set at heavily used locations. A total of three deer were captured with traps and one animal was trapped twice (Table 1).

The first trap was set at the Lake Hope Environmental Resources Center (LHERC) on January 8, at 1800, and a female fawn (No. 1) was trapped, collared, and released by 2200 on the same evening. This animal remained in the area and was periodically located during January and February. No 24-hour monitoring periods were performed because of intensive trapping effort. No. 1 was last located February 26, and her signal was picked up briefly on April 25; thereafter the signal disappeared and was not heard again.

A second trap was set at LHERC January 11, at 2100. A male fawn (No. 4) was trapped and collared at 2300 on the same evening. This animal was retrapped at LHERC February 23, and lost its collar inside the trap. The transmitter was not working, and the animal was instrumented with a new radio-collars, released, and identified as No. 5 (Table 2) before the collar was lost during June. The
collar was found June 27, on a powerline right-of-way near LHERC, after the lockwasher nut and bolt assembly came apart.

Clover traps were not successful after the brief trapping success during January at LHERC. A test was conducted at other trap locations to determine if deer were avoiding trap sites or if apples were losing their desirability as bait. Apples were placed inside and outside traps and checked daily for use. Deer readily ate apples adjacent to the traps but did not enter the traps for more apples. Traps were baited and checked through March, 1974, at which time trapping as a capture method was abandoned.

**Cap-Chur Gun**

Five deer were immobilized with a Cap-Chur gun between March 21 and April 17 (Table 1). The first, a pregnant fawn (No. 2) was immobilized and collared March 21. No monitoring periods were conducted before the animal disappeared May 21, and an air search of approximately 518 km square around the capture location failed to detect a signal.

Another pregnant fawn (No. 8) was captured March 24, and monitoring began during April. This animal remained in the Zaleski area until April 26, when her signal was lost. On June 28, her signal was detected from an airplane over the Union Furnace area in Hocking County. This animal was then radio-tracked for the duration of the study (Table 2).

Deer 10, a female fawn, was immobilized near LHERC on
March 29. This animal was with Deer 1 and an adult doe. Subsequent radio-locations showed No. 10 and 1 remained together for a few days, then Deer 1 either left the area or suffered transmitter failure. No. 10 remained in the study area near LHERC and was monitored for the duration of the study.

A female fawn (No. 7) was immobilized and collared on April 2, and remained in the area until July 5. Several monitoring periods were attempted but the animal was repeatedly in inaccessible areas and consistently had a weak radio signal so time was spent on more readily available animals.

On April 17, the final animal, a female fawn (No. 9), was captured. After recovering from the effects of the drug, the deer repeatedly tried to back out of her collar and twice flipped backwards landing on her back. The following day, she was in an inaccessible area and was monitored from only one location. Therefore, an accurate location was not obtained. I walked into the area on July 31, with a handheld antenna and receiver and found No. 9's transmitter lying on a deer trail about midslope on the other side of the ridge where she was collared. Apparently the deer managed to work the transmitter over her head because the collar was found securely fastened together.

A dart size of 2 cc was used on all animals immobilized. Succinylcholine chloride acted rapidly and catabolized quickly. Animals were immobile long enough (30-45 min) for
a transmitter to be attached and for the animal to be exam-
ined. Animals captured per hour of effort was greater for
the Cap-Chur gun (0.0297) than for trapping (0.0005).

Monitoring

During the period from January 8, 1974, to December 7,
1974, 1,067 radio-locations were taken on six animals
(Tables 1 and 2). Twenty-four hour monitoring began during
April after seven available transmitters were attached to
deer. Prior to April, spot checks were conducted on exper-
imental animals but capture remained paramount.

Most data (856 locations) were obtained from Deer 8 at
Union Furnace and Deer 10 at Zaleski (Table 2). Data
obtained from No. 5 were not used for habitat analysis
because the number of sample habitat plots (n=6) was con-
sidered too small for precise inference. Deer 5 lost his
transmitter. Deer 1, 2, and 7 either left the area or
suffered transmitter failure. An air search picked up the
signal from No. 7 and 9. However, Deer 7 later dis-
appeared and Deer 9 lost her transmitter. The fate of
Deer 1, 2, and 7 remained unknown at the end of the study.

Deer Habitat

A total of 104 deer locations were sampled to deter-
mine physical characteristics and plant composition.
Vegetational samples for Deer 10 in Zaleski (n=62) were
Table 1. Summary of deer captured, instrumented, and radio-tracked.¹

<table>
<thead>
<tr>
<th>Deer No.</th>
<th>Date of Capture</th>
<th>Time</th>
<th>Capture Method</th>
<th>Sex</th>
<th>Chest Girth (cm)</th>
<th>Weight Estimate (kg)</th>
<th>Date Lost</th>
<th>Cause of Signal Loss</th>
<th>Total Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>01/08/74</td>
<td>2200</td>
<td>Trap</td>
<td>F</td>
<td>73.7</td>
<td>30.2</td>
<td>04/25/74</td>
<td>Unknown</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>03/21/74</td>
<td>1300</td>
<td>Gun</td>
<td>F</td>
<td>95.2</td>
<td>62.3</td>
<td>05/12/74</td>
<td>Unknown</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>01/11/74</td>
<td>2300</td>
<td>Trap</td>
<td>M</td>
<td>66.0</td>
<td>22.3</td>
<td>02/23/74</td>
<td>Transmitter Failure</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>02/23/74</td>
<td>1100</td>
<td>Trap</td>
<td>M</td>
<td>73.7</td>
<td>30.2</td>
<td>06/27/74</td>
<td>Transmitter Lost</td>
<td>192</td>
</tr>
<tr>
<td>7</td>
<td>04/02/74</td>
<td>0800</td>
<td>Gun</td>
<td>F</td>
<td>76.2</td>
<td>33.3</td>
<td>07/05/74</td>
<td>Unknown</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>03/23/74</td>
<td>0845</td>
<td>Gun</td>
<td>F</td>
<td>92.7</td>
<td>57.7</td>
<td>Operative</td>
<td>Unknown</td>
<td>444</td>
</tr>
<tr>
<td>9</td>
<td>04/17/74</td>
<td>1030</td>
<td>Gun</td>
<td>F</td>
<td>78.7</td>
<td>36.5</td>
<td>07/31/74</td>
<td>Transmitter Lost</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>03/29/74</td>
<td>2000</td>
<td>Gun</td>
<td>F</td>
<td>73.7</td>
<td>30.2</td>
<td>Operative</td>
<td>Unknown</td>
<td>412</td>
</tr>
</tbody>
</table>

¹ All study animals were fawns.
2 (Townsend 1973).
3 Same animal collared twice.
Table 2. Dates and radio-locations for deer that provided quantitative data during the study.

