MOVEMENTS, HOME RANGE, AND COVER USE: FACTORS AFFECTING THE SUSCEPTIBILITY OF COTTONTAILS TO HUNTING

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ABSTRACT

Winter home ranges for 19 telemetered cottontails (Sylvilagus floridanus) *averaged 2.8 ha for males and 2.2 ha for females. Home ranges determined from retrap and reobservation data for ear-tagged rabbits averaged 5.6 ha for males and 1.2 ha for females.*

Cottontails preferred 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). Destruction of the DCPR cover appears to stimulate the relocation of home ranges and the concomitant formation of winter concentrations of cottontails, Three winter concentrations of cottontails were located and 75 percent of the rabbits flushed during this study were flushed from areas regarded as concentrations.

The tendency of cottontails to flush decreased as cover became harder for hunters and dogs to penetrate. Slower paced hunts with a thorough examination of cover yielded a greater number of rabbit flushes than faster paced hunts with superficial cover examination.

Surprisingly little data are presented in the literature which delineate specific cover use by the cottontail rabbit (Hanson et al. 1969 and Haugen 1943). Live trapping studies have revealed some information regarding movements and home range and general patterns of cover utilization (Chapman and Tretheway 1972a, Haugen 1942, and Heard 1964). However, such studies have required the tagging of large numbers of individuals (difficult to accomplish in areas of low population density) and yielded data only on a relatively small number of rabbits originally tagged. Also, the susceptibility to trapping varies with temperature, barometric pressure, and age class of the rabbits (Chapman and Tretheway 1972b). Traps and trap placement may also bias capture-recapture results. Thus, the accuracy of data and time between observations collected in trap-retrap studies in many instances depends on conditions which researchers are unable to control.

Only in the recent literature have reports of cottontail movements, home range, and cover use been based on telemetry data (Hanson et al. 1969, Holler and Marsden 1970, and Marsden and Conaway 1963). These studies revealed that large amounts of accurate data can be obtained from a high percentage of radio-tagged animals. Only Hanson et al. (1969) specifically examined movements and home range as related to cover use by the cottontail; results of that study were inconclusive in regard to preferred cover types. We are aware of no studies which attempted to relate cover, home range and movements to susceptibility of the cottontail to hunting.

Our objective was to delineate winter cover use of both conventionally tagged and radio-collared cottontails and to more clearly determine those factors affecting the species' susceptibility to hunting.

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MATERIALS AND METHODS

The study area consisted of 190 ha of the 532 ha Percy Priest Wildlife Management Area in Rutherford County, Tennessee. 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 for field trials, dog training, and for juvenile hunters. Except during scheduled dove (*Zenaidura macroura*) 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 study area consisted of four major habitat types: woodlots, grassy or weedy areas, fencerows, and agricultural areas (Fig. 1).

