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I am submitting herewith a thesis written by Bruce F. Anderson entitled "Some Aspects of the Movement Ecology and Susceptibility to Hunting of the Cottontail Rabbit (Sylvilagus floridanus) in Tennessee." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife Management.

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SOME ASPECTS OF THE MOVEMENT ECOLOGY AND SUSCEPTIBILITY TO HUNTING OF THE COTTONTAIL RABBIT (SYLVILAGUS FLORIDANUS) IN TENNESSEE

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee

Bruce F. Anderson

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ABSTRACT

A total of 117 cottontail rabbits were captured during the study. Sex ratios appeared to be approximately 50:50. Weight of adult female cottontails averaged 92-94 g heavier than males.

Population density on the southeastern portion of the study area was estimated at 5.67 rabbits per ha (2.15 rabbits/a). The population was thought to be much less dense in the northwestern portion of the study area, apparently causing lower hunter success on the northwestern portion of the study area than on the southeastern portion.

Winter home range sizes for telemetered cottontails averaged 2.8 ha (6.9 a) for males, and 2.2 ha (5.8 a) for females. Home range sizes determined from retrap and reobservation data for ear-tagged rabbits averaged 5.6 ha (14.6 a) for males and 1.2 ha (3.2 a) for females. Telemetric determination of home range is considered more accurate than determination by retrap and reobservation.

Six home range departures were observed during the study. Two of these departures were attributed to the location of breeding females by male cottontails. Reasons for the remaining four home range departures are unknown.

Cottontails were found to begin crepuscular activities after sunset (December through February) regardless of day length. A literature review revealed that cottontails begin crepuscular activities prior to sunset during the summer months and subsequent to sunset during the winter, thus contributing to a reduction in rabbit sightings between summer and winter by members of the public.

Destruction of preferred diurnal resting cover resulted in the relocation of home ranges by four cottontails. Cover destruction is believed to be a major factor causing relocation of cottontail home ranges and the formation of winter concentrations of cottontails.

Cottontails were found to prefer smaller areas within their existing home ranges for diurnal cover. The area within each rabbit's home range in which the rabbit was found in 80 percent or more of the diurnal readings was designated as the diurnal cover preference range (DCPR) of the rabbit. Destruction of DCPR cover appears to stimulate relocation of home range.

Five winter concentrations of cottontails were located during the study. Three radio-collared cottontails relocated in areas of cottontail concentration. The location of concentrations by hunters should increase

hunter success since 75 percent of the rabbits flushed were from the areas of concentration.

Flushability of cottontails decreased as cover became harder for hunters and dogs to penetrate. The speed and thoroughness with which hunters examined cover also influenced the number of rabbits flushed; the faster-paced hunts with superficial examination of cover resulted in fewer rabbit flushes than did slower-paced hunts with a more thorough examination of cover. Use of trained hunting dogs increased flushing success.

Apparent breeding synchrony was observed in female cottontails in late January and early February after a sudden rise in mean daily temperature. Chi-square 2x2 test for independence indicates that female cottontails in estrous are more easily trapped than males.

Parasites observed on cottontails include ticks (Haemaphysalis leporispalustris and Ixodes dentatus), fleas (Cediopsylla simplex), bot warbles (Cuterebra sp.), and an unidentified species of liver fluke. Fibromatosis was observed in 16 percent of rabbits captured in October and November, and in 9 percent of rabbits captured in January and February.

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CHAPTER I

INTRODUCTION

The cottontail rabbit, (Sylvilagus floridanus), provides hunters in Tennessee, and many other states, with more meat and hunting recreation than any other small game mammal. The cottontail's widespread popularity has led to the accumulation of large amounts of information concerning the life history and habits of the species, including reproduction and mortality (Heard 1963, Lord 1959, Pelton and Provost 1972, Wainright 1969), home ranges and movements (Chapman and Tretheway 1972a, Haugen 1942, Heard 1963, Holler and Marsden 1970, Marsden and Conaway 1963, Mech et al. 1966, Trent and Rongstad 1974), feeding habits (DeCalesta 1971), cover use (Hanson et al. 1969, Haugen 1943), parasites and diseases (Davis, Karstad, and Trainer 1970, Geis 1957, Jacobson and Kirkpatric 1974), and many other studies.

The advent of radio-telemetry has allowed wildlife researchers to obtain larger volumes of detailed information concerning wild species than was possible with some earlier techniques (Adams 1965). Studies in which cottontail home ranges and movements were determined

from trapping data (Chapman et al. 1972a, Haugen 1942, and Heard 1963) required the tagging of relatively large numbers of individuals (which was difficult to accomplish in areas of low population density) and yielded adequate home range data only on a relatively small number of the rabbits originally tagged. Chapman and Tretheway (1972b) reported that the susceptibility to trapping of cottontails varied with temperature, barometric pressure, and age class of the rabbits. Thus the time between observations and accuracy of data collected in trap-retrap studies depended on conditions which researches are unable to control. Telemetry studies regarding cottontail home ranges and movements (Holler et al. 1970, Marsden et al. 1963, Mech et al. 1966, and Trent et al. 1974) revealed that adequate data can be obtained for almost 100 percent of the radio-tagged animals (mortality and transmitter failure are major factors accounting for a small reduction in sample size); thus fewer individuals need be trapped and tagged to obtain an adequate sample size, allowing data collection in areas of relatively low population densities. Also, the time between observations and accuracy of the data obtained via telemetry is greater than that obtained in trap-retrap studies.

Results of two studies (Haugen 1943 and Hanson

et al. 1969) were inconclusive in regard to cover types preferred by cottontails. Haugen (1943) attempted to associate cover availability with the cottontails' susceptibility to hunting. However, no studies were found which associated cottontail home range, cover use and population density with susceptibility of the rabbit to hunting. It was the objective of this study to examine cottontail home ranges, cover use, and population density, and, where possible, delineate their relationship to cottontail susceptibility to hunting. It is hoped that the information can be used to aid the hunter in his quest for the cottontail.

CHAPTER II

DESCRIPTION OF THE STUDY AREA

The study area consisted of approximately 190 ha (150 a) of the 532 ha (1400 a) Percy Priest Wildlife Management Area in Rutherford County, Tennessee (Figure 1). The area was once privately-owned agricultural land until it was bought in the 1960's by the U. S. Army Corps of Engineers. The Corps of Engineers subsequently constructed a dam and created Percy Priest Lake, which is now adjacent to the study area on the northern boundary. Since construction of the lake, the land has been leased by the Tennessee Wildlife Resources Agency and has been used as a field trial and training area for juvenile hunters. Except during scheduled dove hunts, hunting by persons over 16 years of age is prohibited. Management of the area is aimed at sustaining relatively high populations of small game, notably cottontail rabbits and bobwhite quail (Colinus virginianus). The area is also used as a winter waterfowl refuge. The wood duck (Aix sponsa) is the only species of duck which nests on the area in the summer months.

Other avian species observed on the area during the study included the coopers hawk (Accipiter cooperii),

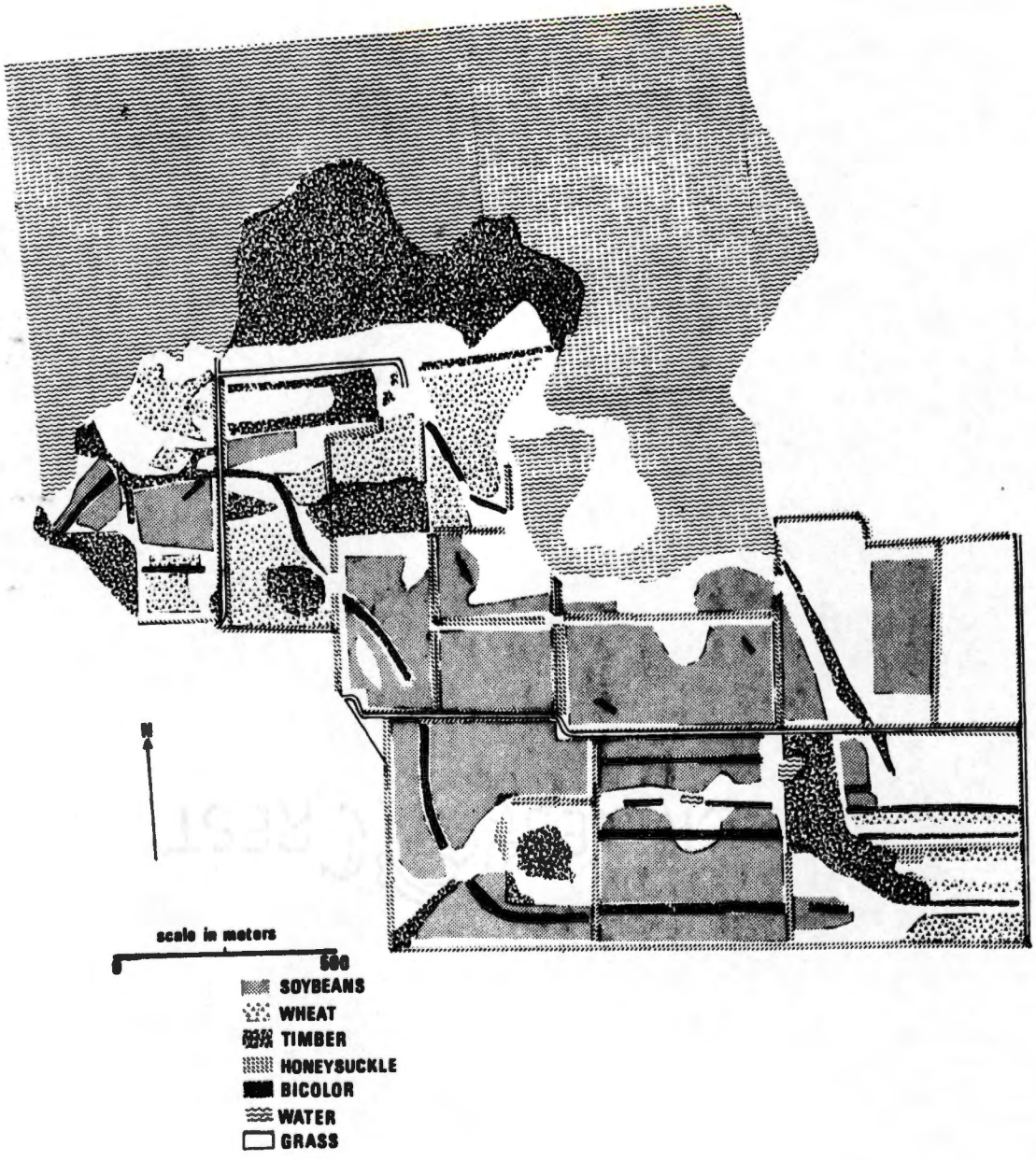


Figure 1. The 190 ha study area on the Percy Priest Wildlife Management Area, Rutherford County, Tennessee.

the sharp-shinned hawk (Accipiter striatus), sparrow hawk (Falco sparverius), marsh hawk (Cirus cyaneus), red-tailed hawk (Buteo jamaicensis), red-shouldered hawk (Buteo lineatus), bald eagle (Haliaeetus leucocephalus), great horned owl (Bubo virgianus), great blue heron (Ardea herodias), green heron (Butorides virescens), black crowned night heron (Nycticorax nycticorax), and a variety of other shore and song birds.

Mammalian species encountered on the area, aside from the cottontail rabbit, included the red fox (Vulpes vulpes), mink (Mustela vison), longtail weasel (Mustela frenata), opossum (Didelphis virginiana), raccoon (Procyon lotor), woodchuck (Marmota monax), Eastern chipmunk (Tamias striatus), Eastern fox squirrel (Sciurus niger), muskrat (Ondatra zibethica), and many other small rodents. Grey fox (Urocyon cinereoargenteus) were not observed; however, two skulls of this species were found on the area.

Within the confines of the study area, there are four major habitat types; woodlots, grassy or weedy areas, fencerows, and agricultural areas (Figure 1).

Woodlots

Woodlots are subdivided into two categories (Figure 2). Woodlots WL1, WL2, WL3 and WL5 consisted of

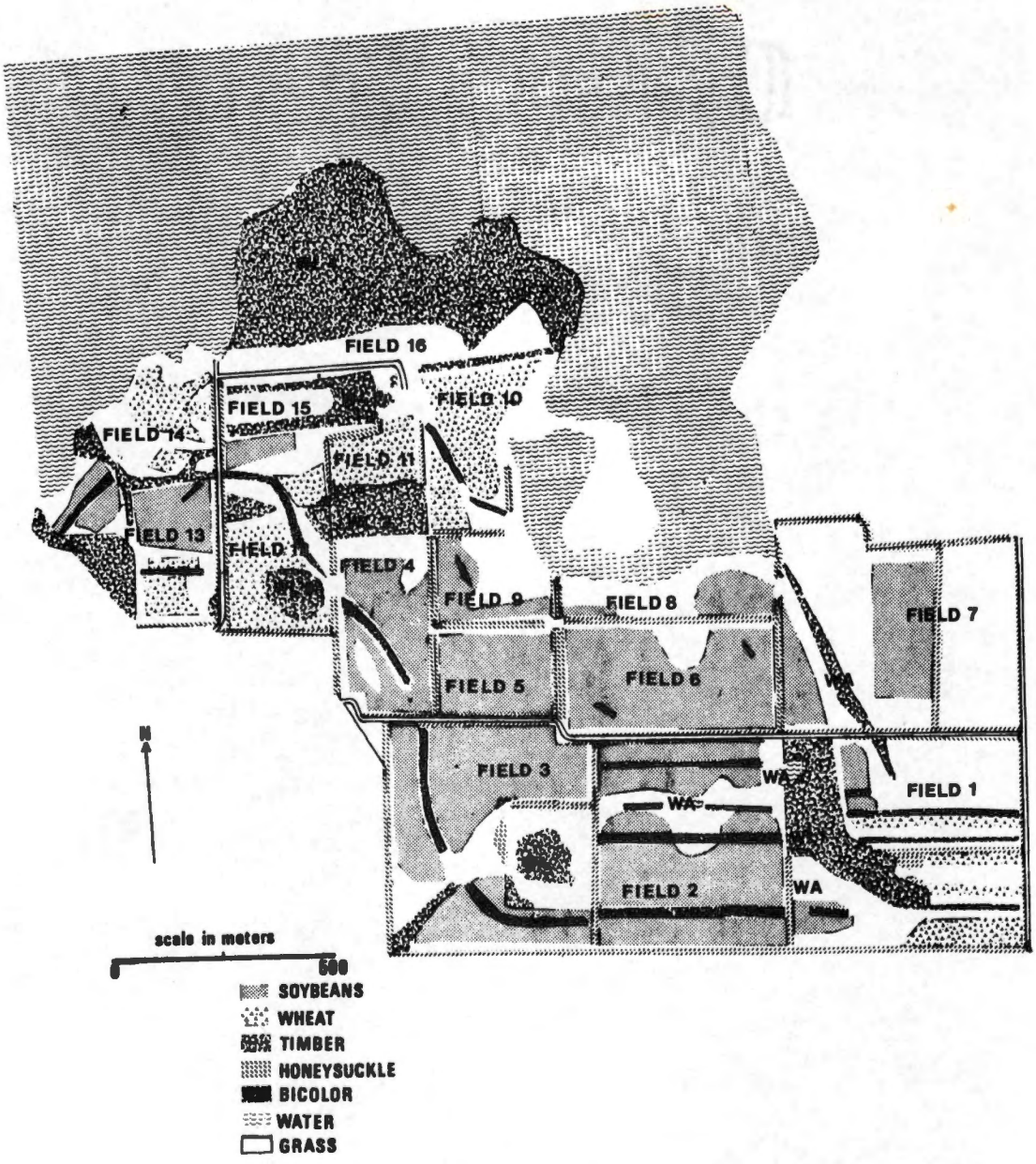


Figure 2. Identification of fields, woodlots (WL), and wet areas (WA) on the 190 ha study area, Percy Priest Wildlife Management Area, Rutherford County, Tennessee.

a predominantly deciduous hardwood overstory with a thick cover of Japanese honeysuckle (Lonicera japonica) at ground level. The remaining woodlot, WL4, did not have a well-defined overstory but was composed primarily of secondary growth of dry site hardwoods and Eastern red cedar (Juniperus virginiana). Most of these trees were under 5 m (15 ft) in height and provided a dense, brushy, ground cover. Besides the brush afforded by growing trees, greenbrier (Smilax sp.), prickly pear (Opuntia compressa), coral berry (Symphoricarpos orbiculatus), relatively small amounts of Japanese honeysuckle and other unidentified plant species further added to the surface entanglement. One woodlot, WL1, is topographically lower than the others and is wetter, having a permanent pond in the interior (Figure 1, page 5). The other woodlots are on higher ground and flood only under extreme conditions (Figure 3).