<table>
<thead>
<tr>
<th>Dates</th>
<th>Deer No.</th>
<th>No. of Locations</th>
<th>Area</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>04/05/74-04/06/74</td>
<td>5</td>
<td>35</td>
<td>Zaleski</td>
<td></td>
</tr>
<tr>
<td>04/05/74-04/12/74</td>
<td>8</td>
<td>31</td>
<td>Zaleski</td>
<td>Lost 04/26/74</td>
</tr>
<tr>
<td>05/11/74-05/12/74</td>
<td>10</td>
<td>28</td>
<td>Zaleski</td>
<td></td>
</tr>
<tr>
<td>05/20/74-05/21/74</td>
<td>5</td>
<td>50</td>
<td>Zaleski</td>
<td></td>
</tr>
<tr>
<td>06/23/74</td>
<td>10</td>
<td>20</td>
<td>Zaleski</td>
<td>Inaccessible area, cleared trails</td>
</tr>
<tr>
<td>07/05/74</td>
<td>8</td>
<td>3</td>
<td>Union</td>
<td>Cleared trails for monitoring stations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Furnace</td>
<td></td>
</tr>
<tr>
<td>07/09/74</td>
<td>10</td>
<td>4</td>
<td>Zaleski</td>
<td>Inaccessible area</td>
</tr>
<tr>
<td>07/11/74</td>
<td>10</td>
<td>4</td>
<td>Zaleski</td>
<td>Cleared trails</td>
</tr>
<tr>
<td>07/12/74-07/13/74</td>
<td>10</td>
<td>11</td>
<td>Zaleski</td>
<td>Cleared trails, established stations</td>
</tr>
<tr>
<td>07/14/74</td>
<td>8</td>
<td>3</td>
<td>Union</td>
<td>Inaccessible area</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Furnace</td>
<td></td>
</tr>
<tr>
<td>07/16/74-07/17/74</td>
<td>8</td>
<td>77</td>
<td>Union</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Furnace</td>
<td></td>
</tr>
<tr>
<td>07/18/74</td>
<td>10</td>
<td>19</td>
<td>Zaleski</td>
<td>Inaccessible area</td>
</tr>
<tr>
<td>08/16/74-08/17/74</td>
<td>10</td>
<td>74</td>
<td>Zaleski</td>
<td></td>
</tr>
<tr>
<td>08/19/74-08/20/74</td>
<td>8</td>
<td>76</td>
<td>Union</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Furnace</td>
<td></td>
</tr>
<tr>
<td>08/23/74</td>
<td>10</td>
<td>38</td>
<td>Zaleski</td>
<td>Disabled antenna</td>
</tr>
<tr>
<td>09/17/74-09/18/74</td>
<td>10</td>
<td>71</td>
<td>Zaleski</td>
<td></td>
</tr>
<tr>
<td>09/20/74</td>
<td>10</td>
<td>30</td>
<td>Zaleski</td>
<td></td>
</tr>
<tr>
<td>09/23/74-09/24/74</td>
<td>8</td>
<td>87</td>
<td>Union</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Furnace</td>
<td></td>
</tr>
<tr>
<td>Dates</td>
<td>Deer No.</td>
<td>No. of Locations</td>
<td>Area</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------</td>
<td>----------</td>
<td>------------------</td>
<td>-----------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>09/27/74-09/28/74</td>
<td>10</td>
<td>82</td>
<td>Zaleski</td>
<td></td>
</tr>
<tr>
<td>10/01/74-10/02/74</td>
<td>8</td>
<td>80</td>
<td>Union Furnace</td>
<td></td>
</tr>
<tr>
<td>10/08/74-10/09/74</td>
<td>10</td>
<td>63</td>
<td>Zaleski</td>
<td></td>
</tr>
<tr>
<td>10/15/74-10/16/74</td>
<td>8</td>
<td>75</td>
<td>Union Furnace</td>
<td></td>
</tr>
<tr>
<td>10/22/74</td>
<td>10</td>
<td>6</td>
<td>Zaleski</td>
<td>Inaccessible area, vehicle disabled</td>
</tr>
<tr>
<td>11/03/74-11/06/74</td>
<td>10</td>
<td>55</td>
<td>Zaleski</td>
<td></td>
</tr>
<tr>
<td>12/02/74-12/03/74</td>
<td>10</td>
<td>8</td>
<td>Zaleski</td>
<td>Deer gun season</td>
</tr>
<tr>
<td>12/03/74</td>
<td>8</td>
<td>6</td>
<td>Union Furnace</td>
<td>Deer gun season</td>
</tr>
<tr>
<td>12/06/74</td>
<td>8</td>
<td>2</td>
<td>Union Furnace</td>
<td>Deer gun season</td>
</tr>
<tr>
<td>12/07/74</td>
<td>10</td>
<td>3</td>
<td>Zaleski</td>
<td>Deer gun season</td>
</tr>
</tbody>
</table>
obtained during the spring \(n=10\), summer \(n=22\), and fall \(n=30\) of 1974. Seven samples were gained on Deer 8 in Zaleski during the spring before she shifted her range to Union Furnace. These samples were combined with those of No. 10 for describing deer habitat in the Zaleski study area. At Union Furnace, 35 sample habitat plots were obtained for Deer 8 (summer \(n=16\); fall \(n=19\)). Species composition of habitat types appears in a list of all plant species recorded in deer habitat plots for each area in Appendices B, C, and D.

**Habitat Selection**

**Overstory Type.** Deer 10 (Zaleski) preferred successional hardwoods, mixed mesophytic, bottomland hardwoods, and mixed oaks (Table 3). All of these types have diverse overstory, understory, and ground cover strata (Tables 4-7). Mixed mesophytic has the most diverse overstory with 13 species; successional hardwoods and mixed oaks contained 9 species each, and bottomland hardwoods contained 7 (Table 4).

Successional hardwoods received more use (27%) than other preferred types (Table 3). Avoidance was shown for oak-hickory and shortleaf pine. Other types were used by Deer 10, but no preference or avoidance was shown (Table 3).

Preferences of No. 8 were identical to No. 10, but also included a preference for grass-forbs (old field) type
<table>
<thead>
<tr>
<th>Overstory Type(^1)</th>
<th>Observations(^1)</th>
<th>Deer 10, Zaleski Habitat Plots</th>
<th>Deer 8, Union Furnace Habitat Plots</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In Each Type (n=121)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chestnut Oak-Hickory(^2)</td>
<td>8(6.6)(^3)</td>
<td>2(3.2)</td>
<td>-0.95</td>
<td>0(0.0)</td>
</tr>
<tr>
<td>Oak-Hickory</td>
<td>58(47.9)</td>
<td>8(12.9)</td>
<td>-4.67*</td>
<td>4(11.4)</td>
</tr>
<tr>
<td>Mixed Oaks</td>
<td>1(0.8)</td>
<td>9(14.5)</td>
<td>3.86*</td>
<td>7(20.0)</td>
</tr>
<tr>
<td>Mixed Mesophytic</td>
<td>3(2.5)</td>
<td>9(14.5)</td>
<td>3.11*</td>
<td>4(11.4)</td>
</tr>
<tr>
<td>Beech-Maple</td>
<td>15(12.4)</td>
<td>5(8.1)</td>
<td>-0.89</td>
<td>0(0.0)</td>
</tr>
<tr>
<td>Bottomland Hardwoods(^4)</td>
<td>2(1.6)</td>
<td>5(8.1)</td>
<td>2.14*</td>
<td>-----</td>
</tr>
<tr>
<td>Successional Hardwoods</td>
<td>4(3.3)</td>
<td>17(27.4)</td>
<td>4.84*</td>
<td>13(37.1)</td>
</tr>
<tr>
<td>Shortleaf Pine(^4)</td>
<td>17(14.1)</td>
<td>0(0.0)</td>
<td>-3.10*</td>
<td>-----</td>
</tr>
<tr>
<td>Red-Other Pines</td>
<td>5(4.1)</td>
<td>2(3.2)</td>
<td>-0.30</td>
<td>0(0.0)</td>
</tr>
<tr>
<td>White Pine</td>
<td>4(3.3)</td>
<td>2(3.2)</td>
<td>-0.30</td>
<td>0(0.0)</td>
</tr>
<tr>
<td>Grass-Forbs</td>
<td>4(3.3)</td>
<td>3(4.8)</td>
<td>0.51</td>
<td>7(20.0)</td>
</tr>
</tbody>
</table>

\(^1\) Control data (Moser 1972).
\(^2\) Chestnut Oak and Chestnut Oak-Hickory combined (Moser 1972:44).
\(^3\) Percentages in parentheses.
\(^*\) Overstory type not present at Union Furnace.
Significant at P≤0.05 (Z-test).
Table 4. Characteristics of the overstory in habitat types utilized by Deer 10 in the Zaleski study area.