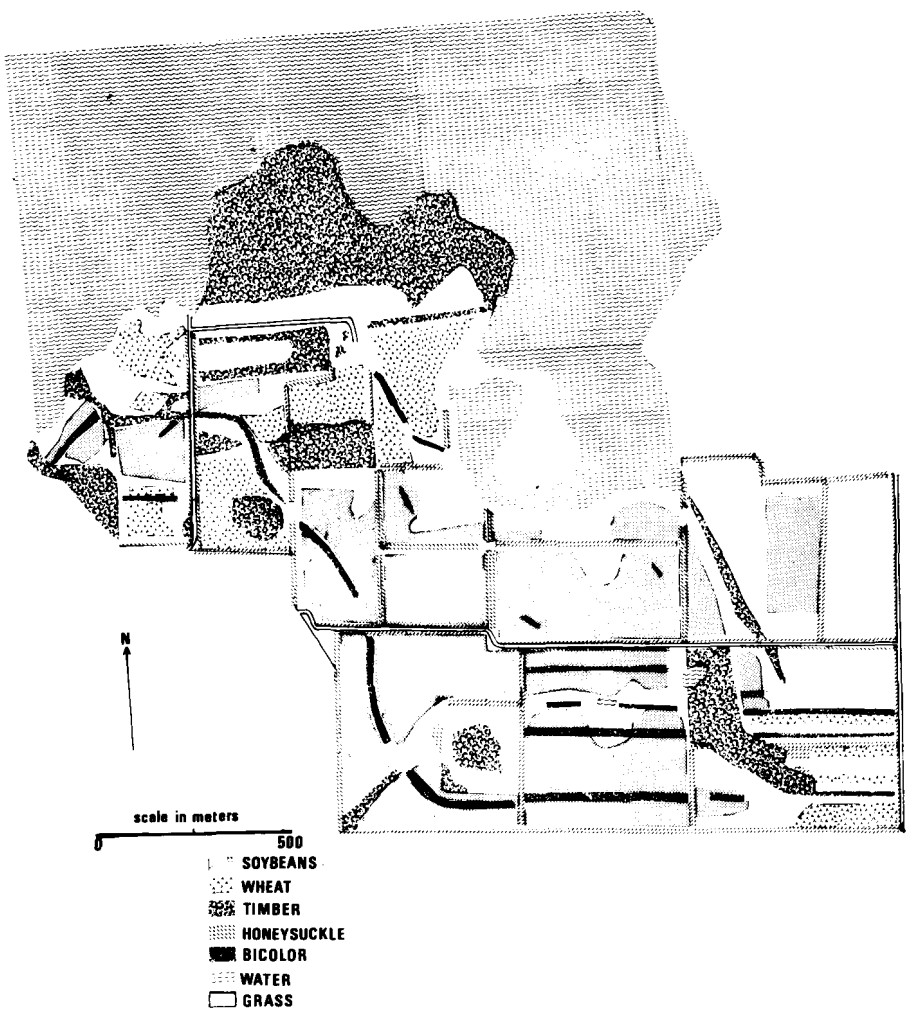

Figure 1. The 190 ha study area on the Percy Priest Wildlife Management Area, Rutherford County, Tennessee.

Five woodlots are found on the study area; four consisted of a predominantly deciduous hardwood overstory with a thick cover of Japanese honeysuckle (*Lonicera japonica*) at ground level (Fig. 1). The remaining woodlot 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 and provided a dense, brushy ground cover. Besides the brush afforded by growing trees, greenbriar (*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.

The grassy or weedy areas included fescue (*Festuca* sp.), Johnsongrass (*Sorghum halepense*), broomsedge (*Andropogon virginicus*), foxtail millet (*Setaria italica*), cocklebur (*Xanthium strumarium*), beggar lice (*Hackelia* sp.), and other assorted forbs. The areas varied from essentially pure stands of a single species (e.g., fescue pastures) to mixtures of several different species.

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 were planted in soybeans (60.2 ha) and wheat (18.6 ha) (Fig. 1). Soybeans were planted in June and July, 1974; strips of soybeans, composing one-fifth of the total soybean acreage, were left standing in the field as food for wildlife. The general planting period for wheat was late September and early October, 1974. By the time the first radio-collared rabbit was captured, tagged, and released on 27 October 1974, all the wheat was planted and small sprigs of wheat were standing in every field.

Cover changes during the study occurred as a result of both 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.

Trapping and Tagging

Trapping was conducted during three periods: 1 October to 9 November 1974, 24 November to 4 December 1974, and 23 January to 28 February 1975. Rabbits were captured using conventional wooden box traps baited with apples. Captured animals 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. It was hoped that the ear-tagged/tail-dyed rabbits would provide additional information concerning rabbit cover use, home ranges and movements.

The ear-tagging and tail-dying procedure was the same as that described by Brady and Pelton (1976). Various combinations of different colored ear tags and tail dyes were used to identify individual rabbits.

Telemetry and Monitoring

Telemetry equipment (Wildlife Materials Inc., Carbondale, Illinois) tuned for 150 Mhz was utilized. The volume (or gain) on the receiver was reduced as a radio-collared rabbit was approached; this technique was used to determine movement of an animal ahead of the observer when it could not be seen. The gain volume was lowered to a point that movements of the rabbit caused the signal to suddenly fade. If the rabbit remained stationary, the signal slowly faded as the observer moved past and away from the rabbit unless the volume was 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. Because of the above, the observer usually approached the rabbit to a distance of 200 to 300 m before a signal was located.

While triangulation has been the method used in many studies to locate telemetered animals, the method 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 such information.

Three cover penetrability types were designated: poor to very poor, fair to good, and excellent. Poor to very poor penetrability was characterized by brushpiles, woodchuck (*Marmota monax*) burrows and dense continuous stands of honeysuckle standing 0.6 m or higher, especially where blackberries also proliferate. Cover with fair to good penetrability was honeysuckle standing lower than 0.6 m. Cover with excellent penetrability included soybeans and grass.

Data for each radio-collared rabbit included location, the date 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 some other designation appropriately describing the movement. Also recorded were the time 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, and the type of cover used (species composition and penetrability). Locations of ear-tagged/tail-dyed rabbits were also noted when these individuals were trapped or flushed.

Simulated Hunts

Seven simulated hunts and one actual hunt were conducted on the study area during the hunting season. The first hunt was conducted on 8 December 1974 and the last on 28 February 1975. On each hunt except the first, dogs were used to aid in locating rabbits. Variations were noted in hunting procedures utilized by different hunters.