Grassy or Weedy Areas

The grassy or weedy areas varied in species composition from predominantly fescue (Festuca sp.), to Johnsongrass (Sorghum halepense), broomsedge (Andropogon virginicus), foxtail millet (Setaria italica), cocklebur (Xanthium strumarium), beggar lice (Desmodium sp.), and other assorted forbs. The areas varied from essentially

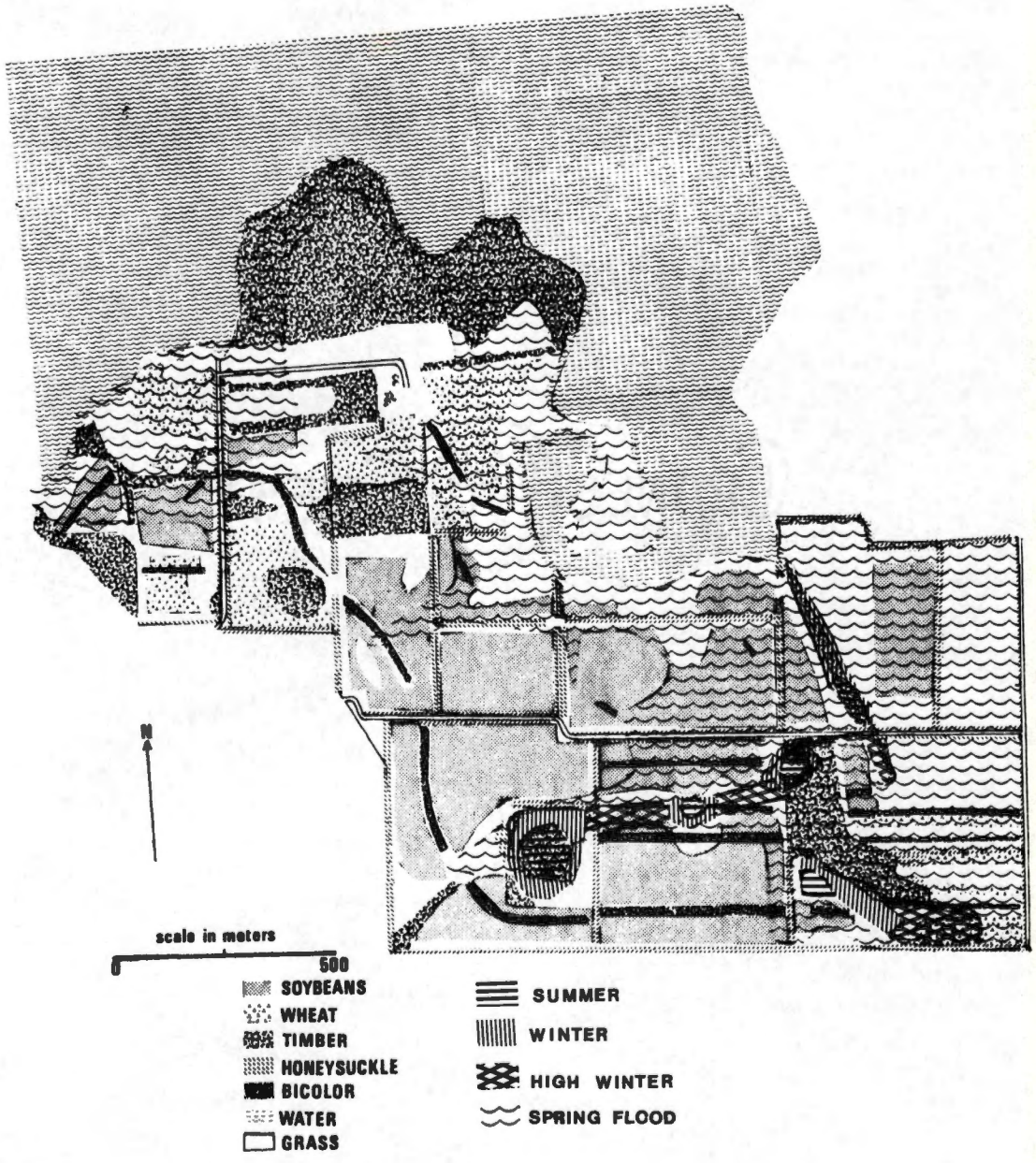


Figure 3. Four water levels observed on the 190 ha study area, Percy Priest Wildlife Management Area, Rutherford County, Tennessee, June 1974 to April 1975.

pure stands of a single species (e.g., fescue pastures) to mixtures of several different species. Some species, notably cocklebur and millet were found in wetter sites. These wet sites were devoid of standing water for only short periods. In addition to cockleburs, these areas were becoming populated by Eastern cottonwood (Populus deltoides), and black willow (Salix nigra). During the winter the above areas contained even more water and became potholes and sloughs with stretches of open water (Figure 3).

Fencerows

Fencerows varied in length (180 m to 1520 m) and width (1 m to 10 m) but did not vary greatly in species composition. All were overgrown with Japanese honeysuckle with most containing patches of blackberries (Rubus argutus).

Agricultural Areas

Agricultural areas were planted in two different crops (Figure 1, page 5). The crop having the most acreage was soybeans, 60.2 ha (158.3 a), followed by wheat, 18.6 ha (48.9 a).

Soybeans were planted in June and July, 1974; one-fifth of the total soybean acreage was left standing

in the field as food for wildlife. Soybeans left in the field were left in strips 1 to 2 m wide around the perimeter and across the interior of the field. Distances between strips varied from about 10 m to approximately 50 m. Soybeans were harvested between November 22 and December 16, 1974.

Wheat, like the soybeans, was cultivated under a sharecropping plan. The general planting period for the wheat was late September and early October, 1974. All the wheat was planted, and small sprigs of wheat were standing in every field by the time the first radio-collared rabbit was captured, tagged, and released on October 27, 1974.

Cover changes on the study area occurred as a result of agricultural manipulation and natural seasonal changes. Harvesting of soybeans produced the most sudden and drastic changes. Seasonal changes in quantity and density of natural cover were also quite substantial, but they occurred more gradually than those precipitated by agricultural harvesting.

CHAPTER III

METHODS AND MATERIALS

Trapping and Tagging

Captured rabbits were either instrumented with radio transmitters or ear-tagged and, in some cases, tail dyed, so that individuals could be identified by an observer at a distance. Traps used were plywood live traps (Brady 1973). A 9"x3/8" bolt in the top of the trap served as a predator guard. The bolt was held up when the trap was set by the inward swinging door, and fell in behind the door under its own weight when the trap was tripped. In all but a few cases the predator guard worked satisfactorily. In the few instances where traps had been entered and rabbits removed, humans were suspected of aiding the entry of hunting dogs into the trap by tipping the trap on its side and removing the predator guard.

Trapping was divided into three separate periods. During the first two periods, traps were placed along field roads and paths. During the third trapping period traps were placed in a grid at a density of one trap per 0.8 ha (2 a) over an area of 57 ha (150 a) (Figure 4). Rabbits captured October 1 to November 9 were either

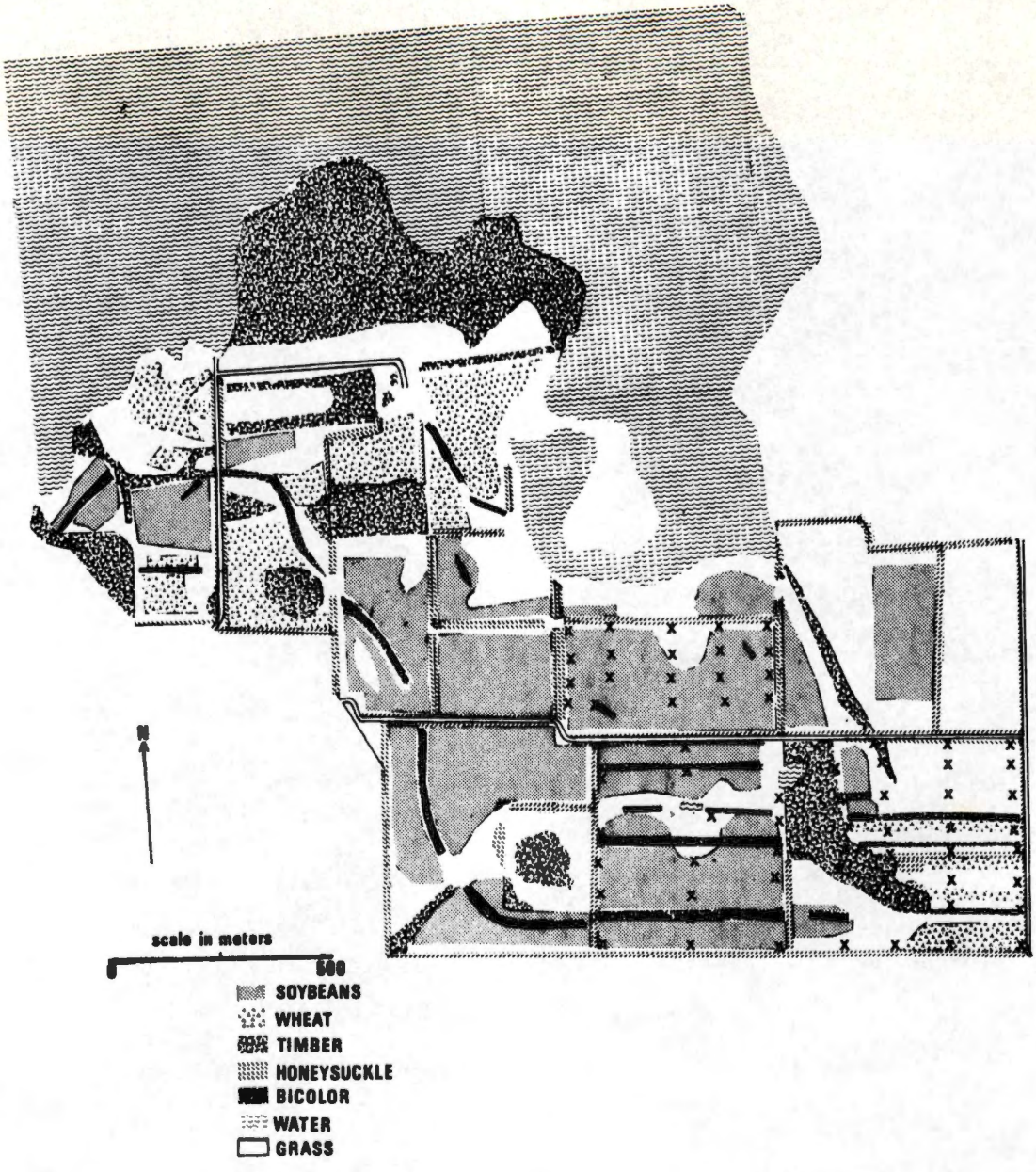


Figure 4. Trap placement January 23, 1975 to February 28, 1975 on the 190 ha study area, Percy Priest Wildlife Management Area, Rutherford County, Tennessee.

fitted with radio-transmitters or ear-tagged; the sample of ear-tagged rabbits could be flushed and observed during simulated hunts later in the year. It was hoped that the ear-tagged rabbits would provide additional information concerning rabbit cover use, home ranges and population densities. The second trapping session (November 24 to December 4) was designed to recapture a collared rabbit that had been lost. Unmarked rabbits captured in traps set to catch the collared rabbit were tagged and released. Animals captured in the third period (January 23 to February 28) were ear-tagged to be observed during simulated hunts. Trap-retrap data from the third period was used in the calculation of a population estimate.

The ear-tagging procedure was the same as that described by Brady (1973:19). Different colored ear tags were used in differing combinations to identify individual rabbits. Two different colored tail dyes, Rhodamine-B (red) and picric acid (yellow), were used to mark rabbits when additional identifying marks were necessary. Rhodamine-B was used to mark male radio-collared rabbits and picric acid was used for female radio-tagged rabbits. Picric acid dye was also used on tails of some ear-tagged rabbits as an additional color indicator, which, when used

in conjunction with ear-tag combinations, differentiated a given rabbit from all others previously or subsequently tagged.

Telemetry and Monitoring

Telemetry equipment included a directional three-element yagi antenna, a 24-channel AVM portable receiver, a set of headphones, and radio-collars (Wildlife Materials, Inc.). The receiver was equipped with a "gain" or volume knob which allowed the observer to increase or reduce the volume of the signal as he moved away from or approached the transmitter. The technique of reducing volume as the rabbit was approached was used to determine movement of the animal ahead of the observer when the rabbit could not be seen, and when the observer was closer than 50 m. For example, assume that an observer approached a rabbit in an effort to determine whether the rabbit moves when approached to a distance of 1 meter, and assume that the rabbit is under very dense honeysuckle which covered such a large area that the observer is unlikely to see the animal if it moved. As the observer approached, he reduced the volume of the signal he is receiving so that if the rabbit moved away from the observer, the signal faded out. At a distance of 2 to 3 m from the rabbit the volume can be reduced to

the fullest possible extent and the signal will continue to be strong (thus the observer knows his approximate distance from the rabbit as well as his direction). The signal intensity increases as the observer approaches closer. If the rabbit moves, the signal suddenly fades. If the rabbit remains stationary, the signal slowly fades as the observer moves past and away from the rabbit, unless the volume is adjusted.