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Number of Observations (n=65)</th>
<th>Mean DBH (cm)</th>
<th>Mean Basal Area (sq m/ha)</th>
<th>Mean Density (stems/ha)</th>
<th>Diversity$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chestnut Oak-Hickory</td>
<td>2(3.0)$^2$</td>
<td>27.43(3.35)$^3$</td>
<td>122.2(50)$^3$</td>
<td>500(0)$^3$</td>
<td>3</td>
</tr>
<tr>
<td>Oak-Hickory$^4$</td>
<td>9(13.8)</td>
<td>22.61(4.37)</td>
<td>81.4(22)</td>
<td>472(50)</td>
<td>8</td>
</tr>
<tr>
<td>Mixed Oak$^5$</td>
<td>9(13.8)</td>
<td>26.16(5.23)</td>
<td>88.5(16)</td>
<td>437(53)</td>
<td>9</td>
</tr>
<tr>
<td>Mixed Meso-phytic$^5$</td>
<td>10(15.4)</td>
<td>19.05(3.58)</td>
<td>46.5(12)</td>
<td>400(81)</td>
<td>13</td>
</tr>
<tr>
<td>Beech-Maple</td>
<td>6(9.2)</td>
<td>22.86(6.86)</td>
<td>92.3(26)</td>
<td>500(102)</td>
<td>9</td>
</tr>
<tr>
<td>Bottomland Hardwoods$^5$</td>
<td>6(9.2)</td>
<td>15.49(1.32)</td>
<td>43.5(20)</td>
<td>500(114)</td>
<td>7</td>
</tr>
<tr>
<td>Successional Hardwoods$^3$</td>
<td>18(27.7)</td>
<td>14.99(1.14)</td>
<td>49.7(14)</td>
<td>542(81)</td>
<td>9</td>
</tr>
<tr>
<td>Red-Other Pines</td>
<td>3(4.6)</td>
<td>17.02(1.24)</td>
<td>110.1(49)</td>
<td>708(232)</td>
<td>2</td>
</tr>
<tr>
<td>White Pine</td>
<td>2(3.0)</td>
<td>18.03(1.07)</td>
<td>133.1(10)</td>
<td>562(312)</td>
<td>2</td>
</tr>
</tbody>
</table>

$^1$ Diversity equals number of different species.

$^2$ Percentages in parentheses.

$^3$ Standard errors in parentheses.

$^4$ Avoided.

$^5$ Preferred.
Table 5. Characteristics of the overstory in habitat types utilized by Deer 8 in the Union Furnace study area.

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Number of Observations (n=28)</th>
<th>Mean DBH (cm)</th>
<th>Mean Basal Area (sq m/ha)</th>
<th>Mean Density (stems/ha)</th>
<th>Diversity&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oak-Hickory&lt;sup&gt;4&lt;/sup&gt;</td>
<td>4(14.3)&lt;sup&gt;2&lt;/sup&gt;</td>
<td>23.01(4.80)&lt;sup&gt;3&lt;/sup&gt;</td>
<td>104.8(41)</td>
<td>531(129)</td>
<td>4</td>
</tr>
<tr>
<td>Mixed Oaks&lt;sup&gt;5&lt;/sup&gt;</td>
<td>7(25.0)</td>
<td>19.79(2.51)</td>
<td>65.6(24)</td>
<td>446(94)</td>
<td>8</td>
</tr>
<tr>
<td>Mixed Mesophytic&lt;sup&gt;2&lt;/sup&gt;</td>
<td>4(14.3)</td>
<td>17.73(3.38)</td>
<td>127.9(61)</td>
<td>718(219)</td>
<td>7</td>
</tr>
<tr>
<td>Successional Hardwoods&lt;sup&gt;5&lt;/sup&gt;</td>
<td>13(46.4)</td>
<td>15.06(2.13)</td>
<td>29.7(13)</td>
<td>417(77)</td>
<td>8</td>
</tr>
</tbody>
</table>

<sup>1</sup> Diversity equals number of different species.
<sup>2</sup> Percentages in parentheses.
<sup>3</sup> Standard errors in parentheses.
<sup>4</sup> Avoided.
<sup>5</sup> Preferred.
Table 6. Characteristics of the understory and ground cover in habitat types utilized by Deer 10 in the Zaleski study area.

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Number of Observations (n=68)</th>
<th>Understory Mean Density (stems/ha)</th>
<th>Diversity&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Ground Cover Diversity&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chestnut Oak-Hickory</td>
<td>2(2.9)&lt;sup&gt;2&lt;/sup&gt;</td>
<td>7000(2000)&lt;sup&gt;3&lt;/sup&gt;</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>Oak-Hickory&lt;sup&gt;4&lt;/sup&gt;</td>
<td>9(13.2)</td>
<td>5944(707)</td>
<td>22</td>
<td>29</td>
</tr>
<tr>
<td>Mixed Oak&lt;sup&gt;5&lt;/sup&gt;</td>
<td>9(13.2)</td>
<td>4555(552)</td>
<td>26</td>
<td>25</td>
</tr>
<tr>
<td>Mixed Mesophytic&lt;sup&gt;5&lt;/sup&gt;</td>
<td>10(14.7)</td>
<td>3462(625)</td>
<td>24</td>
<td>36</td>
</tr>
<tr>
<td>Beech-Maple</td>
<td>6(8.8)</td>
<td>3375(742)</td>
<td>21</td>
<td>30</td>
</tr>
<tr>
<td>Bottomland Hardwoods&lt;sup&gt;5&lt;/sup&gt;</td>
<td>6(8.8)</td>
<td>3437(1189)</td>
<td>14</td>
<td>26</td>
</tr>
<tr>
<td>Successional Hardwoods&lt;sup&gt;5&lt;/sup&gt;</td>
<td>18(26.4)</td>
<td>5264(1582)</td>
<td>26</td>
<td>38</td>
</tr>
<tr>
<td>Red-Other Pines</td>
<td>3(4.4)</td>
<td>4833(1444)</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>White Pine</td>
<td>2(2.9)</td>
<td>562(312)</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Grass Forbs</td>
<td>3(4.4)</td>
<td>4833(3647)</td>
<td>6</td>
<td>19</td>
</tr>
</tbody>
</table>

<sup>1</sup> Diversity equals number of different species.
<sup>2</sup> Percentages in parentheses.
<sup>3</sup> Standard errors in parentheses.
<sup>4</sup> Avoided.
<sup>5</sup> Preferred.
Table 7. Characteristics of the understory and ground cover in habitat types utilized by Deer 8 in the Union Furnace study area.

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Number of Observations (n=35)</th>
<th>Understory</th>
<th>Ground Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean Density (stems/ha)</td>
<td>Diversity¹</td>
</tr>
<tr>
<td>Oak-Hickory ⁴</td>
<td>4(11.4)²</td>
<td>3625(1300)³</td>
<td>18</td>
</tr>
<tr>
<td>Mixed Oak ⁵</td>
<td>7(20.0)</td>
<td>3982(614)⁴</td>
<td>22</td>
</tr>
<tr>
<td>Mixed Mesophytic ⁵</td>
<td>4(11.4)</td>
<td>1188(263)¹</td>
<td>11</td>
</tr>
<tr>
<td>Successional Hardwoods ⁵</td>
<td>13(37.1)</td>
<td>3894(793)⁴</td>
<td>25</td>
</tr>
<tr>
<td>Grass-Forbs ⁵</td>
<td>7(20.0)</td>
<td>1675(824)⁴</td>
<td>7</td>
</tr>
</tbody>
</table>

¹ Diversity equals number of different species.
² Percentages in parentheses.
³ Standard errors in parentheses.
⁴ Avoided.
⁵ Preferred.
and avoidance of beech-maple (Table 3). Bottomland hardwoods preferred by and shortleaf pine avoided by Deer 10 at Zaleski, were absent in the Union Furnace area.

Climatic variables had no direct significant effect on the overstory types that were used by both animals (ANOVA1); however, seasonal use of overstory types changed significantly ($\text{Chi}^2, P<0.0001$). During the spring, red-oak pines received more use (17.6%) by Deer 10 than the other habitat types (Table 8). During the summer, successional hardwoods and mixed mesophytic types received 42.1 and 18.4% use by both animals in both study areas; in the fall, successional hardwoods received 26.5% and mixed oaks and oak-hickory received 22.4 and 20.4%, respectively (Table 8). Fall utilization of mixed oaks and oak-hickory types represented a considerable increase over summer utilization (5.3 and 10.5%, respectively).

