

Cottontail Rabbit Habitat Use on Delaware Wildlife Area, Ohio¹

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ABSTRACT. A radio telemetry study was performed on cottontail rabbits (*Sylvilagus floridanus mearnsii*) to quantify cover type use and infer selections with respect to cover type availability, year, sex- and age-class, time of day, and season. This study recorded 16,785 locations for 62 rabbits from 1981–1983. Briars (*Rubus* spp., *Rosa multiflora*) and old field were the two most used types of cover, together comprising more than 50% of locations. Relative to cover type availability, the briars type was the most preferred ($P \leq 0.05$). Both types were used heavily during day and night throughout the year, although use of briars was higher during day than night ($P \leq 0.05$). Rabbits that had survived a winter and spring spent more time in briars ($P \leq 0.05$) and less time in old field ($P \leq 0.05$) than those that had not. Implications are that wildlife managers must increase their emphasis on providing briars or other dense woody vegetation to maintain rabbit populations. Based on use percentages, rabbit cover type needs would be better met if percentages of area were: briars, herb-shrub, and cropland — each 25–35%; woodland — 0–10%.

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INTRODUCTION

An index to cottontail rabbit density derived from fall trapping on Delaware Wildlife Area (DWA), in central Ohio, declined by 82% from 1956 to 1985 (Boyd 1986). Associated with this decrease were declines of 81% in hunter success and 93% in harvest as determined from mandatory hunter check stations. DWA is one of Ohio's largest (1,935 ha) and oldest (1950) public hunting areas, and has been the major study area of the Division of Wildlife for evaluating upland game management techniques. Long-term data collected there represent the best information available to evaluate the effectiveness of current management plans, and indicate that changes should be made to improve plan success.

Chapman et al. (1982) and Allen (1984) provide good reviews of literature on cottontail habitat needs. Notably lacking are detailed studies quantifying use and selection of cover types. The objectives of this study were: 1) to quantify cover type use; 2) to infer selections based on cover type availability, year, sex- and age-class, time of day, and season; and 3) to make recommendations for improving the effectiveness of habitat management.

STUDY AREA

The DWA is 50 km north of Columbus, OH, in Delaware, Marion, and Morrow counties (Fig. 1). Topography is flat to gently rolling, with steeper slopes adjacent to Delaware Reservoir and feeder streams. Elevations range from 277 to 294 m above sea level. Soils, developed on calcareous clay loam glacial till, are imperfectly to well-drained, and are moderately to highly productive (Matanzo et al. 1969). Mean annual temperature 1951–1980 was 10.1° C, and mean yearly precipitation was 92.8 cm (Cunningham 1982).

Management practices included cooperative cropland

management, seeding grass and/or legumes, planting shrubs and trees, prescribed burning, controlled grazing, and various mechanical and chemical techniques to control woody vegetation. Sharecroppers were not permitted to apply pesticides or to fall-plow; they left 10% of their corn and soybean crops unharvested.

MATERIALS AND METHODS

Rabbits were box-trapped from March 1981 to April 1983, ear-tagged, sexed, weighed, fitted with radio-collars (164–165 Mhz) weighing 28–48 g, and released in the area of capture. Traps were placed along edges of a variety of