The range of the collars used in this study varied. Under open conditions where a minimum of physical material lay between the rabbit and the observer, signals could be received at a distance of 600 to 800 m. Ranges were generally much smaller, however, due to the fact that rolling topography and dense cover often placed large amounts of material between the transmitter and receiver. Usually the observer was required to approach the rabbit to a distance of 200 to 300 m before a signal could be located. In some cases, especially where a given collared rabbit was using a groundhog hole, the range of the signal was cut to as little as 50 to 75 m.

Between October 27, 1975 and November 9, 1975 12 cottontail rabbits were live-trapped and collared with radio-transmitting collars. Late in the study one additional "activity collar" was field tested (February 20,

1975). This last collar was designed to emit differing signals with differing activities undertaken by the rabbit to which it was attached. Constant signals were received from the other 12 collars except when the observer was over about 50 m away and the rabbit moved through heavy cover or changed position relative to the receiver, in which case the volume of the signal alternately faded and increased. It is appropriate to note at this point that the alternate decrease and increase in signal intensity brought about by movement was used in this study and also in a study by Trent et al. (1974) to determine at a distance whether or not a rabbit was moving when it could not be observed visually (e.g., nocturnal movements). As rabbits died or lost their collars, the collars were recovered and placed on new rabbits.

While triangulation is the method used in many studies to locate telemetered animals, the method of location used in this study was, of necessity, approach. Detailed records regarding cover characteristics utilized by rabbits, and data concerning their tendency to flush were required, thus the observer needed to be close enough to the rabbit to obtain the necessary information.

Cover types on the study area were delineated

with respect to two parameters, cover density and cover penetrability. Four types of cover density were designated and the differentiation of types was determined photometrically. A photometer was held in a horizontal position above the cover for which a density determination was to be made and the photometer reading recorded. The photometer was then placed in a horizontal position beneath the cover and the photometer reading recorded. The latter reading was then divided by the first to obtain the percentage of light penetration through the cover. Cover which allowed 10 percent or less of the incident sunlight to pass through to the ground was referred to as very dense; cover allowing 11 to 20 percent of the sunlight incident upon it to pass through was designated as dense; cover allowing 21 to 45 percent of the incident sunlight to pass through was designated as having moderate density; and cover allowing more than 45 percent of the incident sunlight to reach the ground was designated as sparse. Three penetrability types were designated and are described as poor to very poor, fair to good, and excellent. Examples of cover having poor to very poor cover penetrability are brushpiles, woodchuck burrows, and dense continuous stands of honeysuckle standing 0.6 m (2 ft) or higher off the ground, especially where blackberries also proliferate. An example of cover with fair

to good penetrability is honeysuckle standing lower to the ground than 0.6 m. Examples of cover with excellent penetrability are soybeans and grass.

Data for each radio-collared rabbit included location, the date observed, time of day observed, and whether or not the rabbit was flushed. Visual contact was necessary before the rabbit was considered flushed. If the rabbit moved but was not seen, e.g., under heavy cover, the designation made was "not flushed, moved ahead of observer," or other designation appropriately describing the movement. Also recorded was the time length and distance in meters that visual contact (if any) was maintained; if the rabbit moved, whether there was sound or no sound; the closest distance to which the rabbit was approached; the type of cover used (species composition, density, and penetrability); the size and shape of the cover plot and the surrounding vegetation; and rabbit breeding behavior.

Simulated Hunts

A total of seven simulated hunts, and one actual hunt, were conducted on the study area during the hunting season. The first hunt was carried out on December 8, 1974, and the last on February 28, 1975. On each hunt except the first, dogs were used to aid in locating rabbits.

Data recorded during each hunt included locations of rabbits, the density, penetrability, size and shape of cover plots from which rabbits were flushed (and in which radio-collared rabbits not flushed were located). Also recorded were the ratios of flushed to unflushed radio-tagged rabbits, activities of collared rabbits approached during hunts, and variations in the hunting procedures utilized by different hunters, and also by different hunting dogs.

External parasites were collected when found on cottontails and were identified from keys by Lancaster (1973) and Pratt and Wiseman (1962). Scientific names of avian species were obtained from Robbins et al. (1966), scientific names of mammals from Jones et al. (1973), and scientific names of plants from Gleason (1952).

Analysis of Data

Statistical analysis of data was limited since much information was in the form of rankings, thus preventing parametric analysis. Also, the sample size of the collared rabbits (the collared rabbits provided the majority of the data collected) was too small to allow statistical analysis.

Two types of analyses were run, however, on the trapping data. The first of these involved data that

gave strong indication that the trapability of female cottontails relative to males was greatly enhanced when large numbers of females were in estrous. A Chi-square 2x2 test for independence tested whether the capture rate for the female rabbits, relative to the males, was independent of the onset of estrous in the females. A level of significance was chosen at 0.1 since acceptance of the null hypothesis (that females in estrous are more easily captured than males) was expected.

A population estimate, utilizing recapture frequencies from January and February trapping data only, determined the population density when the population was near its yearly low. Rabbits captured prior to the January 23 to February 18 trapping period were excluded from the data used in calculating the estimate unless they were captured between the above dates. If a rabbit previously tagged was again captured during the January-February trapping period, the animal was not considered a recapture until captured more than once during the January-February trapping session.

The population estimate was calculated by the Eberhardt method where $N = \frac{r(s-1)}{s-r}$ and N = population estimate, r = first captures, and s = total captures (Eberhardt 1969). This technique was chosen because a

comparison of this and other methods by Brady (1973: 46) and Edwards and Eberhardt (1967) indicated that the Eberhardt method provided a more accurate population estimate than the other methods.

Two different methods for determining home range were compared in the present study. Telemetry, including diurnal and nocturnal observations, provided home range data for collared rabbits, and trapping and flushing observations provided information on ear-tagged rabbits. Locations of radio-tagged rabbits were plotted for each month on a map; the points around the perimeter of each monthly group were connected, and the area within the lines designated as the home range of the rabbit (Harvey and Barbour 1965). Two exceptions to this method of home range determination are presented in the text and involve cases where two male rabbits were found at points outside their normal resting and feeding areas. These departures constituted less than 1 percent of the data and were deleted from the home range data.

Home ranges for ear-tagged rabbits were obtained by connecting the points at which the rabbit was observed with a series of straight lines, thus a minimum of three observations were needed on an ear-tagged rabbit before any home range estimate was attempted. Any rabbit

observation located at a distance exceeding one quarter the length of the home range from the next nearest point of observation was excluded from home range data; distances this great were considered a departure from the home range by the rabbit (Harvey and Barbour 1965).

CHAPTER IV

RESULTS AND DISCUSSION

A total of 117 cottontail rabbits were captured during the study. Nineteen rabbits were radio-tagged, 79 were ear-tagged, 13 were released because they were judged too small (< 800 g or 1.8 lbs), and 6 escaped prior to tagging (Appendixes A and B).

Population Estimate

The population estimate determined by the Eberhardt method for the 57 ha trapped in January and February was 323 rabbits, a density of 5.67 rabbits per ha (2.15 rabbits/a) (Appendix C). The population in the portion of the study area trapped was thought to be much higher than in the northwestern 87 ha (210 a) of the study area, since trapping in the northwestern portion of the study area was very unproductive (0.005 rabbits captured/trap night) compared to the south and southeastern portions (0.05 rabbits/trap night). Reasons for the general lack of rabbits throughout the northwestern portion of the study area are unknown. Cover was essentially the same in the northwestern and southeastern portions of the study area. It is possible that predation might play a

role in the reduction of rabbit numbers in this area since foxes are reportedly more abundant here than elsewhere on the study area (Larry Beard, Area Manager, personal communication). During the course of the study, fox sign was found in greater abundance in the northwestern portion of the study area than in the south and southeastern areas, and a red fox was flushed on March 11, 1975, from WL4 by beagles. Another factor possibly influencing rabbit numbers is that the northwestern portion of the study area was left predominantly in grass and weeds during the summer months, whereas the south and southeastern portions were planted in soybeans. Possibly the soybean fields are more productive for cottontail rabbits than are the grassy, weedy areas. Other researchers also report varying cottontail densities; Trippensee (1948: 29) reports that cottontail densities of ". . . better than five rabbits per acre . . ." have been observed in Pennsylvania, and Kelker (1943) reports cottontail densities ranging from one rabbit per 1.3 a to one rabbit per 30 a in Wisconsin.

Mortality is not thought to be a significant factor in the calculation of the Eberhardt estimate since the trapping period for rabbits used in making the estimate was relatively short (January 23 through February 28).

As previously mentioned, the Eberhardt estimate is thought to represent the population near its lowest annual point.

There was a sharp decline in flushing success as hunters entered the northwest portion of the study area. No rabbit flushes were observed for the entire study period west of field 8 and north of field 5 (Figure 2, page 7) although this area was hunted in three of the eight simulated hunts (January 21, 1975; February 12, 1975; and February 27, 1975). During these three hunts, 16 cottontails were flushed from the remainder of the study area. Thus, evidence would indicate that the low population in the northwestern portion of the study area resulted in low hunter success.

Home Ranges

Average winter home range sizes for nine male and seven female radio-collared rabbits were found to be 2.8 ha (6.9 a) and 2.2 ha (5.8 a), respectively (Table 1 and Figure 5). Home ranges varied in size from 4.4 ha (11.5 a) for C-18 (a male) to 1.4 ha (3.7 a) for C-2 (a male). The home range sizes for males correspond with the 2.8 ha (6.8 a) for average home range size of male cottontails in spring from a telemetry study by Trent et al. (1974) in Wisconsin. The average home range size

Table 1. Home range sizes of radio-collared cottontails November 1974 to March 1975 on the Percy Priest Wildlife Management Area.

Rabbit Number	Period of Observations	Number of Observations	Home Range Size	
			Hectares	Acres
		Females		
C-3	11/9/74-11/20/74	6	Insufficient Data	
C-8	11/6/74-1/29/75	9, 24[a]	3.1, 2.2[b]	8.0, 5.7[b]
C-9	11/6/74-3/1/75	53	3.1	8.0
C-12	11/7/75-3/1/75	54	2.7	6.9
C-13	11/4/75-3/7/75	59	2.0	5.2
C-15	1/31/75-2/3/75	4	Insufficient Data	
C-16	1/31/75-2/28/75	19	2.9	7.5
C-17	1/24/75-2/18/75	17	1.5	4.0
C-19	2/17/75-3/7/75	10	3.3	8.6
		R=4-59	R=1.5-3.3	R=4.0-8.6
		$\bar{x}$=25	$\bar{x}$=2.2	$\bar{x}$=5.8
		Males		
C-1	10/27/74-1/22/75	11, 15[a]	3.2, 3.2[b]	8.3, 8.3[b]
C-2	11/7/74-1/22/75	38	1.4	3.7
C-4	2/20/75-2/26/75	6	Insufficient Data	
C-5	10/28/74-1/16/75	39	1.6	4.1
C-6	11/7/74-2/24/75	59	2.0	5.2
C-7	11/7/74-3/1/75	17, 46[a]	3.1, 3.3[b]	8.0, 8.6[b]
C-10	11/5/75-3/1/75	17, 40[a]	2.2, 1.7[b]	5.7, 4.6[b]
C-11	11/7/75-11/23/75	12	3.1	8.0
C-14	2/2/75-3/1/75	18	2.9	7.6
C-18	1/31/75-3/10/75	20	4.4	11.5
		R=6-59	R=1.4-4.4	R=3.7-11.5
		$\bar{x}$=34	$\bar{x}$=2.8	$\bar{x}$=6.9

[a]Observations after rabbit moved to a new home range.

[b]Home range size after rabbit moved to a new home range.

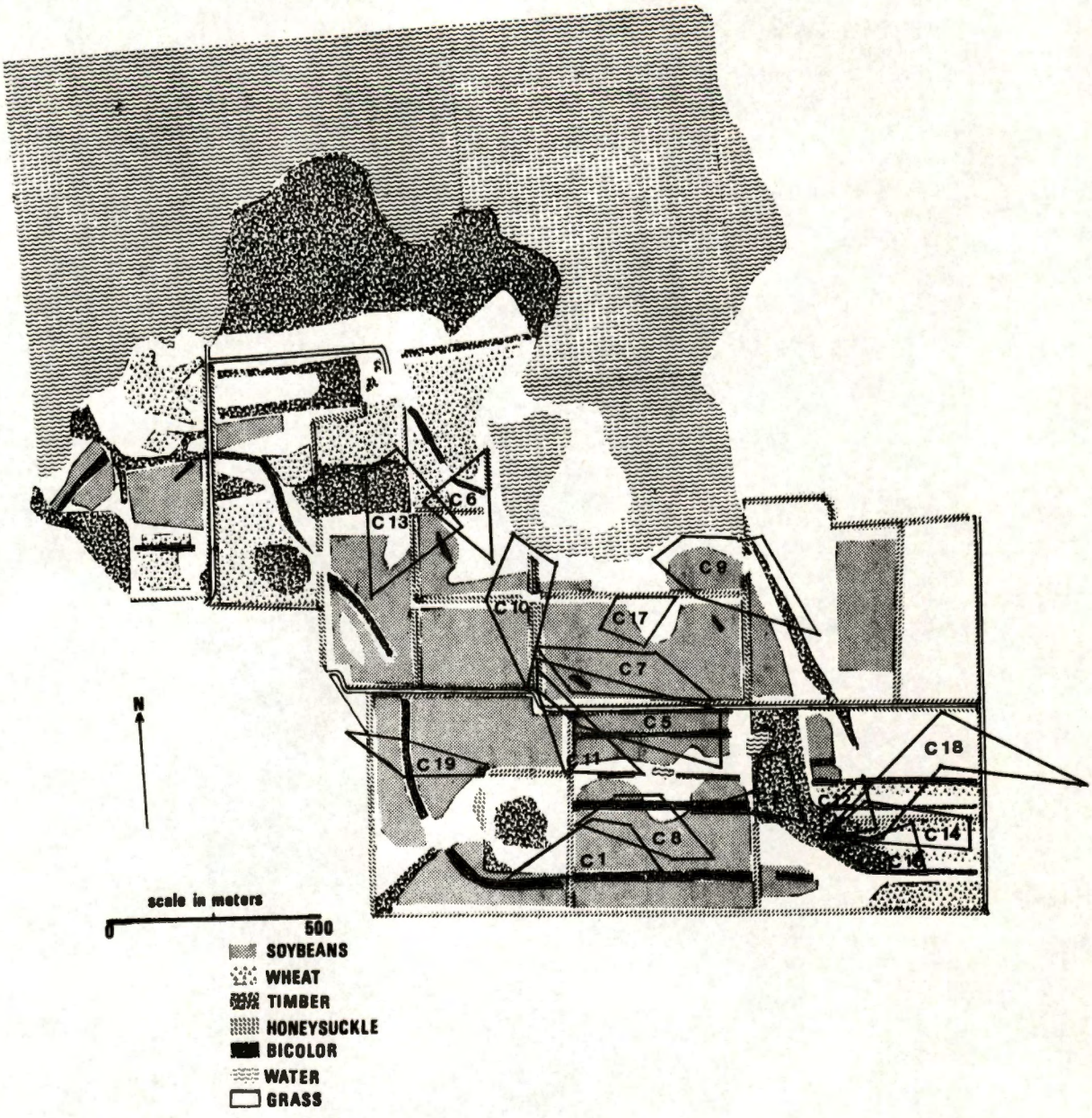


Figure 5. Home ranges of 16 radio-tagged cottontails on the Percy Priest Wildlife Management Area, Rutherford County, Tennessee, November 1974 through February 1975.

for females is somewhat higher than the 1.7 ha (4.3 a) described for females in spring by Trent et al. (1974) and is considerably higher than the 0.8 ha (2.1 a) value (Trent et al. 1974) for home ranges of females in winter. The seasonal changes in sizes of home ranges described by Trent et al. (1974) was not observed in the present study. The seasonal changes in home range sizes reported by Trent et al. (1974) occurred during the spring and summer months and were related to the breeding season; home ranges of males decreased in size as testicles regressed in the fall and sizes remained stable until the breeding season began in the spring. Home range sizes of female cottontails increased during the spring after the onset of breeding and then decreased in size in early summer and remained approximately the same size until the following spring. Testicles had regressed in all male cottontails captured in October and November. Home range sizes of the cottontails observed had decreased to their minimum yearly sizes prior to the initiation of trapping and radio-tracking. Also, trapping and radio-tracking were not extended into the spring months, thus increases in home range sizes may have occurred after the conclusion of the study.