**Forest Size Class.** Deer 8 and 10 exhibited no significant selection for forest size classes (Table 9), but were found most frequently in habitat types with tree size classes of 10-17 and 18-24 cm diameter breast height (dbh). All habitat types at Union Furnace except grass-forbs fell within these dbh categories; at Zaleski only chestnut oak-hickory and mixed oak types did not fall into these categories (Tables 4 and 5).

**Basal Area.** Deer 10 demonstrated a preference for forest stands with basal areas of $44.1^+$ sq m/ha and
Table 8. Seasonal use of overstory types by deer for Zaleski and Union Furnace study areas.

<table>
<thead>
<tr>
<th>Overstory Type</th>
<th>Spring (n=17)</th>
<th>Summer (n=38)</th>
<th>Fall (n=49)</th>
<th>Row Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chestnut Oak-Hickory</td>
<td>2(11.8)(^1)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
<td>2(1.9)</td>
</tr>
<tr>
<td>Oak-Hickory</td>
<td>1(5.9)</td>
<td>2(5.3)</td>
<td>10(20.4)</td>
<td>13(12.5)</td>
</tr>
<tr>
<td>Mixed Oaks</td>
<td>1(5.9)</td>
<td>4(10.5)</td>
<td>11(22.4)</td>
<td>16(15.4)</td>
</tr>
<tr>
<td>Mixed Mesophytic</td>
<td>2(11.8)</td>
<td>7(18.4)</td>
<td>5(10.2)</td>
<td>14(13.5)</td>
</tr>
<tr>
<td>Beech-Maple</td>
<td>2(11.8)</td>
<td>1(2.6)</td>
<td>3(6.1)</td>
<td>6(5.8)</td>
</tr>
<tr>
<td>Bottomland Hardwoods</td>
<td>1(5.9)</td>
<td>5(13.2)</td>
<td>0(0.0)</td>
<td>6(5.8)</td>
</tr>
<tr>
<td>Successional Hardwoods</td>
<td>2(11.8)</td>
<td>16(42.1)</td>
<td>13(26.5)</td>
<td>31(29.8)</td>
</tr>
<tr>
<td>Shortleaf Pine(^2)</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Red-Other Pines</td>
<td>3(17.6)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
<td>3(2.9)</td>
</tr>
<tr>
<td>White Pine</td>
<td>1(5.9)</td>
<td>0(0.0)</td>
<td>1(2.0)</td>
<td>2(1.9)</td>
</tr>
<tr>
<td>Grass-Forbs</td>
<td>2(11.8)</td>
<td>3(7.9)</td>
<td>6(12.2)</td>
<td>11(10.6)</td>
</tr>
</tbody>
</table>

\(^1\) Percentages in parentheses.
\(^2\) Omitted from Chi\(^2\) test because frequency of plots in this type was 0.
Table 9. Mean dbh of trees >10 cm in the Zaleski study area compared to dbh of trees in deer habitat plots in Zaleski and Union Furnace study areas.

<table>
<thead>
<tr>
<th>Mean DBH 1</th>
<th>Observations 2 In Each Class (n=119)</th>
<th>Deer 10, Zaleski Habitat Plots (n=47)</th>
<th>Z</th>
<th>Deer 8, Union Furnace Habitat Plots (n=23)</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-17</td>
<td>46(38.6) 3</td>
<td>18(38.3)</td>
<td>-0.04</td>
<td>10(43.5)</td>
<td>0.43</td>
</tr>
<tr>
<td>18-24</td>
<td>41(34.4)</td>
<td>15(31.9)</td>
<td>-0.31</td>
<td>8(34.8)</td>
<td>0.03</td>
</tr>
<tr>
<td>25-32</td>
<td>25(21.0)</td>
<td>9(19.2)</td>
<td>-0.27</td>
<td>5(21.7)</td>
<td>0.08</td>
</tr>
<tr>
<td>33-39</td>
<td>6(5.0)</td>
<td>5(10.6)</td>
<td>1.31</td>
<td>----4</td>
<td>----4</td>
</tr>
<tr>
<td>40-47</td>
<td>1(0.8)</td>
<td>0(0.0)</td>
<td>-0.63</td>
<td>----4</td>
<td>----4</td>
</tr>
</tbody>
</table>

1 Measured in cm.
2 Control data (Moser 1972).
3 Percentages in parentheses.
4 Class did not occur in home range.
avoidance of basal areas of 0.1-11.0 and 11.1-22.0 sq m/ha (Table 10). Mean basal areas of habitat types utilized by Deer 10, except the basal area of bottomland hardwoods (43.5 sq m/ha), exceeded 44.1+ sq m/ha (Table 4). Deer 8 also showed a preference for forest stands with basal areas of 44.1+ sq m/ha and showed no significant avoidance (Table 10). However, Deer 8 exhibited similar trends towards avoidance of stands with basal areas of 0.1-11.0 and 11.1-22.0 sq m/ha (Table 10). All habitat types, except successional hardwoods, utilized by Deer 8 at Union Furnace had mean basal areas exceeding 44.1+ sq m/ha; successional hardwoods had a mean basal area of 29.7 sq m/ha (Table 5).

Overstory Density. A preference for overstory density of 495-741 stems/ha and avoidance of 1-247 and 989+ stems/ha was shown by Deer 10 (Table 11). The preference category of 495-741 stems/ha was represented by all habitat types except oak-hickory, mixed oak, and mixed mesophytic; however, the three types had overstory densities that ranged from 400-475 stems/ha (Table 4). Avoidance trends of the two deer were similar but no similarities in preferences were detected. Deer 8 showed the greatest preference for 742-988 stems/ha. Mixed mesophytic habitat type at Union Furnace had a mean overstory density of 713 stems/ha while the other types had mean densities that ranged from 417-531 stems/ha (Table 5). Weather, seasons, and time showed no significant effect on selection of overstory density by
Table 10. Basal area of trees >10 cm dbh in the Zaleski study area compared to basal area of trees >10 cm dbh in deer habitat plots in Zaleski and Union Furnace study areas.

<table>
<thead>
<tr>
<th>Basal Area</th>
<th>Observations</th>
<th>Deer 10, Zaleski</th>
<th>Deer 8, Union Furnace</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In Each Class</td>
<td>Habitat Plots</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n=117)</td>
<td>Z</td>
<td>(n=23)</td>
</tr>
<tr>
<td>0.1-11.0</td>
<td>47(40.1)^3</td>
<td>5(10.6)</td>
<td>8(26.1)</td>
</tr>
<tr>
<td>11.1-22.0</td>
<td>39(33.3)</td>
<td>5(10.6)</td>
<td>4(17.4)</td>
</tr>
<tr>
<td>22.1-33.0</td>
<td>18(15.3)</td>
<td>4(8.5)</td>
<td>1(4.4)</td>
</tr>
<tr>
<td>33.1-44.0</td>
<td>9(7.6)</td>
<td>6(12.8)</td>
<td>2(8.7)</td>
</tr>
<tr>
<td>44.1+</td>
<td>4(3.4)</td>
<td>27(57.4)</td>
<td>10(43.5)</td>
</tr>
</tbody>
</table>

1 Measured in sq m/ha.
2 Control data (Moser 1972).
3 Percentages in parentheses.
* Significant at P<0.05 (Z-test).
Table 11. Overstory density in the Zaleski study area compared to overstory density in deer habitat plots in Zaleski and Union Furnace study areas.