Analysis of Data

Two different methods for determining home range were compared in the present study. Telemetry, including diurnal and nocturnal observations, provided home range data for radio-collared rabbits, and trapping and flushing observations provided information on ear-tagged/tail-dyed 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 enclosed area designated as the home range of the rabbit (Harvey and Barbour 1965).

Home ranges for ear-tagged/tail-dyed rabbits were obtained by connecting mapped 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, and possibly a change in location of, home range by the rabbit (Harvey and Barbour 1965).

RESULTS AND DISCUSSION

Between 1 October 1974 and 28 February 1975, 117 cottontail rabbits were captured; 79 were ear-tagged and/or tail-dyed, 13 were released because they were judged too small (<800 g), and 6 escaped prior to tagging. Between 27 October 1975 and 9 November 1975, 12 cottontail rabbits were radio-collared during the study. As the rabbits died or lost their collars, the collars were recovered and placed on new rabbits. Nineteen individual cottontails were radio-collared during the study.

Home Ranges

The average size of winter home ranges for nine male and seven female radio-collared rabbits were found to be 2.8 ha and 2.2 ha, respectively (Table 1). Size of home ranges varied from 1.4 ha to 4.4 ha. The average home range size of males was comparable to the 2.8 ha for average home range size of male cottontails in spring reported from a telemetry study by Trent et al. (1974) in Wisconsin. The average home range for females was somewhat higher than the 1.7 ha described for females in spring by Trent et al. (1974), and

Table 1. Size of home range of radio-collared and ear-tagged cottontails from November 1974 to March 1975 and October 1974 to March 1975, respectively, on the Percy Priest Wildlife Management Area.

Rabbit no.	*Sex*	*No. of observations*	*Home range*	
			Hectares	*Acres*
		Radio-collared cottontails[b]		
C-1	M	11, 15	3.16, 3.16[a]	8.3, 8.3[a]
C-2	M	38	1.4	3.7
C-3	F	6	Insufficient data	
C-4	M	6	Insufficient data	
C-5	M	39	1.6	4.1
C-6	M	59	2.0	5.2
C-7	M	17, 46	3.1, 3.3[a]	8.0, 8.6[a]
C-8	F	9, 24	3.1, 2.2[a]	8.0, 5.7[a]
C-9	F	53	3.1	8.0
C-10	M	17, 40	2.2, 1.7	5.7, 4.6
C-11	M	12	3.1	8.0
C-12	F	54	2.7	8.0
C-13	F	59	2.0	5.2
C-14	M	18	2.9	7.6
C-15	F	4	Insufficient data	
C-16	F	19	2.9	7.5
C-17	F	17	1.5	4.0
C-18	M	20	4.4	11.5
C-19	F	10	3.3	8.6
		Ear-tagged cottontails[c]		
2	M	5	4.4	11.5
9	F	3	1.5	4.0
12	M	5	6.9	17.8
27	F	3	0.5	1.2
29	F	5	2.4	6.3
47	F	3	0.9	2.3
50	F	3	1.1	2.9
51	F	6	1.5	4.0
65	F	3	0.7	1.7
67	F	3	1.1	2.9

[a]Home range after rabbit moved to a new home range.
[b]Mean: M = 2.8 ha (6.9a); F = 2.2 ha (5.8a).
[c]Mean: M = 5.6 ha (14.6a); F = 1.2 ha (3.2a).

was considerably higher than the 0.8 ha value (Trent et al. 1974) for home ranges of females in winter.

Average home range sizes for cottontails based on recapture and reobservations of 10 ear-tagged/tail-dyed rabbits were 5.6 ha for males and 1.2 ha for females (Table 1). Home range size varied from 0.7 ha to 6.9 ha. Dalke and Sime (1938) reported an average home range size for male cottontails in Michigan as 1.5 ha and 0.9 ha for females; Heard (1963) reported similar results in 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 5.7 ha and stated that males were found to ". . . roam over . . ." 40.5 ha based on trap-retrap observations. Thus, although most trap-retrap studies show roughly corresponding home range sizes, 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 the trap-retrap methods of home range determination.