Average home range sizes for cottontails based on

recapture and reobservations of 10 ear-tagged rabbits were found to be 5.6 ha (14.6 a) for males, and 1.2 ha (3.2 a) for females (Table 2 and Figure 6). The largest home range was found to be 6.9 ha (17.8 a) for rabbit number 12 (a male); the smallest was found to be 0.7 ha (1.7 a) for rabbit number 65 (a female). Dalke and Sime (1938) report an average home range size for male cottontails in Connecticut of 8.3 a, and an average home range size for females of 2.9 a when home range was determined from trapping data. Allen (1939) gives average home range size for male cottontails in Michigan as 3.6 a and 2.2 a for females; Heard (1963) reports similar results from Mississippi. Both Allen (1939) and Heard (1963) employed a trap-retrap method for determining home range. Haugen (1942) reported an average home range size for female cottontails in winter in Michigan as 14 a and stated that males were found to ". . . roam over . . ." 100 a, based on trap-retrap observations. Thus, although most trap-retrap studies show roughly corresponding home range sizes for cottontails, the discrepancies indicated in the study by Haugen (1942) and between the telemetry and reobservation data in the present study indicate probable biases inherent in trap-retrap methods of home range determination.

The location of the home ranges of five telemetered

Table 2. Home range sizes for ear-tagged cottontails October 1974 to March 1975 on the Percy Priest Wildlife Management Area.

Rabbit Number	Number of Observations	Home Range Size	
		Hectares[a]	Acres[b]
Males			
2	5	4.4	11.5
12	5	6.9	17.8
Females			
9	3	1.5	4.0
27	3	0.5	1.2
29	5	2.4	6.3
47	3	0.9	2.3
50	3	1.1	2.9
51	6	1.5	4.0
65	3	0.7	1.7
67	3	1.1	2.9

[a]Mean: M = 5.6; F = 1.2.

[b]Mean: M = 14.6; F = 3.2.

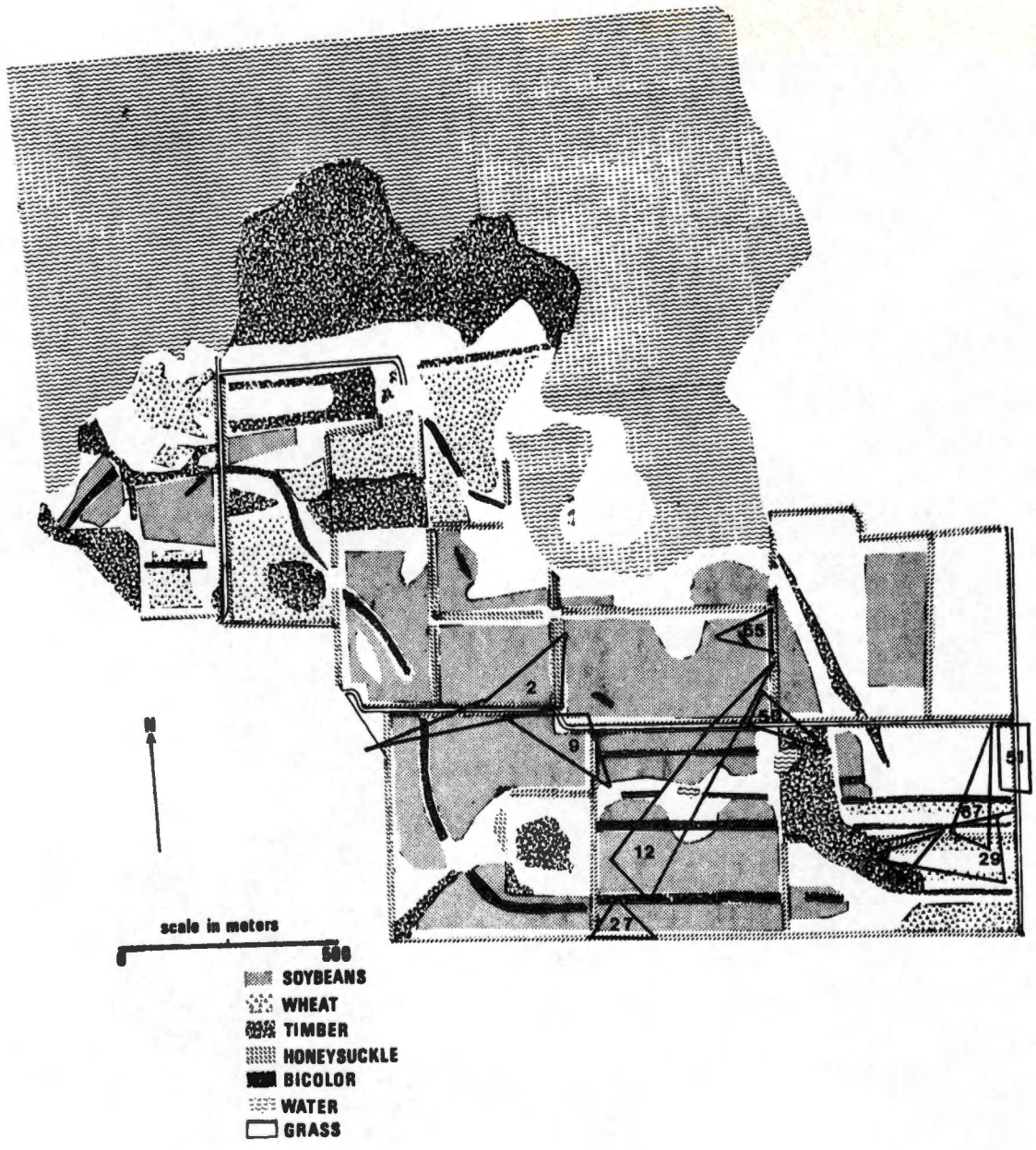


Figure 6. Home ranges for 10 cottontails based on trap-retrap and reobservation data on the Percy Priest Wildlife Management Area, Rutherford County, Tennessee.

rabbits changed during the course of the study (Figure 7). Three of the rabbits which changed home range (C-1, C-7, and C-8) had been using the soybean fields for diurnal cover 60 percent of the time or greater (60.0 percent, 83.3 percent, and 76.9 percent for C1, C-7, and C-8, respectively) and relocated subsequent to the destruction of this cover via harvesting (November 26, 1974 to December 4, 1974). Rabbit C-6 altered its home range on March 11, 1975, one day after its original home range became flooded and hunting pressure was applied, causing the rabbit to seek more suitable refuge cover. One of the five (C-10) was observed to relocate its home range on December 10, 1974, but no drastic cover changes were observed in the area used by C-10 as diurnal cover. Therefore, it appears that C-10 altered its home range in response to some condition or conditions other than cover availability. Early studies (Trippensee 1948: 23-41) indicate that cottontails tend to concentrate ". . . in areas of protecting cover . . ." during the winter months. Haugen (1943) also reported a migration of rabbits into winter concentrations. Some rabbits in the population may have relocated without the stimulus of sudden, severe cover reduction had that cover reduction not occurred. However, this hypothesis is thought to be

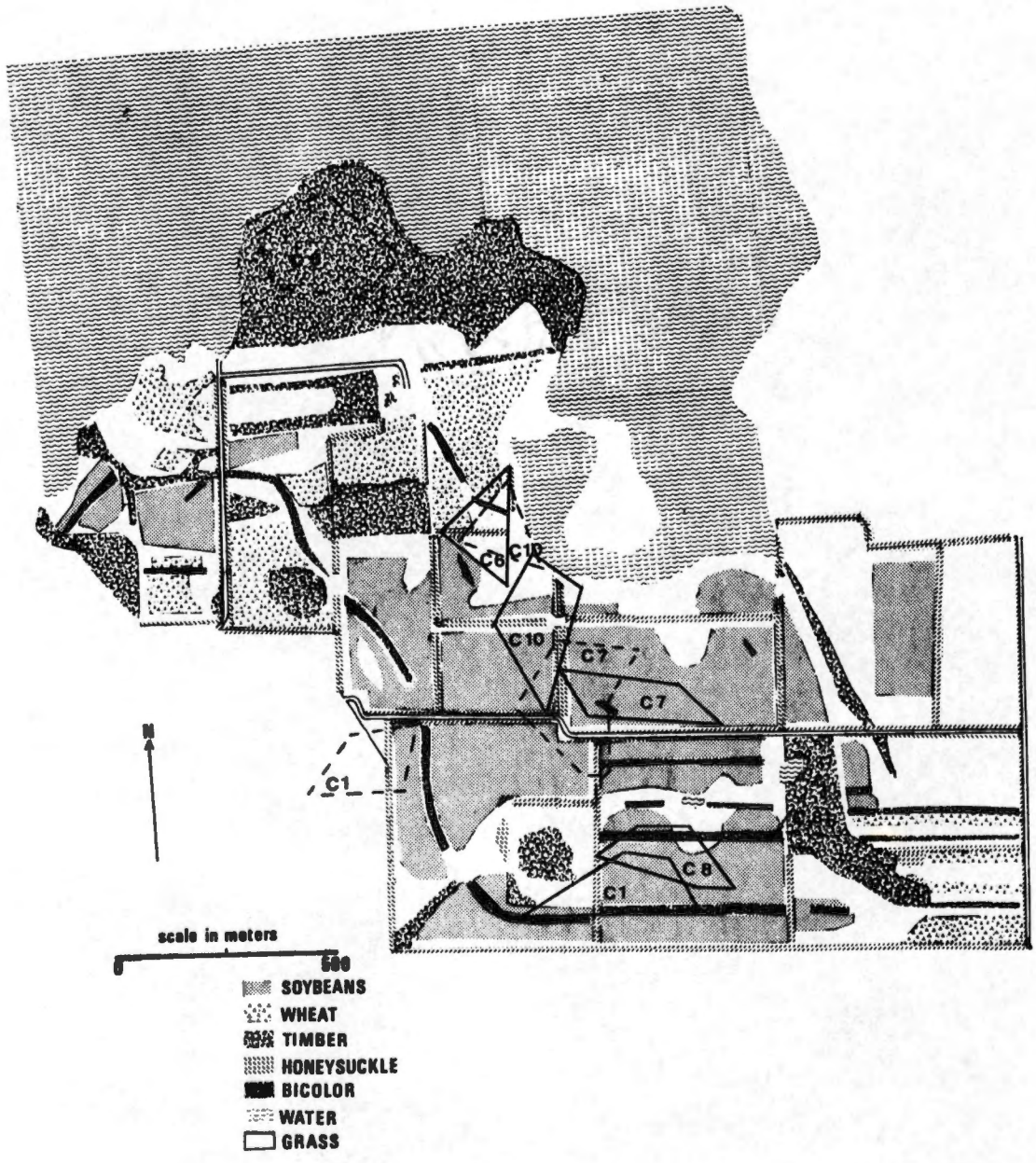


Figure 7. Original home ranges (solid line) and home ranges subsequently established (broken line) by five radio-tagged cottontails on the Percy Priest Wildlife Management Area, Rutherford County, Tennessee.

inconsequential since radio-collared rabbits other than C-10 which did not suffer sudden cover loss remained in their original home ranges. Changes in home range for cottontails observed in this study occurred as a result of sudden, catastrophic reduction of preferred cover within the existing home range, and that, unless major degeneration of cover occurs, cottontails will remain in their established home ranges. A similar conclusion was drawn by Haugen (1943) after the establishment of brush piles and artificial burrows in areas normally vacated by rabbits during the winter prevented a large number of rabbits from leaving the area; provision of food without cover in other areas did not prevent rabbits from leaving.

The shifts in home range described above resulted in the evacuation of harvested areas by rabbits and the subsequent relocation of these rabbits in areas retaining suitable cover (See section entitled Habitat Use and Preference, page 42). While portions of the home ranges of three of the four radio-collared cottontails which changed home ranges in late November (C-1, C-7 and C-8) encompassed portions of harvested soybean fields during the winter months (Figure 7), the rabbits were found to prefer areas of thick, heavy cover within their respective

home ranges for diurnal cover (See Habitat Use and Preferences). Thus hunters may not find rabbits in areas where rabbits were located prior to the hunting season if harvest of crops or other practices seriously decrease existing cover. However, hunters may find concentrations of rabbits in areas of thick winter cover near the harvested areas (See Concentrations of Rabbits, page 49).

Of the rabbits which changed home ranges, none were observed to return to their entire original home range, although rabbits C-10 and C-7 did utilize portions of their former home ranges throughout the winter (Figure 7, page 34). Rabbit C-8 was observed to return only once to a point within its original home range and it subsequently returned, after one day, to the home range it was using at the time. After changing home ranges, rabbits C-1 and C-6 were never observed to return to any area within their vacated home ranges, even though subsiding flood water left the original home range of rabbit C-6 essentially unchanged.

Except under conditions previously mentioned, most rabbits were observed to remain within their respective home ranges; however, six rabbits (collared rabbits C-6, C-10, C-19, and ear-tagged rabbits 12, 29, and 51) were

found during the study at points outside their home range boundaries (Figure 8).