<table>
<thead>
<tr>
<th>Overstory Density</th>
<th>Observations In Each Class (n=118)</th>
<th>Deer 10, Zaleski Habitat Plots (n=47)</th>
<th>Z</th>
<th>Deer 8, Union Furnace Habitat Plots (n=23)</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-247</td>
<td>29(24.5)</td>
<td>3(6.4)</td>
<td>-2.67*</td>
<td>3(13.0)</td>
<td>-1.21</td>
</tr>
<tr>
<td>248-494</td>
<td>36(30.5)</td>
<td>17(36.2)</td>
<td>0.70</td>
<td>9(39.1)</td>
<td>0.81</td>
</tr>
<tr>
<td>495-741</td>
<td>17(14.4)</td>
<td>20(42.5)</td>
<td>3.91*</td>
<td>4(17.4)</td>
<td>0.37</td>
</tr>
<tr>
<td>742-988</td>
<td>14(11.8)</td>
<td>5(10.6)</td>
<td>-0.22</td>
<td>6(26.1)</td>
<td>1.79</td>
</tr>
<tr>
<td>989 +</td>
<td>22(18.6)</td>
<td>2(4.3)</td>
<td>-2.37*</td>
<td>1(4.4)</td>
<td>-1.70</td>
</tr>
</tbody>
</table>

1. Measured in stems/ha.
2. Control data (Moser 1972).
3. Percentages in parentheses.
* Significant at P<0.05 (Z-test).
Table 12. Understory density in the Zaleski study area compared to understory density in deer habitat plots in Zaleski and Union Furnace study areas.

<table>
<thead>
<tr>
<th>Understory Density</th>
<th>Observations²</th>
<th>Deer 10, Zaleski Habitat Plots (n=62)</th>
<th>Deer 8, Union Furnace Habitat Plots (n=33)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-7412</td>
<td>10(8.3)³</td>
<td>54(87.1)</td>
<td>31(93.9)</td>
</tr>
<tr>
<td>7413-14824</td>
<td>34(28.3)</td>
<td>7(11.3)</td>
<td>2(6.1)</td>
</tr>
<tr>
<td>14825-22236</td>
<td>35(29.1)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
</tr>
<tr>
<td>22237-29648</td>
<td>21(17.5)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
</tr>
<tr>
<td>29649-37060</td>
<td>12(10.0)</td>
<td>1(1.6)</td>
<td>0(0.0)</td>
</tr>
<tr>
<td>37061-44472</td>
<td>4(3.3)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
</tr>
<tr>
<td>44473-51884</td>
<td>2(1.6)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
</tr>
<tr>
<td>51885 +</td>
<td>2(1.6)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
</tr>
</tbody>
</table>

1 Measured in stems/ha.
2 Control data (Moser 1972).
3 Percentages in parentheses. Significant at P≤0.05 (Z-test).
deer (ANOVA, Chi²).

**Understory Density.** Deer 8 and 10 showed a marked preference for areas with understory density of 1-7,412 stems/ha (Table 12). Both animals avoided significantly areas with densities of 7,413-29,648 stems/ha, and appeared to avoid all high density understory. Deer 10 also showed an avoidance of the 29,649-37,060 stems/ha class at Zaleski. Mean understory densities for all habitat types utilized by Deer 8 and 10 were in the category 1-7,412 stems/ha (Tables 6 and 7). Weather, season, and time showed no effect on selection of understory density by deer (ANOVA, Chi²).

**Topography.** Deer 8 and 10 exhibited a preference for ridgetops, an avoidance for slopes, and no significant selection for hollows, although Deer 8 showed a tendency to avoid hollows (Table 13). Ridgetops utilized by deer consisted mostly of chestnut oak-hickory, successional hardwoods, and grass-forbs habitat types (Tables 15 and 16).

Weather did not affect the selection of topography by Deer 8 and 10 (ANOVA). Seasons and time had no effect on topographic use by deer when the two experimental animals were tested separately (Chi²). However, when data were combined for both animals and tested by day-night periods for seasonal preference, the results were almost significant (P=0.08) for fall (Table 14). Although slopes were avoided overall by both animals, 85.2% of slope utilization
Table 13. Topography in the Zaleski study area compared to topography in deer habitat plots in Zaleski and Union Furnace study areas.

<table>
<thead>
<tr>
<th>Topography</th>
<th>Observations$^1$ (n=121)</th>
<th>Deer 10, Zaleski Habitat Plots (n=62)</th>
<th>Deer 8, Union Furnace Habitat Plots (n=35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ridge</td>
<td>4(3.3)$^2$</td>
<td>7(11.3)</td>
<td>10(28.6)</td>
</tr>
<tr>
<td>Slope</td>
<td>105(86.7)</td>
<td>46(74.2)</td>
<td>24(68.6)</td>
</tr>
<tr>
<td>Hollow</td>
<td>12(9.9)</td>
<td>9(14.5)</td>
<td>1(2.9)</td>
</tr>
</tbody>
</table>

1 Control data (Moser 1972).
2 Percentage in parentheses.
* Significant at P≤0.05 (Z-test).
Table 14. Topography of deer habitat plots for Deer 8 and 10 inclusive, during fall, 1974, compared by time.

<table>
<thead>
<tr>
<th>Time</th>
<th>Ridge</th>
<th>Topography</th>
<th>Hollow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>2(7.4)</td>
<td>23(85.2)</td>
<td>2(7.4)</td>
</tr>
<tr>
<td>Night</td>
<td>7(31.8)</td>
<td>13(59.1)</td>
<td>2(9.1)</td>
</tr>
<tr>
<td>Total</td>
<td>9(18.4)</td>
<td>36(73.5)</td>
<td>4(8.2)</td>
</tr>
</tbody>
</table>

1 Day=0800-2000, night=2000-0800.
2 Percentages in parentheses.
in fall occurred during the day and 59.1% during night (Table 14). Ridges were used most at night (31.8%) during the fall and least (7.4%) during the day. Hollows differed only slightly in use between day and night (7.4 and 9.1%) during the fall (Table 14). The slope category contained all habitat types except bottomland hardwoods (Tables 15 and 16).

**Aspect.** Deer 8 at Union Furnace showed avoidance of west-facing slopes and a preference for flat areas; Deer 10 at Zaleski showed similar trends but no significant effects were detected (Table 17). Habitat types utilized by both animals were present on all aspects (Tables 15 and 16).

Selection of aspect by deer was not significantly influenced by weather (ANOVA). Selection of seasonal aspect by both animals was significant only in the fall (P=0.04, \( \chi^2 \)). During the fall south slopes were utilized most during the day (44.4%); during night flat areas were used most (40.9%) and only slightly during the day (7.4%) (Table 18). North slopes were second in day usage (25.9%), while at night north and west slope utilization ranked last (9.1%). Day and night utilization of east and west slopes during the fall differed only slightly (Table 18).

In contrast, during summer days Deer 8 and 10 spent almost equal time (32 and 28%) on north and south slopes, while at night they spent twice as much time (46.2%) in areas with no aspect as they did during the day (20%)
<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Number of Observations</th>
<th>Topography</th>
<th>Aspect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ridge</td>
<td>Slope</td>
</tr>
<tr>
<td>Chestnut Oak-Hickory</td>
<td>2</td>
<td>1(50)</td>
<td>1(50)</td>
</tr>
<tr>
<td>Oak-Hickory</td>
<td>9</td>
<td>1(11)</td>
<td>7(78)</td>
</tr>
<tr>
<td>Mixed Oak</td>
<td>9</td>
<td>8(89)</td>
<td>1(11)</td>
</tr>
<tr>
<td>Mixed Mesophytic</td>
<td>10</td>
<td>8(80)</td>
<td>2(20)</td>
</tr>
<tr>
<td>Beech-Maple</td>
<td>6</td>
<td>1(17)</td>
<td>5(83)</td>
</tr>
<tr>
<td>Bottomland Hardwoods</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successional Hardwoods</td>
<td>18</td>
<td>3(17)</td>
<td>15(83)</td>
</tr>
<tr>
<td>Red-Other Pines</td>
<td>3</td>
<td>3(100)</td>
<td></td>
</tr>
<tr>
<td>White Pine</td>
<td>2</td>
<td>2(100)</td>
<td></td>
</tr>
</tbody>
</table>

1 Percentages in parentheses.
Table 16. Topography and aspect of habitat types utilized by Deer 8 in the Union Furnace study area.