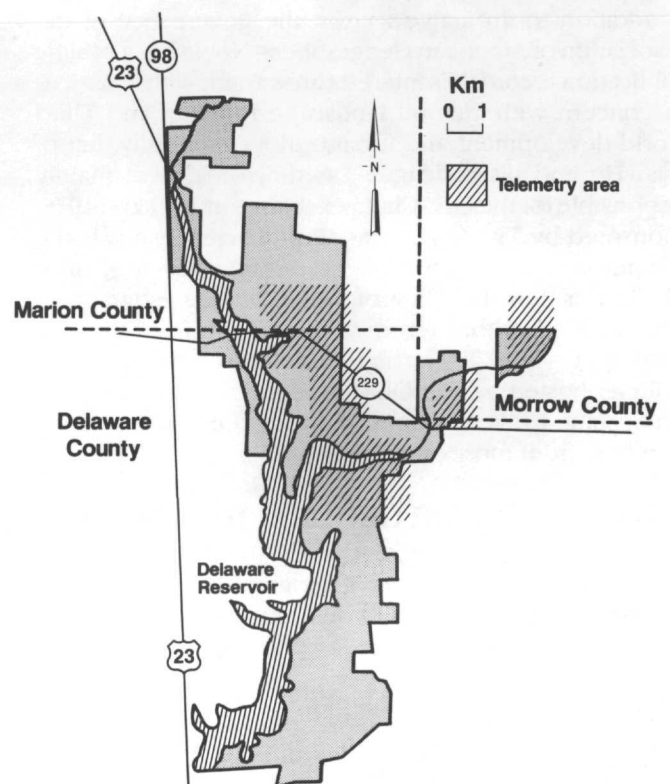


FIGURE 1. Location of the Delaware Wildlife Area, OH.

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cover types in an attempt to capture rabbits that had an opportunity to use several cover options. Only rabbits ≥ 900 g were radio-tagged. Radio-tagged rabbits were recaptured for transmitter replacement by using hare nets and wire ferrets (Althoff and Storm 1985), or box traps.

Rabbits were located daily from May 1981 through April 1983, and were also located every two hours during a 72-hour period in the middle of each month to equally sample all times of day. Locations were determined primarily by triangulation with a vehicle-mounted null receiving system. System accuracy and precision were evaluated by having four observers record azimuths to seven transmitters from seven receiving sites. Differences between 48 recorded and true azimuths had a mean of 0° ($SD = \pm 2^\circ$). Efforts to minimize radio-location errors included receiving close to rabbits (usually < 150 m), and completing fixes within two to three minutes. Also, the 5% of 2-azimuth fixes with the largest distance from plotted location to the farthest corner of error polygon were deleted because they had the greatest probability of error. Eighty percent of all locations were 2-azimuth fixes.

Locations obtained by approach or by triangulation with more than 2 azimuths were plotted on gridded aerial photographs (scale 1 cm = 24 m, grid cell size = 1 mm²) to obtain x,y coordinates. Coordinates for 2-azimuth locations were calculated with a FORTRAN® triangulation program.

Cover Types

Patches of vegetation ≥ 0.1 ha were classified into eight cover types by using a scheme based on similarities in vegetational structure or management practice, and were defined as follows:

Briars. — Areas with $\geq 40\%$ shrub cover, with briars (*Rubus* spp., *Rosa multiflora*), vines (*Vitis* spp., *Lonicera japonica*), conifers (*Pinus* spp.), and/or brushpiles comprising $\geq 20\%$ of the shrub cover; characterized by low, dense woody vegetation and found primarily in planted multiflora hedgerows, old fields, and young woodlands with a persistent multiflora understory. Shrubs were defined as woody vegetation < 10.2 cm dbh.

Old field. — Areas with $\geq 70\%$ herb cover, but lacking mowed areas, warm season grass plantings, or a shrub component as described for briars; composed of areas ranging in age from 2-year-old abandoned cropfields to young woodlands.

Warm-season grass. — Fields planted and maintained with warm-season grasses, primarily switchgrass (*Panicum virgatum*).

Mowed. — Areas planted to grass-legume cover and mowed or partially mowed once annually, in midsummer.

Crop. — Plowed, planted, or harvested grain (corn, soybean, wheat, oat) fields.

Idle crop. — Unplowed grain fields during and after May in year after harvest.

Woodland. — Areas with $\geq 50\%$ tree cover, $< 70\%$ herb ground cover, and no shrub component as described for briars.

Miscellaneous. — Pond, road, residence, and wetland.