Rabbit C-19 was captured February 17, 1975 and collared at a distance of 647 m by land route (an area of open water stood between the capture site and the home range of the rabbit, Figure 2, page 7) beyond its usual diurnal resting cover. The rabbit was found dead on April 7, 1975, at a point 305 m (by land route) from the capture site. Prior to the location of the carcass, the closest distance to which the rabbit was observed to approach the capture site was 457 m (by land route). The reason for the departure is unknown.

Rabbit C-6 was also found at a location a short distance outside its home range on February 1, 1975 (during a six-day period regarded as the onset of breeding) and was found within 1.5 m (5 ft) of rabbit C-13, a female. The observer entered the cover in which these two rabbits were located in order to determine if the rabbits would move in divergent directions or remain together when disturbed. The rabbits were found to remain together when disturbed; the movements of the female were copied closely by the male. A similar phenomenon was observed between rabbits C-14 (a male) and C-12 (a female) on February 3, 1975, although both

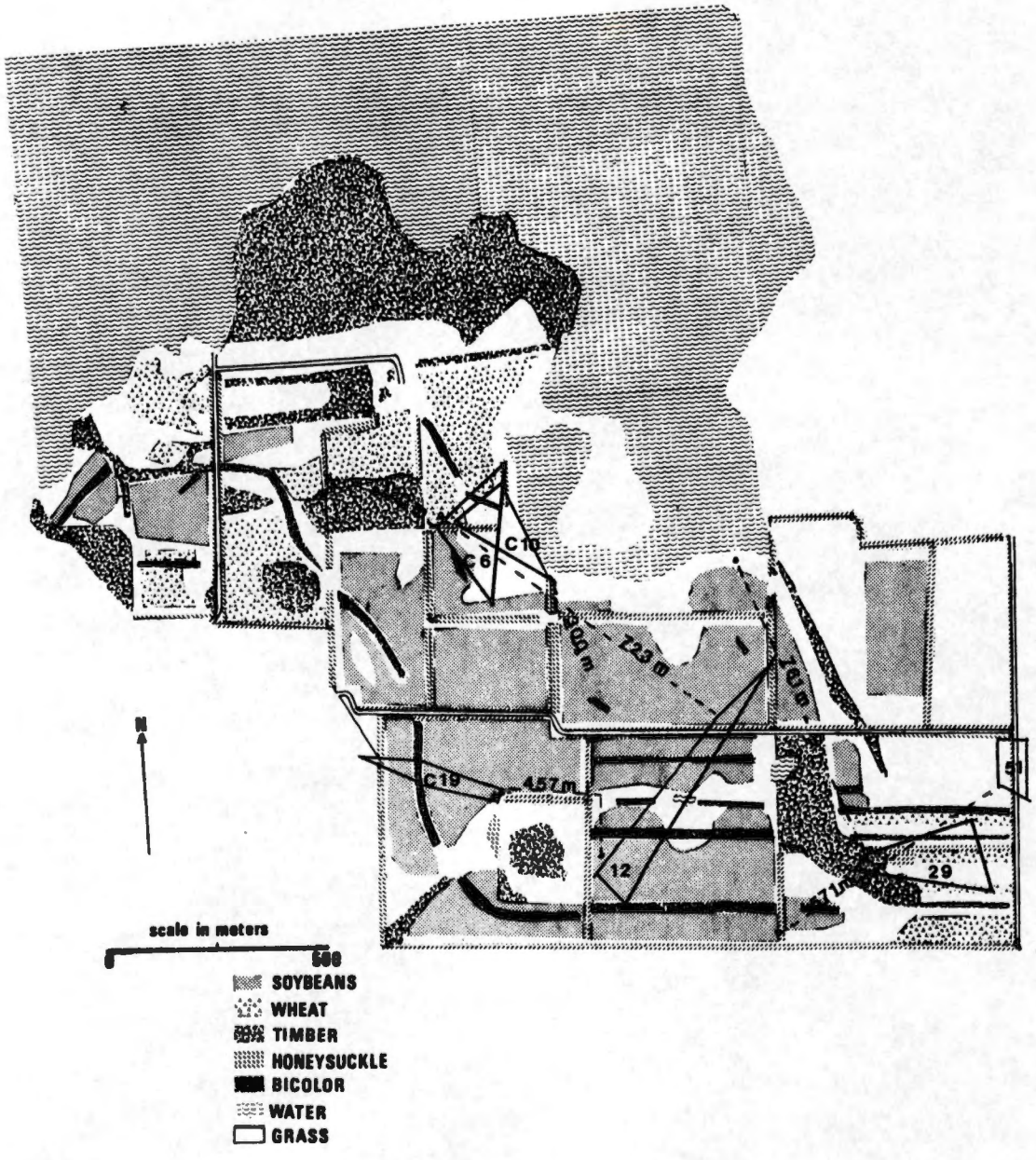


Figure 8. Home range departures by six cottontail rabbits on the Percy Priest Wildlife Management Area, Rutherford County, Tennessee.

rabbits were within their respective home ranges. No movements of this nature were observed between rabbits of the same sex or prior to the breeding season. It is assumed that the female was in estrous and that the home range departure by the male was in response to the location of the female.

Rabbit C-10 (a male) was found outside the boundary of its second home range on February 3, 1975, during the six-day period (January 31 to February 5) when a relatively large number of female cottontails were observed to be in estrous. This departure also is thought to have occurred in response to the location by C-10 of a breeding female. The departure lasted less than 24 hours.

Reasons for the home range departures of three ear-tagged rabbits are unknown; two of the rabbits (29 and 51) were females observed outside their home ranges on February 12, 1975 and February 28, 1975, respectively, and the third rabbit was observed outside its home range on November 3, 1974, prior to the breeding season.

Home range departures such as those described above may lead to erroneous derivation of sizes of home ranges when recapture frequencies are utilized in home range determination; inclusion of these points into home range data would result in home range sizes larger than

actual. Trippensee (1948: 26) cited a study by Schwartz (1940) in which 1 percent of the trapping data was excluded in the determination of the home ranges of cottontails due to the fact that 1 percent of the points where rabbits were recaptured were 390-2560 ft from the next nearest point of observation. The above possibly accounts for the large average home ranges reported by Haugen (1942).

There is insufficient data on both radio-collared and ear-tagged rabbits to make any assessment of the area encompassed by a rabbit traveling outside its home range other than information given above. However, Trippensee (1948: 26) cited a Wisconsin study (Anonymous 1939) in which it was found that rabbits returned to a pothole from which they had been trapped if they were released at a distance not exceeding 1 mile from the pothole.

While the effects of home range departures on the susceptibility of cottontails to hunting was not ascertained, it is believed that, due to the short duration of these departures, the susceptibility of the rabbit to hunting would probably not be significantly affected.

Onset of Crepuscular Activity

One observed phenomenon which may tend to discourage hunters is their lack of observation of rabbits in early morning and late afternoon during the winter. Marsden and Conaway (1963) reported that cottontails did not vary the onset of crepuscular activities with increasing day length, and Holler and Marsden (1970) reported that cottontails began evening activities during the twilight period following sunset in late winter and early spring but well before sunset in late spring and summer.

Mech et al. (1966) reported, on the other hand, a wide individual variation in onset and cessation of activities by cottontails, and that sunrise and sunset were believed to be the factors controlling the onset and cessation of activities. However, the method of observation of the rabbits used by Mech et al. was telemetric monitoring from a tower some distance from the rabbits monitored. The researchers reported that movement by the rabbit of a distance of 16 to 65 m (50 to 200 ft) was required before onset of movement could be definitely established. Cottontails in the present study began moving in the evening in a small area for periods of up to 30 minutes. Therefore, the data

obtained by Mech et al. regarding onset of activity may be in error.

Eighteen telemetric observations were obtained during the present study for which the onset of evening activities of 12 radio-collared rabbits were ascertained (Table 3). Rabbits began moving at or subsequent to sunset December, 1974 through February, 1975. It appears from the above that cottontails begin activities in the summer months prior to sunset, in which case they may be easily seen, and in winter subsequent to sunset, in which case they are not readily observed. Thus the "disappearance" of cottontails during the winter months cannot be attributed entirely to a decline in the population, but also to a decline in activity during the daylight hours.

Habitat Use and Preference

Radio-tagged cottontails were found to have areas within their home ranges which were preferred as diurnal resting places. The area within its home range in which a rabbit was located in 80 percent or more of the diurnal observations will be referred to hereafter as the diurnal cover preference range (DCPR) of the rabbit (Table 4 and Figure 9).

The diurnal cover preferred by the radio-collared

Table 3. Onset of crepuscular activities in relation to sunset for 12 radio-collared cottontails on the Percy Priest Wildlife Management Area, December 1974 through February 1975.

Rabbit Number	Date	Time of Sunset Central Standard Time	Time of Onset of Activity Central Standard Time
C-1	1/19/75	5:00	5:10
	2/14/75	5:27	5:30
C-5	12/12/74	4:33	6:45
	1/13/75	4:54	5:30-5:45[a]
C-6	2/14/75	5:27	5:30-6:10[a]
C-7	2/10/75	5:23	5:35
	2/14/75	5:27	5:30-5:55[a]
C-9	12/12/74	4:33	6:20
	1/13/75	4:54	5:30
	1/19/75	5:00	5:00
	2/14/75	5:27	5:45-6:45[a]
C-10	2/14/75	5:27	5:30-6:05[a]
C-12	2/14/75	5:27	5:30-6:45[a]
C-13	2/14/75	5:27	6:20
C-14	2/14/75	5:27	5:30-6:45[a]
C-16	2/14/75	5:27	5:45-6:45[a]
C-17	2/14/75	5:27	5:30-5:50[a]
C-18	2/14/75	5:27	5:30-6:45[a]

[a]Exact time of onset of activity unknown, but occurred between the times shown.

Table 4. Size of area and percentage of home range in which 19 radio-collared cottontails were located in 80 percent or more of the diurnal observations (DCPR[a]) taken on the Percy Priest Wildlife Management Area, November 1974 to March 1975.

Rabbit Number	Number of Observations	Size of DCPR Before Home Range Change		Size of DCPR After Home Range Change (If Any)		Percentage of Total Home Range Covered By DCPR
		Hectares	Acres	Hectares	Acres	
C-1	11, 15[b]	3.3	8.0	Minute, Limited to One Brushpile		96.4, 1.1[c]
C-2	38	0.3	0.6			15.3
C-3	6	Insufficient Data				
C-4	6	0.3	0.5			Insufficient Data
C-5	39	1.0	2.3			55.5
C-6	59	1.2	2.9	Insufficient Data		55.5
C-7	17, 46[b]	1.1	2.7	0.5	1.2	33.1, 13.4[c]
C-8	9, 24[b]	2.0	4.9	1.7	4.0	60.1, 70.0[c]
C-9	53	2.6	6.3			78.5
C-10	17, 40[b]	1.3	3.2	0.4	0.9	55.1, 18.8[c]
C-11	12	1.1	2.6			32.1
C-12	54	1.0	2.5			36.3
C-13	59	0.3	0.6			11.0
C-14	18	1.0	2.5			33.5
C-15	4	Insufficient Data				
C-16	19	1.0	2.5			33.5
C-17	17	0.5	1.2			28.6
C-18	20	0.7, 1.2	1.7, 2.9			45.0
C-19	10	Minute, Limited to One Brushpile				1.1
Total	593					

Table 4 (continued)

Rabbit Number	Number of Observations	Size of DCPR Before Home Range Change		Size of DCPR After Home Range Change (If Any)		Percentage of Total Home Range Covered By DCPR
		Hectares	Acres	Hectares	Acres	
	R=4-59 $\bar{x}$=23.4	R=0.3-3.3 $\bar{x}$=1.6	R=0.6-8.0 $\bar{x}$=2.1	R=0.5-1.7 $\bar{x}$=0.8	R=0.9-4.0 $\bar{x}$=2.3	R=1.1-96.4 $\bar{x}$=38.7

[a]DCPR = Diurnal cover preference range.

[b]Number of observations after rabbit moved to a new home range.

[c]Percentage of home range covered by DCPR after rabbit moved to a new home range.

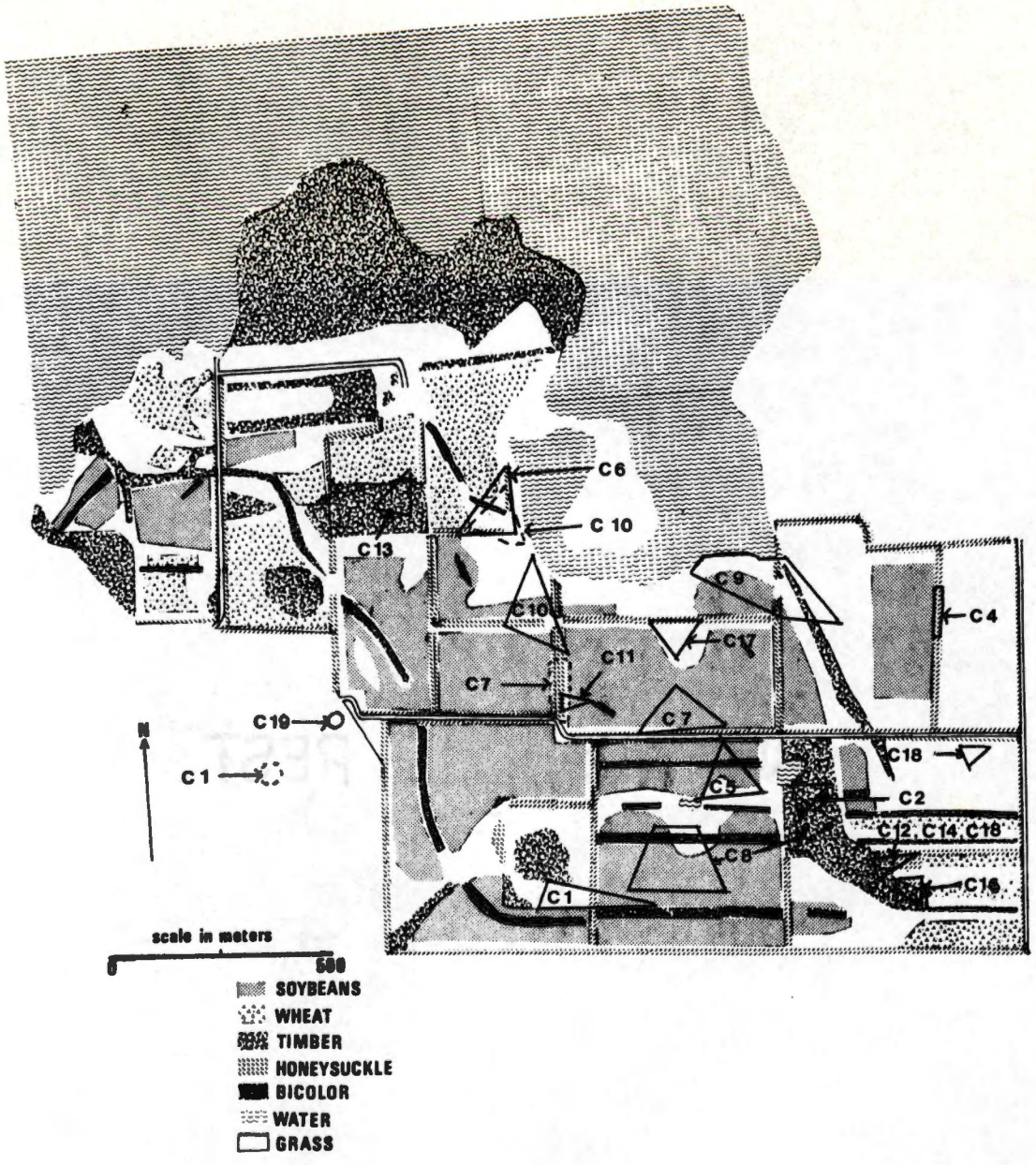


Figure 9. Diurnal cover preference ranges (DCPR) for 17 radio-collared cottontails before home range shift (solid line) and after home range shift (broken line) on the Percy Priest Wildlife Management Area, Rutherford County, Tennessee.

rabbits ranged from virtually impenetrable brushpiles (C-1 after home range change, and C-19) to tall, unmowed grass and soybeans before harvest (C-1 before home range change; C-5, C-7 and C-8 before home range change; C-9, C-11, and portions of the DCPR for C-6, C-17 and C-18) (Figure 9). The remaining six telemetered cottontails preferred dense honeysuckle. The portions of the DCPR for C-6, C-17 and C-18 that were not located in grassy areas were also located in dense honeysuckle. One rabbit, C-18, preferred two different areas that were separated by wheat fields and bicolor strips (Figure 9). Of the 16 DCPR utilized during the hunting season by cottontails, two (13 percent) were located in impenetrable cover (brushpiles); seven rabbits (29 percent) had their DCPR located in dense honeysuckle; four rabbits (25 percent) had their DCPR in grassy areas; and three rabbits (19 percent) had their DCPR which included areas of honeysuckle and areas of grass.