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Number of Observations</th>
<th>Topography</th>
<th>Aspect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ridge</td>
<td>North</td>
</tr>
<tr>
<td>Oak-Hickory</td>
<td>4</td>
<td>4(100)²</td>
<td>1(25)</td>
</tr>
<tr>
<td>Mixed Oak</td>
<td>7</td>
<td>7(100)</td>
<td>2(29)</td>
</tr>
<tr>
<td>Mixed Mesophytic</td>
<td>4</td>
<td>4(100)</td>
<td></td>
</tr>
<tr>
<td>Successional Hardwoods</td>
<td>13</td>
<td>6(46) 7(54)</td>
<td>2(15)</td>
</tr>
<tr>
<td>Grass-Forbs</td>
<td>7</td>
<td>4(57) 2(27)</td>
<td>1(14)</td>
</tr>
</tbody>
</table>

² Percentages in parentheses.
Table 17. Aspect in the Zaleski area compared to aspect of deer habitat plots in Zaleski and Union Furnace study areas.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Observations&lt;sup&gt;1&lt;/sup&gt; (n=121)</th>
<th>Deer 10, Zaleski Habitat Plots (n=62)</th>
<th>Deer 8, Union Furnace Habitat Plots (n=35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>23(19.0)&lt;sup&gt;3&lt;/sup&gt;</td>
<td>14(22.6)</td>
<td>9(25.7)</td>
</tr>
<tr>
<td>South</td>
<td>35(28.9)</td>
<td>16(25.8)</td>
<td>11(31.4)</td>
</tr>
<tr>
<td>East</td>
<td>21(17.4)</td>
<td>11(17.7)</td>
<td>4(11.4)</td>
</tr>
<tr>
<td>West</td>
<td>26(21.5)</td>
<td>7(11.3)</td>
<td>1(2.9)</td>
</tr>
<tr>
<td>None&lt;sup&gt;2&lt;/sup&gt;</td>
<td>16(13.2)</td>
<td>14(22.6)</td>
<td>10(28.6)</td>
</tr>
</tbody>
</table>

<sup>1</sup> Control data (Moser 1972).
<sup>2</sup> Category added by author.
<sup>3</sup> Percentages in parentheses.

* Significant at P≤0.05 (Z-test).
Table 18. Aspect of habitat plots for Deer 8 and 10 by day and night use during the summer and fall of 1974.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Summer</th>
<th></th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day</td>
<td>Night</td>
<td>Day</td>
</tr>
<tr>
<td>North</td>
<td>8(32.0)(^2)</td>
<td>4(30.8)</td>
<td>7(25.9)</td>
</tr>
<tr>
<td>South</td>
<td>7(28.0)</td>
<td>2(15.4)</td>
<td>12(44.4)</td>
</tr>
<tr>
<td>East</td>
<td>5(20.0)</td>
<td>0(0.0)</td>
<td>3(11.1)</td>
</tr>
<tr>
<td>West</td>
<td>0(0.0)</td>
<td>1(7.7)</td>
<td>3(11.1)</td>
</tr>
<tr>
<td>None</td>
<td>5(20.0)</td>
<td>6(46.2)</td>
<td>2(7.4)</td>
</tr>
</tbody>
</table>

\(^1\) Significant at P=0.04 (chi\(^2\)).
\(^2\) Percentage in parentheses.
(Table 18). East and west slopes appeared to be utilized during both seasons less frequently than other slopes.
DISCUSSION

Capture

Clover traps were not a reliable method of capturing deer. Utilization of baited traps by deer occurred only during periods of limited food availability resulting from severe weather conditions. These conditions occur infrequently in southeastern Ohio (Schriver and Heet 1974). Francis (1975) also experienced difficulty in trapping deer in the Zaleski study area and attributed poor trapping success to mild winters and abundance of food; the Ohio Division of Wildlife (McClain 1977, pers. comm.) experienced the same difficulty in southeastern Ohio. Wildlife personnel at the National Aeronautics and Space Administration's Plum Brook Station, Erie County, Ohio, trap as many as 1,000 deer during a severe winter but trapping success has decreased to 247 animals during a mild winter when natural food was available (Francis 1977, pers. comm.). In Illinois, Hawkins et al. (1967) had difficulty trapping deer during the spring and summer when natural food was abundant.

In contrast, Sparrowe and Springer (1970) had good success with the clover trap in South Dakota. In New York, Sage (1972, pers. comm.) stated that deer were easily trapped with box traps in the Adirondacks.

Trap malfunction also influenced trapping success.
The trap became inoperable when covered with ice and less effective when covered with wet snow. Sparrowe and Springer (1970) also experienced difficulty in South Dakota when ice and wind-blown debris caused several malfunctions of clover traps. The success or failure of the clover trap appears to vary among geographical regions and within a particular region, depending on severity of winter and availability of natural foods.

Few fawns (3) and no adults were trapped. This result may be explained by the extreme wariness observed in adult does near traps. Fawns were interested in the bait and not nearly as wary as adult does; however, neophobia of a female appeared to strongly affect her fawns when she was near them. In southeastern Ohio, Francis (1975) trapped all fawns (2) and no adults. Hawkins et al. (1967), in southern Illinois, stated that adult deer were suspicious of box traps and, of the 28 deer caught in box traps, 24 (86%) were fawns. Zorichak (1956), in Minnesota, trapped 75 deer during a severe winter and 50 (67%) were fawns. In general, fawns appear to be vulnerable to trapping. However, the ratio of fawns to adults trapped probably depends upon the region and severity of winter.

In March, the frequency of encountering deer along the roads increased markedly. Thus, the Cap-Chur gun could be used and became an effective method of capturing deer. Warm weather probably stimulated deer movement along
roadsides where there was an abundance of new vegetative growth. Vegetation in the forest interior had not begun to grow. Groups containing 3, 5, and 7 animals were common along roads during March, April, and May; animals in groups appeared to be less nervous than single deer, thus rendering grouped animals easier targets for capture. Tibbs (1967), in Pennsylvania, noted that deer were in the largest groups during April.

All animals (5) immobilized with the gun were female fawns; two were pregnant according to their weights. Fawns were selected because they were most frequently seen, were least frightened by autos, and showed the smallest variation in weight. The reason for a constant sex class may stem in part from social preference. Male fawns are behaviorally more independent than female fawns and may be driven away by does earlier than the females (Townsend 1976, pers. comm.). Gravid does may be attracted to roadsides for nutrient needs peculiar to them and not experienced by males. Adult does were probably all pregnant and up to 70% of the female fawns might have bred (Nixon 1970). This roadside behavioral pattern is also supported by work conducted in southern Indiana (Weeks and Kirkpatrick 1976). The investigators found that deer exhibited an intensified Na drive during April and May; the common factor was a resurgence of vegetative growth, usually heavy in Na, along roadsides. Pregnant does need Na for developing fetuses
and amniotic fluid; at the same time male deer need a lesser amount of Na for antler development. Hence, the deer available near the road may have been a biased sample of the deer population.

Conversely, summer appeared to be an inopportune time to capture deer, since few animals were seen along roads. I rarely observed fawns near the road until August; and then only a few fawns were seen as they swiftly crossed the road and disappeared into the forest. Food was abundant throughout the forest in summer, and roadside vegetation could not be expected to draw animals. Townsend and Bailey (1975) noted that does restrict their activity during the fawning period, and Weeks and Kirkpatrick (1976) found that does experience a restricted salt drive, which probably coincides with heavy lactation, during summer and fall.

Cap-Chur darts of 2 cc increased success of capture by increasing accuracy of shots. Darts of 1 and 3 cc exhibited erratic flight patterns and were considered unsuitable for firing at deer. The 2 cc dart usually held a true course for 18-40 m when propelled by a medium power .22 caliber charge. Succinylcholine chloride doses were prepared and darts were completely assembled each morning. Previous experience showed that when darts were refrigerated overnight and used again the next day, the plunger lubricant lost its effectiveness and the drug did not inject upon impact. Also, a small amount of precipitant
resulted when the drug-containing dart was refrigerated. This precipitant plugged needles and could have prevented immobilization.

Monitoring

Equipment problems, vehicle maintenance, and animal movement into new and inaccessible areas were the most serious problems encountered during the study. Consequently, two monitoring periods per month on each animal were difficult to achieve. Monitoring periods were cancelled while radio receivers were sent to the manufacturer several times for repair.