The location of the home ranges of five telemetered rabbits changed during the course of the study. Three of these rabbits had been using soybean fields for diurnal cover 60 percent of the time or greater (60.0, 83.3, and 76.9 percent) and relocated subsequent to the destruction of this cover via harvesting of soybeans (26 November 1974 to 4 December 1974). One rabbit altered its home range on 11 March 1975, one day after its entire original home range became flooded and hunting pressure was applied, causing the rabbit to seek more suitable refuge cover. Another rabbit (C-10) was observed to relocate its home range on 10 December 1974, but no drastic cover changes were observed in the area used as diurnal cover; therefore, it appears that this rabbit altered its home range in response to some condition or conditions other than cover availability. Early studies (Trippensee 1948:23-41) indicated that cottontails tend to concentrate ". . . in areas of protective cover . . ." during the winter months. Haugen (1943) also reported movement 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 inconsequential since changes in home range for radio-collared rabbits other than C-10 occurred as a result of sudden and extensive reduction of preferred cover within their existing home range, and that, unless sudden reduction of cover occurred, cottontails remained 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 areas harvested for crops and the subsequent relocation of these rabbits in areas retaining suitable cover. Such shifts may partially explain why hunters may not find rabbits in areas where rabbits were observed prior to the hunting season, particularly if harvest of crops or other practices seriously decreases existing cover. However, hunters may find concentrations of rabbits in areas of thick winter cover near such harvested areas.

Of the rabbits which changed home ranges, none were observed to return to their original home range, although two individuals did utilize small portions of their former home ranges throughout the winter. One rabbit 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, two other rabbits were never observed to return to any area within their vacated home ranges, even though subsiding flood water left the original home range of one essentially unchanged.

Except under conditions previously mentioned, most rabbits were observed to remain within their respective home ranges; however, six rabbits were found briefly during the study at points outside their home range boundaries at distances of 120, 300, 457, 571, 723, and 761 m. Five of these six movements occurred between 1 February and 28 February 1975. Initial onset of estrous was observed in trapped females between 1 January and 5 February, and breeding activities were observed for both telemetered and nontelemetered rabbits during this period. We feel that onset of breeding precipitated these brief home range departures.

Home range departures may lead to erroneous derivation of greatly enlarged home range sizes much larger than reported in previous studies and the present study. Trippensee (1948:26) cited a study by Schwartz (1940) in which one percent of the trapping data was excluded in the determination of the home ranges of cottontails due to the fact that one percent of the points where rabbits were recaptured were 120-780 m from the next nearest point of observation. The above possibly accounts for the large average home ranges reported by Haugen (1942). There are insufficient data on both radio-collared and ear-tagged/tail-dyed rabbits to make any assessment of the area encompassed by a rabbit traveling outside its home range other than the information given above. However, Trippensee (1948:26) cited a Wisconsin study (Anon. 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 1.0 mi (1.6 km) from the pothole.

The effects of home range departures on the susceptibility of cottontails to sport hunting were not ascertained; we feel that, due to the short duration of these departures,

susceptibility is not greatly affected. However, other physiological-behavioral factors associated with the onset of breeding may affect cottontail availability to hunters.

Onset of Crepuscular Activity

One phenomenon which may tend to discourage hunters is the lack of observation of rabbits in early morning and late afternoon during the winter in contrast to observations prior to hunting season on the same area. 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 believed that sunrise and sunset were the factors controlling the onset and cessation of activities. However, the method of observation of 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 was required before onset of movement could be definitely detected. Cottontails in the present study began moving in the evening for periods of up to 30 minutes before covering 16 to 65 m. Therefore, the data obtained by Mech et al. may not be an accurate indicator of the onset of activity.

Eighteen telemetric observations were obtained during the present study for which the onset of evening activities of 12 radio-collared rabbits were ascertained (Table 2). Rabbits began moving at or subsequent to sunset December 1974 through February 1975. It appears from these data that cottontails begin activities in winter subsequent to sunset, in which case they would not be readily observed. Thus, at least one explanation (other than population decline) for the "disappearance" of cottontails from areas where they were previously observed may be attributed to a decline in activity during daylight hours.

Table 2. Onset of crepuscular activities in relation to sunset for twelve radio-collared cottontails on the Percy Priest Wildlife Management Area, December 1974 through February 1975.

Rabbit no.	*Date*	*Time of sunset Central Standard Time*	*Time of onset of activity Central Standard Time*
C-1	1/19/75	17:00	17:10
	2/14/75	17:27	17:30
C-5	12/12/74	16:33	18:45
	1/13/75	16:54	17:30-17:45[a]
C-6	2/14/75	17:27	17:30-18:10[a]
C-7	2/10/75	17:23	17:35
	2/14/75	17:27	17:30-17:55[a]
C-9	12/12/74	16:33	18:20
	1/13/75	16:54	17:30
	1/19/75	17:00	17:00
	2/14/75	17:27	17:45-18-45[a]
C-10	2/14/75	17:27	17:30-18:05[a]
C-12	2/14/75	17:27	17:30-18:45[a]
C-13	2/14/75	17:27	18:20
C-14	2/14/75	17:27	17:30-18:45[a]
C-16	2/14/75	17:27	17:45-18:45[a]
C-17	2/14/75	17:27	17:30-17:50[a]
C-18	2/14/75	17:27	17:30-18-45[a]

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

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 in which a rabbit was located in 80 percent or more of the diurnal observations will be referred to as the diurnal cover preference range (DCPR) of the rabbit (Table 3).