Sizes of DCPR varied and comprised varying percentages of the total home range of the rabbit covering between 1.1 percent and 96.4 percent (mean = 38.7 percent) of the home range (Table 4, page 44). Rabbits occupying home ranges in which cover remained fairly uniform throughout (e.g., C-1, C-8, and C-9) had their DCPR

that covered a larger percentage of the home range (60 percent or more) than did rabbits occupying home ranges where there were two or more different types of cover (e.g., honeysuckle and grass). The significance of the size and percentage of home range covered by a DCPR with relation to rabbit susceptibility to hunting is unknown.

Except for radio-collared rabbits that changed or altered their home ranges, no rabbit was observed to change its DCPR during the course of the study, indicating that cottontails are as reluctant to alter their DCPR as they are to change home ranges. In fact, it appeared that the destruction of DCPR cover was the stimulus which precipitated change in home range since destruction of cover used by a given rabbit less than 60 percent of the time had no effect on either DCPR or home range (p. 33). It is at this point that DCPR becomes important to the hunter. Some agricultural practices or other occurrences (flooding) cause the DCPR of rabbits to become unsuitable for continued use; consequently, rabbits relocate. Relatively small areas, which retain suitable cover, are likely spots for the relocation of DCPR. Thus, daytime concentrations of rabbits are formed which may develop into hunting "hot spots," and areas in which crops were harvested become more sparsely populated, resulting in lower hunter success.



Concentrations of Rabbits

Three apparently dense concentrations of cottontails were located during the study. Only one of these concentrations (5.8 ha or 14 a) was located on the study area (Figure 2, page 7, WL1). This woodlot was observed to contain seven rabbits ear-tagged in fields 1, 2, and 6 as well as six collared rabbits previously mentioned (Figure 9, page 46). One rabbit captured in field 3 (Rabbit 3) prior to soybean harvest was also flushed during a simulated hunt in WL1. No ear-tagging was undertaken in field 7 (adjacent to WL1); thus information on rabbits using portions of this field is lacking. However, two rabbits ear-tagged in field 6 were also subsequently observed in the southwestern "triangle" (that area between the fencerow bordering fields 6 and 7 and the wet area shown in Figure 3, page 9) of field 7 and in WL1. Some rabbits in WL1 are believed to have come from the harvested soybean fields outside the eastern border of the study area. A total of 18 rabbits were flushed in six simulated hunts from this woodlot.

A second concentration of rabbits (4.2 ha or 10 a) was observed south of WL1 and adjacent to the southeastern border of the study area (not shown on map

of study area). The habitat of this area consisted of old fields, interspersed with honeysuckle, blackberries, rock piles and a small woodlot with honeysuckle understory. This concentration was surrounded on three sides by soybean fields of various sizes and on one side (the south side) by suburban housing. One rabbit ear-tagged in the southeastern quarter of field 2, and six rabbits ear-tagged in the portion of field 1 between the water (winter level, Figure 3, page 9) and the southern border of the study area were subsequently observed in this concentration. A total of six rabbits were flushed in one simulated hunt from this concentration.

The third concentration was located outside the western border of the study area (not shown on map of study area) adjacent to field 3. Cover in the 4.2 ha (10 a) area consisted primarily of a series of brushpiles, created by a bulldozing operation, undergrown with some honeysuckle, surrounded by grass, and, in some cases, small areas of open woodland. Collared rabbits C-1 and C-19 were located in this concentration. In addition to the two radio-collared rabbits, two ear-tagged rabbits were flushed by beagles (along with four unmarked rabbits) on March 7, 1975, from a brushpile occupied by C-19 within the area of concentration. One of these ear-tagged

rabbits (No. 2) was captured a total of three times along the northern border of field 3 prior to the harvest of soybeans. Observers were unable to determine the ear-tag combination on the second rabbit and consequently the original capture site of this rabbit remains unknown.

Two apparently sparser concentrations of rabbits were also located. One of these was located in field 7 and extended a short distance outside the north boundary of the study area (encompassing approximately 4.2 ha or 10 a). The rabbits in this area were located in the northern portion of a strip of thick honeysuckle and blackberries that runs the length of field 7, in the fencerow along the northern boundary, and in patches of honeysuckle and grass outside the study area. One collared rabbit (C-4) was captured in field 1 and was subsequently found to prefer the area of concentration in field 7. A total of four rabbits were flushed from this concentration during one hunt (February 15, 1975).

The factor thought to be most responsible for fewer numbers of rabbits in field 7 is the fact that there were fewer soybean fields to be harvested in the immediate vicinity of the concentration, and those that were harvested were much smaller than those surrounding or adjacent to the other concentrations. Thus, fewer rabbits were forced to relocate.

The other concentration was located in the grassy area of field 8. Two ear-tagged rabbits captured in field 6 were observed in this area and one collared rabbit (C-9) also utilized the area. Except for nearby fencerows, the area in field 8 was almost devoid of patches of honeysuckle and blackberries. Rabbits found in previously mentioned concentrations showed a decided preference for thick cover of poor penetrability (Table 5). The fact that cover in field 8 was predominantly grass, a cover type having excellent penetrability, is thought to be a major factor for fewer rabbits than other concentrations since the potential of predation in these areas is almost certainly greater than for areas of poor cover penetrability. Observations of activities of rabbits during simulated hunts indicate that cottontails prefer areas of dense, tangled cover through which they are able to move in a variety of directions without becoming visible, or areas where they may be visible for only short periods as they move across small openings in the cover plot. (See section entitled Hunts, Cover Types, and Flushing Tendencies, page 55.) Some collared rabbits in WL1 moved ahead of observers without noise or visual contact, and rabbit C-19 moved through its brushpile not only on

Table 5. Cover penetrability type preferences for radio-collared cottontails for the months November through February on the Percy Priest Wildlife Management Area, 1974-1975.

Month	Cover Penetrability Type	Number of Rabbit Observations	Percent of Total Observations	
November	Excellent	86	57.75	- 81.88
	Fair to Good	45	28.13	
	Poor to Very Poor	29	18.13	
		160		
December	Excellent	24	19.67	- 27.87
	Fair to Good	10	8.20	
	Poor to Very Poor	88	72.13	
		122		
January	Excellent	22	18.97	- 27.59
	Fair to Good	10	8.62	
	Poor to Very Poor	84	72.41	
		116		
February	Excellent	29	17.58	- 25.46
	Fair to Good	13	7.88	
	Poor to Very Poor	123	74.55	
		165		

the ground but also by climbing fallen brush without becoming visible to observers. The above preference is an obvious deterrent to predation (and hunting) since it not only hinders detection by predators, but also slows most pursuers so that the rabbit has a better chance of escape.

No other concentrations of rabbits were found despite the fact that areas such as WL2, WL3, WL4, and WL5 (Figure 2, page 7) offered cover similar to that in which rabbit concentrations were located. However, these woodlots (WL2, WL3, WL4, and WL5) are located in the northwestern portion of the study area where, as previously discussed, the rabbit population was much lower than in the south and southeastern portion of the area. The location of concentrations of cottontails in winter by hunters should greatly increase hunter success in view of the fact that 46 of 61 (75.4 percent) rabbits flushed during simulated hunts were flushed from areas of cottontail concentrations.

Acreages of rabbit concentrations covered only approximately 21 percent of the acreage covered by the soybean fields from which rabbits were apparently drawn. Also these areas of concentration were located in blocks (e.g., WL1, 5.8 ha or 14 a) rather than in strips of cover (e.g., fencerows 1.0 to 10.0 m wide).

Knowledge that portions of a rabbit population will

concentrate in the areas adjacent to where soybeans are combined leads to management implications. In areas extensively cultivated for soybeans (and perhaps other row crops) where fall harvest of crops causes severe cover degeneration, the provision or maintenance of nearby areas which afford thick, dense cover of relatively poor penetrability should create cottontail concentrations. It appears that cover plots of relatively poor penetrability maintained in blocks rather than strips, 8.3 ha (20 a) of cover for every 41.7 ha (100 a) of cropland appears sufficient to hold large numbers of rabbits. Trippensee (1948: 27) indicated that cottontails do well on ". . . agricultural lands where cropland, grassland, woodland, and . . . brushland . . . are about equally represented and well distributed." Thus the plots should be located in areas where good natural cover is otherwise lacking and be as evenly distributed as possible in order to draw rabbits from as many areas of cropland as possible.

Hunts, Cover Types, and Flushing Tendencies

Data concerning the flushing tendencies of cottontails were gathered during simulated hunts (one actual hunt was also included).

An alteration in the cover penetrability type utilized by the sample of radio-collared rabbits was observed between the months November and December (Table 5, page 53). All four of the cottontails which changed home range due to dramatic cover degeneration established a new DCPR in cover of poor to very poor penetrability; other rabbits did not change their cover preferences. Thus the change was brought about by the change in cover penetrability type utilized by the cottontails which were forced to change home ranges.

In 19 out of 23 observations of radio-collared rabbits during simulated hunts, the rabbits were found to be in cover of poor to very poor penetrability (Table 6, also see Appendix D). This number constituted 82.6 percent of the observations of radio-collared rabbits and illustrated, as previously mentioned, a decided preference by wintering cottontails for dense, tangled cover that is difficult for hunters and dogs to penetrate. Of the 19 observations of rabbits where rabbits were located in cover of poor to very poor penetrability, only three (15.8 percent) resulted in flushes. In the remaining four observations, all were found to be in cover of excellent penetrability. These four observations constitute only 17.4 percent of the total number of observations; however, three of the four

Table 6. Numbers of radio-tagged cottontails flushed and not flushed from three cover penetrability types when approached to distances of 10 meters or less in eight simulated hunts on the Percy Priest Wildlife Management Area.

Cover Penetrability Type	Number of Rabbits		Distance of Rabbits from Observers			
			Meters		Feet	
	Flushed	Not Flushed	Range	Mean	Range	Mean
Poor to Very Poor	3	16	0.3-9.2	2.8	1-30	8.5
Fair to Good	0	0	-	-	-	-
Excellent	3	1	0.3-1.8	1.3	1-6	3.8
Totals	6	17				

rabbits found in cover of excellent penetrability (75 percent) were flushed. Thus, whereas more rabbits were located in cover of poor to very poor penetrability, the rabbits found in cover of excellent penetrability were more easily flushed. The fact that rabbits forced to relocate showed a marked preference for cover of poor to very poor penetrability (Table 5, page 53) has a definite bearing on the susceptibility of the cottontail to hunting since the tendency of rabbits to flush from this cover type is low.

Average distance of rabbits from observers at the time the rabbit was flushed (mean flushing distances) did not vary greatly with changes in cover penetrability. Flushing distances varied from 0.3 m (1 ft) to 13.2 m (45 ft) and averaged 2.3 m (7.6 ft) (Table 7). A total of 61 rabbits including radio-tagged, ear-tagged, and unmarked individuals, were flushed during the simulated hunts (Table 7, also see Appendix D). Of these, 30 (49.2 percent) were flushed from cover having poor to very poor penetrability, eight (13.1 percent) were flushed from cover of fair to good penetrability, and 23 (32.8 percent) were flushed from cover of excellent penetrability. Rabbits are more easily flushed (on a percentage basis) from areas of excellent cover penetrability;

Table 7. Numbers of ear-tagged and unmarked cottontails flushed during eight simulated hunts on the Percy Priest Wildlife Management Area.

Cover Penetrability Type	Number of Rabbits Flushed	Distance of Rabbits from Observers			
		Meters		Feet	
		Range	Mean	Range	Mean
Poor to Very Poor	30	0.3-13.7	2.6	1-45	8.6
Fair to Good	8	0.6- 3.1	1.3	2-10	4.1
Excellent	23	0.3- 6.1	2.5	1-20	8.1
Total	61				

however, the greater number of rabbits residing in areas of poor to very poor cover penetrability resulted in a greater number of flushes.

Telemetered cottontails showed a preference for the very dense cover type (Table 8). This preference became much more pronounced between November and December, due to the relocation of rabbits previously discussed. The percentage of observations where rabbits were found in very dense cover became slightly higher as winter progressed, presumably due to the further degeneration of existing cover which left less dense cover types sparser than before. Once rabbits had shifted home ranges and re-established DCPR, cover preference remained the same for the remainder of the study.

While cover of poor to very poor penetrability was always ranked as very dense, the same density designation could also be applied to cover of greater penetrability; i.e., cottontails found in grassy areas of excellent penetrability tended to prefer forms located under wind-blown grass, grassy clones, piles of soybean chaf, and other places where, photometrically, the cover density was high. However, as previously discussed, the tendency of rabbits to flush is greater on a percentage basis for rabbits located in areas of excellent cover penetrability,

Table 8. Cover density preferences for radio-collared cottontails for the months November through February on the Percy Priest Wildlife Management Area, 1974-1975.