Transmitters suffered a 60% rate of failure prior to a year of operation, and 30% were inoperative within three months. One transmitter quit working before it was attached to an animal and another faulty one was recovered from a retracted animal; these were sent to the manufacturer for repair. Three animals disappeared and an air search failed to detect their signals. Two other animals' signals were discovered by aircraft, so the former three were probably not found because their transmitters failed. Certainly a search area of 518 kilometers square was sufficiently large to detect any reasonable emigration by deer. Hawkins and Montgomery (1969), in Illinois, suffered a similar fate when seven deer (26%) either left the study area or their transmitters failed after 61 days.
One 8-element yagi antenna, fractured from stress, broke in two pieces and a new antenna was ordered. The other yagi was sheared in half by a low-hanging limb; the new yagi suffered a similar fate. Antennas were repaired by a local machine shop. One of the monitoring vehicles, a military jeep, developed a cracked engine block, and a replacement jeep was procured and rigged for monitoring.

Animals that moved into inaccessible areas were monitored after ridgetop trails were cleared. The system of old trails that appears common to all areas of Zaleski proved valuable. In addition, four-wheel drive vehicles were required to successfully negotiate trails. The monitoring system which included 8-element yagi antennas, antenna masts, compass charts, and azimuth indicators was a workable and reliable system. Monitoring was consistently interrupted by receiver malfunction and time delay because equipment was sent to Minneapolis, Minnesota for repair. In future studies, a nearby repair facility or qualified technician within the organization could greatly reduce the amount of time lost.

Habitat Selection

Deer 10 (Zaleski) displayed a strong preference for successional hardwoods, with successional hardwoods receiving more use (27%) than other preferred types. Deer 8 and 10 used successional hardwoods most during the summer (42.1%)
and fall (26.5%) and least during the spring (11.8%). An explanation for these seasonal trends may be; (1) that deer utilize successional hardwoods less in the spring because female deer move to roadsides to utilize new grasses and forbs (McCaffery et al. 1974 and Weeks and Kirkpatrick 1976); and, (2) that considerable use of successional hardwoods occurs during the summer because this type provides substantial understory density and diversity. A substantial understory density may be needed by does for the fawning period and important diversity in the understory and herbaceous layer may provide preferred foods for does and fawns. Cartwright (1975), in northwestern Arkansas, observed that does spent most of their time in forest habitat during the fawning season.

Compared to other types, successional hardwoods had the highest understory and ground cover diversity (26 and 38, respectively in Zaleski and 25 and 35 at Union Furnace). Summer foods of deer such as grasses, new leaves of woody vegetation, and fruit from raspberry, blackberry, and grape (Harlow et al. n.d., Nixon et al. 1970, and Weeks and Kirkpatrick 1976) were abundant in successional hardwoods (Appendices C and D). Francis (1975) found no selection for successional hardwoods by a yearling buck. However, sex of the study animal differed from this study's experimental animals (yearling does), and his buck had two different home ranges, one of which was not
botanically sampled.

Deer 8 and 10 also showed a preference for mixed oak. Mixed oaks were used most in the fall (22.4%) and least during the spring and summer (5.9 and 10.5%). Francis (1975), in the Zaleski area, observed that a male yearling also utilized mixed oaks. Harlow et al. (1975) state that heavy usage of oak forest by deer is undoubtedly related to mast abundance and that acorns totaled 83% by volume of the diet of white-tailed deer from late summer and early fall to winter in the mountainous area of southwestern Virginia. Others from Indiana, Ohio, and other Appalachian states have noted that acorns were eaten by deer whenever available (Liscinsky et al. n.d., Dalke 1941, Dunkeson 1955, Duvendeck 1962, Korschgen 1962, Nixon and McClain 1968, Harlow and Hooper 1971, and McCaffery et al. 1974). Mast was abundant in the study area during fall, 1974 (pers. obs. and Donohoe 1976, pers. comm.), and non-instrumented deer were observed often in oak types. On one occasion (09/10/74), I observed a yearling doe feed intensively for 30 minutes on acorns before she left the ridge. A severe mast failure has not been documented in southeastern Ohio since fall, 1966 (Nixon and McClain 1969 and Donohoe 1977, pers. comm.).

Avoidance for oak-hickory may have been caused by the small percentage of use during the spring and summer (5.9 and 5.3%). Deer usage of oak-hickory during the fall was 20.4% and probably constituted a preference. However, seasonal
sample size was probably too small to indicate this preference. Furthermore, interspersion of oak-hickory and mixed oak made habitat typing difficult at times and probably resulted in less oak-hickory types.

Both animals showed a preference for mixed mesophytic and Deer 10 in Zaleski also preferred bottomland hardwoods. Mixed mesophytic and bottomland hardwoods were used most during the summer (18.4 and 13.2%, respectively). Bottomland hardwoods, absent at Union Furnace, received no use during the fall and little during spring (5.9%). In the Zaleski area, mixed mesophytic occurred adjacent to the bottomland hardwoods that were along Raccoon Creek and were utilized by Deer 10. These types appear to provide a cool moist microclimate during the summer, in addition to providing a diverse selection of herbaceous species and fresh leaves from the understory vegetation. Mixed mesophytic had the highest overstory diversity (13) of the Zaleski habitat types and ranked about the same (?) with other types at Union Furnace. In understory and ground cover diversity, mixed mesophytic ranked second to successional hardwoods (24 and 36, respectively) at Zaleski and ranked second to last (11) and last (16) in diversity at Union Furnace. Bottomland hardwoods had species diversities of: overstory, 7; understory, 14; and ground cover, 26. Nixon et al. (1970) observed that deer in the Zaleski area appeared to utilize mature forest during the summer. Summer food habit studies have shown that deer eat fresh green

Neither animal appeared to utilize the pine types. An avoidance was shown for shortleaf pines by both animals, and white and red pine received minimal use. Deer were seen in pine plantations during the day and appeared to be moving. Undoubtedly, deer traverse plantations during daily movement but do not spend an appreciable amount of time in them. Total use of white and red pine for all seasons combined were 1.9 and 2.9% respectively. Visual observations made in pine plantations in the Zaleski area showed that herbaceous and shrub layers were sparse or absent, especially with pine stands with complete canopy closure. Diversity for white pine plantations in Zaleski was 4 in the understory and 10 for the ground cover stratum. Halls (1974), in Texas, states that growth of browse plants is reduced by pine overstory. Francis (1975), in Zaleski, and Kohn and Mooty (1971), in Minnesota, noted avoidance of red pine by deer. Pine plantations appear to have no value for deer in southeastern Ohio and occupy sites that could be better used in deer management for successional hardwoods.

The grass-forbs (old field) type was preferred by Deer 8 at Union Furnace, while Deer 10 at Zaleski showed no selection. The Zaleski area contains about 4% grass-forbs (Moser 1972).
which was utilized almost evenly throughout the year by 10; spring, summer, and fall averaged about 10% use. Undoubtedly, the young doe in Zaleski utilized roadside vegetation during the spring, but was not detected because investigators were driving the roads to capture more animals.

At Union Furnace, grass-forbs was visually estimated to make up about 10% of the area. Most of this type occurred on an old reverting strip mine area that contained mostly forbs, sumac, and little grass. The significant use of grass-forbs by Deer 8 was probably due to the animal consistently feeding on the lawn of an unoccupied home. The lawn was not mowed during the spring and had a dense growth of green grass throughout the summer. The doe shifted her range during late August to a more forested portion of the area. This shift was probably related to mast availability and a changing food supply. Pledger (1975) noted that habitat shifts are probably due to changes in vegetation and food supply and Schilling (1938), in North Carolina, said there is a definite movement by deer to the oak-chestnut vegetation type when mast falls.