The diurnal cover preferred by radio-collared rabbits ranged from virtually impenetrable brushpiles to tall, unmowed grass and soybeans before harvest. Of the 16 DCPR's utilized during the hunting season by cottontails, two (13 percent) were located in an impenetrable cover (brushpiles), seven (29 percent) were in dense honeysuckle, four (25 percent) were in grassy areas, and three (19 percent) used both areas of honeysuckle and 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 ($\bar{x}$ = 38.7 percent) of the home range (Table 3). Rabbits occupying home ranges in which cover remained fairly uniform throughout (N = 3) had DCPR's 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 susceptibility to hunting is unknown.

Table 3. 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, limit to one brushpile				1.1
Total	595					
Range	4-59	0.3-3.3	0.6-8.0	0.5-1.7	0.9-4.0	1.1-96.4
Average	23.4	1.6	2.1	0.8	2.3	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.

Except for the 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's 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. 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 obviously good spots for the relocation of the DCPR. Thus, daytime concentrations of rabbits are formed which likely develop into hunting "hot spots," and areas in which crops were harvested become more sparsely populated, usually resulting in lower hunter success.

Concentration of Rabbits

Population density for the eastern half of the study area (60 ha) was estimated to be 5.7 rabbits/ha (Anderson 1975) using the method of Eberhardt (1969). However, during the course of the study three apparent higher concentrations of cottontails were discovered through livetrapping, telemetry, and simulated hunts. One of the concentrations (a 5.8 ha woodlot) was observed to contain 8 ear-tagged/tail-dyed rabbits originally tagged in four adjacent fields and 6 radio-collared rabbits. The two remaining concentrations were located outside the study area but near its boundary. All areas of rabbit concentrations were characterized by thick cover of poor penetrability and in proximity to previously harvested soybean fields or other areas of sparse cover and excellent penetrability. 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 categorized as cottontail concentrations.

Observations of activities of rabbits during simulated hunts indicated that cottontails obviously 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. It was determined telemetrically that some collared rabbits in the 5.8 ha woodlot moved ahead of observers without noise or visual contact, and one individual moved through its brushpile not only on the ground but also by climbing fallen brush without becoming visible to observers. Such behavior is an obvious deterrent to predation (and hunting) since it not only hinders detection by predators, but also slows most pursuers and improves the chance of escape for the rabbit.

The area covered by rabbit concentrations was only 21 percent of the area covered by the soybean fields from which rabbits were apparently drawn. Also these areas of concentrations were located in blocks (e.g. the 5.8 ha woodlot) rather than in strips of cover (e.g. fencerows, 1.0 to 10.0 m wide).

Our data substantiate the idea that in areas extensively cultivated for soybeans (and perhaps other row crops) and where fall harvest or 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. Cover plots of relatively poor penetrability maintained in blocks rather than strips (ideally 8.0 ha of cover for every 40.0 ha 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 . . . 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 of November and December (Table 4). All four of the cottontails which changed home range due to dramatic cover degeneration established a new DCPR in cover of poor to very penetrability; other rabbits did not

Table 4. Cover penetrability type preferences for radio-collared cottontails for the months November through February on the Percy Priest Wildlife Management Area, 1974-75.

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		

change their cover preference. 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 of 23 (82.6 percent) observations of radio-collared rabbits during simulated hunts, the rabbits were found in cover of poor to very poor penetrability. Of the 19 observations where rabbits were approached 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 constituted only 17.4 percent of the total observations; however, three of the four rabbits approached in cover of excellent penetrability 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 4) 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.

Flushing distances varied from 0.3 m to 13.7 m and averaged 2.3 m. Sixty-one rabbits including radio-tagged, ear-tagged, and unmarked individuals, were flushed during the simulated hunts. 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; however, the greater number of rabbits residing in areas of poor to very poor cover penetrability resulted in a greater number of flushes.

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, 4.1 - 8.3 ha/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) were of shorter duration than the slower-paced hunts since walking for long periods with only a few rabbits flushed tended to discourage hunters. It appears that slow-paced hunts and thorough examination of cover by hunters will yield greater hunter success than fast-paced hunts with cursory examination of cover.

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