Month	Cover Density Type	Number of Observations	Percent of Total
November	Very Dense	81	52.60
	Dense	34	22.08
	Moderate	29	18.83
	Sparse	10	6.49
		154	
December	Very Dense	95	75.40
	Dense	25	19.84
	Moderate	4	3.17
	Sparse	2	1.59
		126	
January	Very Dense	94	81.74
	Dense	14	12.17
	Moderate	5	4.35
	Sparse	2	1.74
		115	
February	Very Dense	135	81.33
	Dense	17	10.24
	Moderate	9	5.42
	Sparse	5	3.01
		166	

resulting in the fact that the observations of rabbits where cover density was determined photometrically showed little relationship with cottontail flushes. It is concluded from the above that cover density determinations used in studies to test cottontail susceptibility to hunting should not be based on photometric differences but rather on differences in penetrability (including factors such as the entangling potential of the cover, e.g., honeysuckle compared to grass, the amount of physical damage that the plant species may inflict on the hunter, e.g., blackberries compared to grass, etc.).

Hunting Technique and Flushing Success

The speed and thoroughness with which hunters moved through areas of rabbit cover also influenced the number of rabbit flushes. Hunts in which hunters travelled at a relatively slow but steady pace, 4.8-8.3 ha/hr (10-20 a/hr), and in which dogs and hunters were able to examine the existing cover thoroughly, yielded much higher numbers of rabbit flushes (58 rabbits in six hunts or 9.7 rabbits per hunt) than did hunts in which the pace was quicker and the examination of the cover more superficial (three rabbits in two hunts or 1.5 rabbits per hunt).

The two fast-paced hunts (12.5-25.0 ha/hr, or

30-60 a/hr) were of shorter duration than the slower-paced hunts since walking for long periods with only a few rabbit flushes tended to discourage hunters. Slow-paced hunts and thorough examination of cover by hunters will yield greater hunter success than fast-paced hunts with cursory examination of cover.

Dogs were used to aid hunters in locating rabbits in seven of the eight simulated hunts and were credited with locating 28 of the 52 rabbits flushed (53.9 percent) in hunts in which dogs participated. However, there appeared to be a difference in the hunting abilities of different dogs. Two bird dogs were used to locate rabbits in four of the seven hunts including dogs, and beagles were used in three. Bird dogs located 13 rabbits and beagles 15. The bird dogs moved through the cover more rapidly than beagles; the bird dogs avoided the very dense areas of cover and moved along small trails and openings running through the woodlots and other areas of thick cover. Nevertheless, the bird dogs were able to locate approximately the same number of rabbits as the beagles by virtue of the fact that they were apparently able to detect rabbits by odor and sight at greater distances than were beagles. Beagles were forced to enter thick cover to locate rabbits, but bird dogs were able to smell and see rabbits without actually

entering the cover, and pointed the rabbit, allowing the hunters to approach and flush the rabbit. The disadvantages of using bird dogs to hunt rabbits are that bird dogs will not hunt well in areas where there are no trails or other relatively open spaces running through blocks of thick cover, and that they will not track rabbits, resulting in the fact that, if the hunter is unable to shoot the rabbit when flushed, he probably will not get a second chance (bird dogs used in this study would pursue rabbits by maintaining visual contact, and, on occasion, a flushed rabbit was returned by the dogs to the hunters). An advantage of using bird dogs to locate rabbits is that hunters are likely to find more rabbits than if the dogs were not used. It should be noted at this point that bird dogs are not customarily used as rabbit dogs; however, the observations described above indicate that they may be used in the location of rabbits to the hunter's advantage.

The utility of beagles to the hunter was found to vary with the individual dog. Some beagles were observed to readily enter thick cover in an effort to locate rabbits, whereas other beagles did not. Beagles hunting through thick cover accounted for 100 percent (15) of the rabbits located by beagles; beagles which

normally did not hunt through thick cover would join in the chase after the rabbit was flushed, but were of no value in locating rabbits. Consequently, beagles which will hunt through heavy cover are of more value to the hunter than those which only chase a rabbit after it has been flushed. The advantages of using beagles to hunt rabbits are as follows: beagles entering heavy cover to locate rabbits will provide more rabbits for the hunter than would be encountered if the dogs were not used, and beagles will pursue cottontails, often running them into relatively open areas where a clear shot is afforded. Also, if the hunter misses a shot at the rabbit, it may be returned again by the beagles so the hunter may shoot again.

The flushing of rabbits into open areas appears to enhance harvesting success. Twelve rabbits were flushed in the actual hunt (February 15, 1975), and four of these were harvested. All of the harvested rabbits were taken in open areas.

Harvesting success may possibly be improved in blocks of heavy cover, without seriously increasing predation, by constructing paths at wide intervals within the blocks. Hunters should be better able to intercept rabbits as they run across these paths than are other predators.

Sex Ratios and Susceptibility to Trapping during Estrous

Sex ratios during the first trapping session were 50:50 when rabbits under 908 g are included (Table 9) and also in the third session after rabbits captured during a six-day period corresponding to the onset of estrous in the females were excluded (the amount of data collected in session two is considered to be too small for accurate assessment). During the onset of breeding (January 31, 1975 to February 5, 1975) which appeared to be synchronized in the females and correlated to a sudden increase in late winter temperatures as described by Pelton and Provost (1972), females were captured in an abnormally high ratio relative to males (12:5). The first female cottontail found to be in estrous was captured on January 31, three days after a 10° C (19° F) increase in the mean daily temperature between the dates of January 27 (mean temperature, 10° C, 49° F) and January 28 (mean temperature, 20° C, 68° F). The mean daily temperature for the month of January, prior to January 28 was 4.5° C (40° F). The last rabbit found to be in estrous was captured on February 5, six days later. Altogether, four rabbits known to be in estrous were captured during this six-day period, six were found not to be in estrous, and two were questionable.

Table 9. Sex ratios, mean weights of rabbits over 908 g, mean weights of rabbits weighing less than 908 g, and total number of cottontails captured in three trapping sessions on the Percy Priest Wildlife Management Area, 1974-1975.

Session	Sex Ratio		Average Weights (g) Adults (Greater Than 908 g)			Average Weights (g) Juveniles (Less Than 908 g)			Total Captures
	Adult M:F	Juvenile (Less Than 908 g) M:F	M	F	Combined	M	F	Combined	
1	20:15	7:9	1115	1209	1162	665.6	574	619.8	51
2	2:1	0:0	1022	1022	1022	0	0	0	3
3	23:30	0:4	1181	1273	1227	0	872.5	872.5	57
3[a]	18:18	0:4	1157	1274	1216	0	872.5	872.5	40

[a]Excluding individuals captured during onset of breeding (January 31 - February 5).

Chi-square test for independence resulted in non-significance at the 0.1 level. Thus the abnormally high rate of capture for female cottontails during the onset of breeding (or estrous) is assumed to be related to the onset of breeding. Consequently, data collected during the onset of breeding is thought to have biased the sex ratio value and can be justifiably eliminated when determining sex ratio. The researcher concluded that the sex ratio was approximately equal in the study population.

Parasites and Diseases

While parasites and diseases were given only cursory attention, some interesting phenomena and relationships were observed. The only disease which appeared to be prevalent in the rabbit population was fibromatosis. Davis et al. (1970) stated that although the exact method of transmission is unknown, the seasonal incidence of the disease (usually greatest in early fall) and laboratory tests suggest that one or more arthropod vectors are involved. Of 51 rabbits captured between October 1, 1974 and November 9, 1974, eight were found to have one or more fibromatosis lesions. These eight represent 16 percent of the total number of rabbits trapped.

During the January-February trapping session, only five of 57 rabbits captured showed fibromatosis lesions,

and all lesions were regressing. The January-February incidence of the disease included only 9 percent of the total rabbits trapped, reducing the incidence of infected individuals by 7 percent and indicating a 44 percent decline in fibromas between November and late winter.

Parasites encountered included two species of tick, one species of flea, bot warbles (Cuterebra sp.), and in one rabbit (C-12) liver damage was attributed to an unidentified species of liver fluke (flukes could not be obtained for identification).

Nymphs of the "rabbit tick" (Haemaphysalis leporispalustris) were observed primarily on rabbits captured in the fall. No adults of this species were observed on fall-trapped animals, but heavy infestations (approximately 50 ticks or more) of adult ticks were observed on cottontails in March 1975. While adult H. leporispalustris are almost entirely limited to rabbits as a host species, immature stages commonly infest a number of hosts (Lancaster, 1973). In addition to the nymphal infestations on cottontails found in this study, Bishopp and Trembley (1945) reported heavy infestations of immature H. leporispalustris on bobwhite quail and meadowlarks (Sturnella magna).

The second commonly observed species of tick was identified as Ixodes dentatus. The Ixodes species was

found only during late February and early March, and heavy infestations were observed on some individuals. Both species were found to inhabit a given individual at the same time, and both appeared to prefer the region of the head and neck. Cooney and Hays (1972), in a study conducted in Alabama, reported that these species were found on 79 percent of the cottontails collected for observation. Both species are vectors of tularemia.

The common rabbit flea (Cediopsylla simplex) was also obtained from several trapped rabbits and was common in every season. Flea infestations did not appear to be excessive on most cottontails, although six individuals had what appeared to be very heavy infestations.

Bot fly larvae were observed in two rabbits (Nos. 10 and 12) captured October 25 and October 26, respectively. Rabbit 10 had one bot warble in the genital area; rabbit 12 had an exit hole in the genital area left by a warble that had exited prior to the capture of the rabbit, and one warble still imbedded in the right side.

Jacobson and Kirkpatric (1974) analyzed the effects of a variety of parasite infections on penned cottontails, including one species of bot larvae (Cuterebra buccata) and both tick species mentioned above.

The results of these experiments indicate that the parasite infestations did not adversely affect the cottontails. However, these cottontails were well fed and not subjected to the rigors of the natural world, thus the combined effects of parasitism and stress were not ascertained. Geis (1957) reported that death observed in two cottontails was attributed to heavy bot infestations and that weights of juvenile rabbits infested with bots averaged less than juveniles which had no bot infestations.

The effects of parasites on cottontails observed in the present study was not ascertained; however, no rabbits infested with parasites showed external indications of infection, and none appeared in poor condition.

Summary

A total of 117 cottontail rabbits were captured in live traps during the study (October, 1974 to March, 1975). Sex ratios based on trapping data were approximately 50:50. Mean weights of female cottontails were 92-94 g (0.2 lb) heavier than mean weights for males; the females averaged 1209 g (2.7 lbs) during the first trapping period and 1274 g (2.8 lbs) in the third, and males averaged 1115 g (2.5 lbs) during the first session and 1157 g (2.6 lbs) in the third.

Population density on the southeastern portion of the study area was determined to be 5.67 rabbits per ha (2.15 rabbits/a) and was thought to be much less dense in the northwestern portion of the study area. No cottontail flushes were observed in the northwestern portion of the study area during simulated hunts and the poor success was attributed to lower population density.

Sizes of cottontail home ranges varied with sex, individual, and method of home range determination. Average home range sizes determined telemetrically were 2.8 ha (6.9 a) for males and 2.2 ha (5.8 a) for females. Average home range sizes determined by recapture and reobservation of ear-tagged rabbits were 5.6 ha (14.6 a) for males and 1.2 ha (3.2 a) for females. Telemetric determination of home range is considered more accurate than determination by reobservation.

Six cottontails were observed outside their home range boundaries during the study. Two of these departures were attributed to the location of breeding females by male cottontails. Reasons for the remaining four home range departures are unknown.

Cottontails were found to begin evening crepuscular activities after sunset (December through February) regardless of day length. A review of the

literature revealed that rabbits were observed in other studies to begin crepuscular activities before sunset in summer and after sunset in winter. Reduction in rabbit sightings by members of the public between summer and winter was attributed to the fact that rabbits began activities in summer prior to sunset, and in winter, subsequent to sunset.

Relocation of home ranges was observed in four radio-tagged rabbits after the destruction of cover in which the rabbits were found diurnally 60 percent of the time or more. Destruction of diurnal cover is believed to be at least one major factor causing relocation of cottontail home ranges and the consequent formation of rabbit concentrations. Departures and relocations of cottontails from their normal home ranges are discussed in light of the susceptibility of the species to hunting. Cottontails were found to prefer smaller areas within their existing home ranges for diurnal cover. The area within each rabbit's home range in which the rabbit was found in 80 percent or more of the diurnal readings taken was designated as the diurnal cover preference range (DCPR) of the rabbit. Destruction of DCPR cover appears to stimulate the relocation of home range.

Five cottontail concentrations were observed

during the study. Wintering cottontails appeared to prefer continuous stands of thick cover, since the larger winter concentrations were located in areas of this type. Three radio-collared cottontails which relocated their home ranges were found to relocate in areas of cottontail concentrations. Location of concentrations should greatly increase hunter success since 46 of the 61 (75.4 percent) rabbits flushed in simulated hunts were flushed in areas of cottontail concentration.

The tendency of cottontails to flush was related, in addition to population density, to cover penetrability. Cottontails were observed to be more easily flushed from areas of excellent cover penetrability than from areas of poor cover penetrability; however, because of the higher rabbit density in the areas of poor cover penetrability, hunting in these areas resulted in a greater number of rabbits flushed. No relationship was found between photometrically-determined cover density and rabbit flushes.

The speed with which hunters move through and examine cover was negatively related to flushing success. Slow-paced hunts in which hunters covered 4.1 to 8.3 ha/hr (10-20 a/hr) yielded an average of 9.7 rabbits per hunt, whereas fast-paced hunts in which hunters covered

12.5 to 25.0 ha/hr (30-60 a/hr) yielded an average of only 1.5 rabbits per hunt.

The use of trained hunting dogs also greatly increased flushing success. Dogs were credited with locating 28 of the 52 (53.9 percent) rabbits flushed in the hunts in which dogs participated.

Female cottontails appeared to exhibit breeding synchrony in late winter. Chi-square 2x2 test for independence indicated that females were more easily captured than males during the apparent period of estrous.

Parasites observed on cottontails included two species of tick (Haemaphysalis leporispalustris and Ixodes dentatus), one species of flea (Cediopsylla simplex), bot warbles (Cuterebra sp.), and an unidentified species of liver fluke. Fibromatosis was observed on 16 percent of rabbits captured October 1, 1974 to November 9, 1974 and on 9 percent of the rabbits captured January 23, 1975 to February 28, 1975, indicating a 44 percent reduction in lesions.

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APPENDIXES

APPENDIX A

Table 10. Radio frequencies, tagging dates, sex, weight and breeding status on date captured for radio-collared rabbits on the Percy Priest Wildlife Management Area, 1974-1975.