Deer showed no significant selection for forest size class. Francis (1975) noted that a yearling buck avoided the 10-17 cm size class. No selection by Deer 8 and 10 may indicate: (1) that the study area has similar size classes and has more even-aged stands; or, (2) that deer do not prefer any one size class, but utilize different habitat types during different seasons. According to Moser (1972), 75% of the
study area falls into the 10-17 and 18-24 cm dbh size classes; and 73.7% of the habitat samples, representing 7 of 10 habitat types utilized by deer, were in the 10-24 cm dbh category. Hence, the study area appears to have relatively even aged habitat types; therefore, as deer utilized different types throughout the study, a preference was not shown. Kohn and Mooty (1971) observed that deer utilize different habitat types as seasons change because availability of preferred forage species also changes with the season. A larger habitat sample size and a larger overstory quadrat for trees would be advantageous to describing size class utilization.

Preferences were shown for forest stands with basal areas of 44.1 sq m/ha and densities of 495-741 stems/ha. This basal area approximates the mean basal area for mixed mesophytic (46.5 sq m/ha), bottomland hardwoods (43.5 sq m/ha), and successional hardwoods (49.7 sq m/ha) that were preferred by deer. However, the density category includes or is close to all mean overstory densities for all habitat types utilized by deer.

Avoidance of forest stands with basal areas of 0.1-22.0 sq m/ha and overstory density of 1-247 and 989+ stems/ha was demonstrated by Deer 10 at Zaleski. It appears Deer 10 avoided lightly and heavily stocked areas (grass-forbs and pine plantations). Differences in preference and avoidance is probably related to the availability of food.

Deer 8 and 10 exhibited a slight preference for ridgetops
and a slight avoidance for slopes during the fall. Ridgetop preference in the fall is undoubtedly related to the availability of mast. Oak types typically occurred on the ridgetops and upper slopes in both study areas.

Deer 8 and 10 were significantly affected by aspect during the fall. Both animals utilized a south aspect during the day and night. Areas with south aspects are warmer during the day and probably remain warmer at night than areas with north aspects.

**Habitat Management Implications**

Investigators in southeastern Ohio have observed that minimum home ranges for three bucks (one adult and two yearlings) were 582, 493, and 265 ha; minimum home ranges for three does (one adult and two yearlings) were 310, 187, and 64 ha (Nixon 1965, Francis 1975, and Schriver 1976). From these observations, it appears that a deer habitat management unit of 300-600 ha would be feasible in southeastern Ohio public forestlands.

Based on data from this study, a deer management unit should consist of: (1) 30-40% oaks (mast-producing size); (2) 35% successional hardwoods; (3) 15-20% mixed mesophytic and/or beech-maple or bottomland hardwoods; and, (4) 5-10% grass-forbs (old field). These percentages represent the amount of utilization by two deer in two separate, but similar areas. It was noted earlier that deer undoubtedly
utilized the upper slopes and ridgetop oak types for mast during the fall. Successional hardwoods are important throughout the year for their diversity and cover quality. Nixon (1965 and 1970) observed that more bedding sites, buck rubs, and preferred browse species occurred in successional hardwoods than occurred in other types. More mature types such as mixed mesophytic and beech-maple provide a variety of broad-leaved and evergreen herbaceous material and a moist cool microclimate during the summer. A summer preference for more mature timber was also observed by Nixon (1970) and Francis (1975). The grass-forbs type was utilized throughout the spring, summer, and fall. Nixon (1970) said that 10% of each 607.5-hectare unit should be managed as old fields.

The existing practice of mowing roadsides at least once a year in public forests and wildlife areas also enhances the grass-forbs habitat. Deer particularly utilize this type during the spring when new green grass and forbs emerge. Care must be taken not to enhance roadsides where heavy traffic flow might conflict with deer usage.

Pine plantations should be considered as poor habitat for deer and should be avoided or held to a minimum. Pines, when planted on abandoned farmlands, reverting fields, or clearcuts eventually decrease the diversity of woody and herbaceous plant species and rob the area of natural vegetation. Nixon (1968), in management implications on wildlife
areas for southeastern Ohio, also agrees that extensive pine conversion in old fields should be avoided.

Habitat utilization and home range undoubtedly varies among regions and would certainly be related to deer density. Therefore, future deer studies in Ohio could investigate the relationship of habitat and home range to deer density in different geographical regions.
SUMMARY AND CONCLUSIONS

Seven white-tailed deer were captured and instrumented between January 8 and April 17, 1974 with transmitters in the 150-151 MHz frequency range. Remote injection was a reliable method of capturing deer during the spring. An immobilizing dart gun with succinylochlorine chloride (prepared fresh daily) inside a 2 cc dart is a reliable method of capturing deer. The clover trap was used with limited success during severe weather in January and is considered an unreliable method of capturing deer in southeastern Ohio.

During the period from January 8, 1974 to December 7, 1974, 1,067 radio-locations were taken on six animals. Error of radio location was tested, and average area of error was 0.14 ha. The telemetry monitoring system is considered a workable and reliable system in southeastern Ohio.

Deer locations (104) were sampled to determine physical parameters, preference, and avoidance of areas used by two deer. Mixed oaks, mixed mesophytic, and successional hardwoods were preferred by both deer. Successional hardwoods consistently received more use (27.4 and 37.1%) by both animals than other preferred types during summer and fall. Mixed oaks and oak-hickory were used most during the fall.

Avoidance was shown for shortleaf, white, and red pine habitat types. Forest stands with overstory density of 495-741 stems/ha were preferred by one yearling doe and
stands with densities of 1-247 and 939+ stems/ha were avoided by the same animal. Deer showed no significant selection or trends towards forest size class. Deer generally appeared to avoid forest stands with basal areas of 0.1-22.0 sq m/ha and preferred stands of 44.1+ sq m/ha. Deer showed a marked preference for areas with understory density of 1-7,412 stems/ha and avoidance of areas with 7,413-29,648 stems/ha.

Ridgetops were preferred, slopes were avoided and hollows were neither preferred nor avoided. North and south slopes appeared to be utilized more than east and west slopes, and flat areas were used more during night than day. Weather had no discernable effect on habitat selection.

A deer habitat management unit of 300-600 ha appears feasible in southeastern Ohio public forestlands and should consist of: (1) 30-40% oaks (mast-producing size); (2) 35% successional hardwoods; (3) 15-20% mixed mesophytic and/or beech-maple or bottomland hardwoods; and, (4) 5-10% grass-forbs (old field). Pine plantations should be considered as poor habitat for deer and should be avoided or held to a minimum.
LITERATURE CITED


APPENDIX A

Brand Names, Models, and Manufacturers of Equipment Used in This Study.

Cap-Chur Gun
.22 Caliber Charges
2 cc Darts

Succinylcholine Chloride
(Sucostrin)

Receivers (Model W)
Transmitters (Deer)

8-Element Yagi Antenna
3-Element Yagi Antenna

Transceivers (Walkie-Talkies)
(Model 15-775B)

Dental Acrylic

Mechanical Pyranograph
(Model R401)

Taylor Thermograph Recorder
(Model 381P34)

Electronic Calculator
(Hewlett-Packard 65)

Palmer Chemical and Equipment Company
Douglesville, Georgia

E. R. Squibb and Sons Inc., Chicago, Illinois

Dav-Tron
Minneapolis, Minnesota

Hy-Gain Electronics Corp., Lincoln, Nebraska

Midland International Corp., Kansas City, Missouri

Harry J. Bosworth Company
Chicago, Illinois

Weathermeasure Corp.
Sacramento, California

Fisher Scientific Company
Cleveland, Ohio

Hewlett-Packard
Cupertino, California
APPENDIX B

Frequency of occurrence of trees in the overstory of deer habitat plots in Zaleski and Union Furnace study areas.

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<th>Taxon</th>
<th>CO-H</th>
<th>O-H</th>
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<th>MM</th>
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<th>BH²</th>
<th>SH</th>
<th>SP²</th>
<th>R-OP</th>
<th>WP</th>
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2 Habitat type absent in Union Furnace study area.

3 Zaleski frequency above line, Union Furnace below.
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APPENDIX C

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2 Habitat type absent in Union Furnace study area.
3 Zaleski frequency above line, Union Furnace below.
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APPENDIX D

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