Rabbit Number	Radio Frequency (Mhz)	Tagging Date	Sex	Weight (g)	Breeding Status
C-1	150.871	10/27/74	M	1044	Not Breeding
C-2	150.880	11/ 6/74	M	1090	Not Breeding
C-3	150.931	11/ 9/74	F	1362	Not Breeding
C-4[a]	150.945	2/20/75	M	1375	Breeding
C-5	150.963	10/28/74	M	1158	Not Breeding
C-6	150.997	11/ 6/74	M	1135	Not Breeding
C-7	151.008	11/ 6/74	M	1022	Not Breeding
C-8	151.028	11/ 4/74	F	999	Not Breeding
C-9	151.063	11/ 5/74	F	1498	Recently Lactating
C-10	151.071	10/30/74	M	1226	Not Breeding
C-11	151.099	11/ 6/74	M	953	Not Breeding
C-12	151.118	11/ 6/74	F	1657	Not Breeding
C-13	151.133	11/ 4/74	F	1135	Not Breeding
C-14	150.880	2/ 1/75	M	1330	Testicles Descended
C-15	150.931	1/31/75	F	1450	In Heat
C-16	151.028	1/30/75	F	1390	Not Breeding
C-17	151.099	1/23/75	F	1000	Not Breeding
C-18	150.963	1/30/75	M	1320	Testicles Descended
C-19	150.931	2/17/75	F	1400	Unknown

[a]Activity collar.

APPENDIX B

Table 11. Rabbit number, capture dates, sex, weights, and breeding status on capture date, ear tag number, and color markings of rabbits captured on the Percy Priest Wildlife Management Area, 1974-1975.

Rabbit Number	Capture Date	Sex	Weight (g)	Breeding Status	Ear Tags		Tail Dye Color
					Left Color-No.	Right Color-No.	
1	10/10/74	F	568	Juvenile	Green-390	0	0
2	10/18/74	M	1135	Not Breeding	Orange-392	0	0
3	10/20/74	M	1181	Not Breeding	Red-399	0	0
4	10/20/74	M	1249	Not Breeding	Blue-382	0	0
5	10/22/74	F	1249	Not Breeding	Black-378	0	0
6	10/23/74	F	1476	Not Breeding	White-400	0	0
7	10/23/74	M	1271	Not Breeding	Green-395	Green-396	0
8	10/23/74	M	1022	Not Breeding	Green-388	Orange-389	0
9	10/25/74	F	1271	Not Breeding	Green-380	Red-381	0
10	10/25/74	F	1112	Not Breeding	Green-393	Blue-394	0
11	10/25/74	F	1180	Not Breeding	0	Green-376	0
12	10/26/74	M	1135	Not Breeding	0	Orange-386	0
13	10/26/74	M	800	Not Breeding	0	Red-385	0
14	10/26/74	M	1180	Not Breeding	0	Blue-377	0
15	10/26/74	F	953	Not Breeding	0	Blue-1	0
16	10/30/74	M	1000	Not Breeding	0	White-2	0
17	11/ 3/74	F	999	Not Breeding	Orange-3	Green-4	0
18	11/ 5/74	M	817	Not Breeding	Orange-5	Orange-6	0
19	11/ 7/74	M	1044	Not Breeding	Orange-7	Red-8	0
20	11/ 7/74	F	1226	Not Breeding	Orange-9	Blue-10	0
21	11/ 7/74	M	953	Not Breeding	Red-11	Green-12	0
22	11/ 8/74	F	1180	Not Breeding	Red-13	Orange-14	0
23	11/ 9/74	F	908	Not Breeding	Red-15	Red-16	0
24	11/ 9/74	M	1249	Not Breeding	Red-17	Blue-24	0
25	11/ 9/74	M	1135	Not Breeding	Red-22	Black-23	0
26	11/29/74	M	1022	Testicles Descended	Red-26	White-27	0
27	12/ 4/74	F	1022	Not Breeding	Blue-28	Green-29	0

TABLE 11 (continued)

Rabbit Number	Capture Date	Sex	Weight (g)	Breeding Status	Ear Tags Left Color-No.	Ear Tags Right Color-No.	Tail Dye Color
28	12/ 4/74	M	1022	Testicles Descended	Blue-30	Orange-32	0
29	1/23/75	F	1200	Not Breeding	Blue-51	Red-52	0
30	1/23/75	F	900	Not Breeding	Blue-53	Blue-54	Red
31	1/23/75	M	1250	Not Breeding	Blue-55	Black-56	0
32	1/23/75	F	1300	Not Breeding	Blue-57	White-58	0
33	1/23/75	F	850	Not Breeding	Black-59	Green-60	0
34	1/23/75	M	950	Not Breeding	Black-61	Orange-62	0
35	1/23/75	F	1210	Not Breeding	Black-63	Red-64	0
36	1/23/75	F	860	Not Breeding	Black-65	Blue-66	0
37	1/23/75	M	1250	Testicles Descended	Black-67	Black-68	Red
38	1/24/75	F	1010	Not Breeding	Black-69	White-70	0
39	1/24/75	M	1070	Not Breeding	White-71	Green-72	0
40	1/24/75	M	1080	Not Breeding	White-73	Orange-74	0
41	1/24/75	F	1100	Not Breeding	White-75	Red-76	0
42	1/24/75	F	1200	Not Breeding	White-77	Blue-78	0
43	1/24/75	F	1290	Undecided	White-79	Black-80	0
44	1/24/75	F	1010	Not Breeding	Green-81	Black-82	0
45	1/24/75	M	1110	Not Breeding	Green-83	White-84	0
46	1/24/75	F	1250	Not Breeding	Orange-85	Black-86	0
47	1/24/75	F	1300	Not Breeding	Orange-87	White-88	0
48	1/24/75	F	1260	Not Breeding	White-89	White-90	0
49	1/25/75	M	950	Not Breeding	Orange-91	Red-92	0
50	1/25/75	F	880	Not Breeding	Green-93	0	Yellow
51	1/25/75	F	1090	Not Breeding	Orange-94	0	Yellow
52	1/25/75	M	1360	Not Breeding	Red-95	0	Yellow
53	1/27/75	M	1430	Not Breeding	Blue-96	0	Yellow
54	1/27/75	M	1120	Not Breeding	Black-97	0	Yellow
55	1/30/75	M	980	Not Breeding	White-98	0	Yellow
56	1/30/75	F	1070	Not Breeding	0	Green-99	Yellow
57	1/31/75	F	1130	Not Breeding	0	Orange-100	Yellow
58	1/31/75	F	1100	Not Breeding	0	Red-101	Yellow
59	2/ 1/75	M	1100	Not Breeding	0	Blue-102	Yellow
60	2/ 2/75	F	1360	Not Breeding	0	Black-103	Yellow

TABLE 11 (continued)

Rabbit Number	Capture Date	Sex	Weight (g)	Breeding Status	Ear Tags Left Color-No.	Ear Tags Right Color-No.	Tail Dye Color
61	2/ 2/75	M	1100	Testicles Descending	0	White-104	Yellow
62	2/ 2/75	M	1350	Not Breeding	Green-105	Green-106	Yellow
63	2/ 2/75	F	1310	In Heat	Green-107	Orange-108	Yellow
64	2/ 3/75	F	1120	Undecided	Green-109	Red-110	Yellow
65	2/ 3/75	F	1300	Undecided	Green-111	Blue-112	Yellow
66	2/ 3/75	F	1140	Not Breeding	Green-113	Black-114	Yellow
67	2/ 3/75	F	1490	Not Breeding	Green-115	White-116	Yellow
68	2/ 4/75	F	1440	In Heat	Orange-117	Green-118	Yellow
69	2/ 4/75	M	1450	Testicles Descended	Orange-119	Orange-120	Yellow
70	2/ 5/75	F	1250	Not Breeding	Orange-121	Red-122	Yellow
71	2/ 5/75	F	1170	In Heat	Orange-123	Blue-124	Yellow
72	2/14/75	M	1140	Not Breeding	Orange-125	Black-126	Yellow
73	2/14/75	M	1150	Not Breeding	Orange-127	White-128	Yellow
74	2/14/75	M	1140	Testicles Descended	Blue-129	Green-130	Yellow
75	2/15/75	F	1200	Not Breeding	Blue-131	Orange-132	Yellow
76	2/15/75	M	1220	Testicles Descended	Blue-133	Red-134	Yellow
77	2/15/75	M	1180	Testicles Descended	Blue-135	Blue-136	Yellow
78	2/16/75	F	1240	Not Breeding	Blue-137	Black-138	Yellow
79	2/18/75	M	1050	Testicles Descended	Blue-139	White-140	Yellow

APPENDIX C

Table 12. Trapping data January 23, 1975 to February 26, 1975 for 57 hectares of the Percy Priest Wildlife Management Area.

Date	Rabbit Number	Captures[a]	
		First	Recapture
1/23/75	29	*	
1/23/75	30	*	
1/23/75	31	*	
1/23/75	32	*	
1/23/75	33	*	
1/23/75	34	*	
1/23/75	35	*	
1/23/75	36	*	
1/23/75	37	*	
1/23/75	C-17	*	
1/24/75	38	*	
1/24/75	39	*	
1/24/75	40	*	
1/24/75	41	*	
1/24/75	42	*	
1/24/75	43	*	
1/24/75	44	*	
1/24/75	45	*	
1/24/75	46	*	
1/24/75	47	*	
1/24/75	48	*	
1/25/75	C-12	*	
1/25/75	49	*	
1/25/75	50	*	
1/25/75	51	*	
1/25/75	52	*	
1/27/75	24	*	
1/27/75	53	*	
1/27/75	54	*	
1/30/75	C-8	*	

TABLE 12 (continued)

Date	Rabbit Number	Captures[a]	
		First	Recapture
1/30/75	C-18	*	
1/30/75	55	*	
1/30/75	56	*	
1/31/75	57	*	
1/31/75	58	*	
2/ 1/75	59	*	
2/ 1/75	C-14	*	
2/ 1/75	C-17		*
2/ 1/75	47		*
2/ 2/75	60	*	
2/ 2/75	61	*	
2/ 2/75	62	*	
2/ 2/75	63	*	
2/ 2/75	51		*
2/ 3/75	C-7	*	
2/ 3/75	7	*	
2/ 3/75	27	*	
2/ 3/75	64	*	
2/ 3/75	65	*	
2/ 3/75	66	*	
2/ 3/75	67	*	
2/ 4/75	68	*	
2/ 4/75	69	*	
2/ 5/75	70	*	
2/ 5/75	71	*	
2/ 5/75	51		*
2/14/75	72	*	
2/14/75	73	*	
2/14/75	74	*	
2/14/75	59		*
2/14/75	65		*
2/14/75	67		*
2/14/75	C-12		*
2/14/75	C-17		*
2/15/75	75	*	
2/15/75	76	*	

TABLE 12 (continued)

Date	Rabbit Number	Captures[a]	
		First	Recapture
2/15/75	77	*	
2/15/75	C-9	*	
2/16/75	78	*	
2/17/75	C-19		*
2/17/75	58		*
2/17/75	65		*
2/17/75	67		*
2/18/75	79	*	
2/20/75	C-4	*	
2/20/75	C-7		*
2/25/75	72		*
2/26/75	71		*

[a]First captures = 63; recaptures = 15; total captures = 78.

APPENDIX D

Table 13. Individual radio-tagged cottontails flushed and not flushed from three cover penetrability types when approached to distances of 10 meters or less in eight simulated hunts on the Percy Priest Wildlife Management Area.

Hunt Number	Observations of Individual Rabbits	Flushed or Not Flushed[a]	Penetrability Type[b]	Closest Distance of Hunter to Rabbit	
				Meters	Feet
1	C-5	F	3	0.3	1
	C-2	NF (M)	1	6.1	20
2	C-12	NF	1	0.9	3
	C-5	NF	3	1.5	5
	C-2	NF (M)	1	Unknown	Unknown
	C-8	NF (M)	1	Unknown	Unknown
3	C-12	F	1	0.6	2
4	C-7	NF (M)	1	0.6	2
5	C-12	NF	1	3.1	10
	C-10	NF	1	6.1	20
	C-17	NF	1	2.1	7
	C-9	F	3	1.5	5
	C-14	F	1	0.6	2
6	C-14	NF	1	1.5	5
	C-17	NF	1	2.1	7
	C-12	F	1	0.3	1
7	C-14	NF	1	1.5	5
	C-12	NF	1	6.1	20
	C-16	NF (M)	1	1.5	5
	C-9	F	3	1.8	6
	C-13	NF	1	9.2	30
8	C-12	NF	1	2.1	7
	C-14	NF	1	9.2	30

[a](M) indicates rabbit moved to avoid flushing.

[b]1 = Poor to Very Poor Penetrability, 2 = Fair to Good Penetrability, 3 = Excellent Penetrability.

Table 14. Cover penetrability and flushing distances for ear-tagged and unmarked cottontails flushed during eight simulated hunts on the Percy Priest Wildlife Management Area.

Hunt Number	Cover[a] Penetrability	Distance of Rabbit from Observer When Flushed	
		Meters	Feet
1	1	0.3	1
	1	3.1	10
	1	4.8	15
	2	1.5	5
	3	0.9	3
	3	0.3	1
	3	0.6	2
	3	0.9	3
2	3	3.1	10
	1	2.1	7
	1	0.3	1
	1	1.5	5
	1	1.5	5
	1	4.8	15
	3	1.5	5
	1	3.1	10
	3	6.1	20
	2	0.6	2
	1	13.7	45
	2	3.1	10
	2	0.6	2
	2	0.9	3
3	1	6.1	20
4	1	0.3	1
	3	4.8	15
	3	0.6	2
	3	Unknown	Unknown
	3	1.5	5
	2	0.6	2
5	3	3.1	10
	3	Unknown	Unknown
	2	1.5	5
	1	0.3	1
	1	Unknown	Unknown

TABLE 14 (continued)

Hunt Number	Cover[a] Penetrability	Distance of Rabbit from Observer When Flushed	
		Meters	Feet
	3	4.8	15
	2	1.2	4
	1	1.5	5
	3	0.3	1
6	1	6.1	20
	3	0.6	2
	1	3.1	10
	1	2.1	7
	1	0.3	1
	1	0.6	2
	1	0.3	1
	1	Unknown	Unknown
7	3	1.8	6
	3	Unknown	Unknown
8	1	6.1	20
	1	2.7	9
	1	0.6	2
	3	Unknown	Unknown
	1	0.6	2
	1	Unknown	Unknown
	3	3.7	12

[a]1 = Poor to Very Poor Penetrability, 2 = Fair to Good Penetrability, 3 = Excellent Penetrability. Total observations = 61. Number of rabbits flushed from each cover penetrability type: 1 = 30, 2 = 8, 3 = 23.

VITA

Bruce F. Anderson was born on July 9, 1951, in Jackson, Tennessee. He moved to Nashville, Tennessee, at the age of three and attended Hickman Elementary School and Donelson High School in that city. In September, 1969, he entered The University of Tennessee and received a Bachelor of Science degree in Animal Husbandry in June, 1973.

He entered The Graduate School at The University of Tennessee in September, 1973, and received the Master of Science degree with a major in Wildlife Management in December, 1975.

He is married to the former Merry Elizabeth Moore of Sevierville, Tennessee.