Use of Cover Types

Radio-locations that were determined during 72-hour tracking periods were used to quantify use. Computer programs were generated to link location coordinates with digitized cover map data, and to calculate percentage of locations in each type for each rabbit for total, seasonal, and diurnal time periods (SPSS® 1983). Total time represents all 72-hour data gathered for a rabbit during the two-year period. Seasonal time periods were winter (Dec-Feb), spring (Mar-May), summer (Jun-Aug), and fall (Sep-Nov). Diurnal time periods were day (sunrise to sunset) and night (sunset to sunrise). Rabbits having < 10 locations in total or seasonal time periods or < 5 locations in diurnal time periods were deleted from analyses.

Rabbits surviving more than one seasonal time period with a functional radio collar were treated as independent samples in each period. Calculations were made of mean percentage of locations, by cover type, to summarize use on the study area by the rabbit population. Each rabbit was weighted equally in mean percentage calculations.

Selection of Cover Types

Selections were determined in two ways. The first involved comparing use estimates to availabilities at the study area level of selection as described by Johnson (1980). Briefly, for each season, cover types were ranked from most- to least-preferred and the null hypothesis that all types were equally preferred was tested. If rejected, a multiple comparison procedure was used to identify significant differences among ranks.

The second way of inferring selections involved determining differences in use between years, sex- and age-classes, and diurnal time periods, or among seasonal time periods, when availabilities were equal. The Wilcoxon rank-sum test (WRS) was used to determine if use percentages differed between years and sex- and age-classes. Wilcoxon's matched-pairs signed-rank test (WMP) was used to determine if use differed between diurnal time periods. The Kruskal-Wallis (KW) test was applied to determine if day or night use values varied among seasons. When differences attained significance, Dunn's multiple comparison test (DMC; Hollander and Wolfe 1973) was used to determine between which seasons use differed.

Two age-classes were defined: AGE0 for rabbits that had not yet survived through spring following their first winter; and AGE1 for those that had survived. Habitat use of AGE1 rabbits was of interest because these rabbits had the greatest probability of surviving long enough to produce offspring. Age-class determinations were based on dried eye lens weights ($n = 26$; Lord 1963), or trapping ($n = 3$) and body weight records ($n = 33$). Determination of ages using body weights were based on mean ± 1 SD weights of lens-weighed (known age) radio-tagged rabbits (Olentangy Wildlife Experiment Station, unpublished data). Rabbits < 1275 g in summer, < 1325 g in fall, and < 1350 g in winter and spring, were placed in AGE0. Rabbits ≥ 1275 g in summer, ≥ 1325 g in fall, or ≥ 1550 g in winter and spring were placed in AGE1. Rabbits ≥ 1350 g and < 1550 g in winter and spring could not be aged

reliably because of overlap in standard deviations of age-class weights.

Cover Type Associations

Use of combinations, or associations, of cover types were determined by generating a list of cover types (excluding miscellaneous) present in each total home range. Old field, mowed, and warm season grass types were pooled into a single herb-shrub type because they were dominated by perennial herbaceous vegetation. Similarly, idle crop and crop types were pooled into cropland because they were dominated by annual and biennial vegetation. A cover type was considered to be present when it made up $\geq 5\%$ of a home range. Individual home ranges were determined by the convex polygon method (Mohr 1947). Frequency of rabbit home ranges in each association was used to document use, and selection was inferred by using chi-square tests to compare observed frequencies with expected frequencies generated from randomly located circles equal in area to the median total rabbit range (6.90 ha). Circles were used because 82% of total home ranges had linearity index values < 2.0 (Ables 1969). Expected frequencies were calculated by multiplying the percentage of random ranges ($n = 100$) that were in each association by the number of total home ranges ($n = 62$).

Statistics

Statistical analyses, unless otherwise cited, were performed with SAS[®] (SAS Institute, Inc. 1985). A significance level of $P \leq 0.05$ was chosen for all tests except DMC. A $P \leq 0.15$ was necessary to detect differences in multiple comparisons after the KW test indicated use differences among seasons.

RESULTS

Sixty-two rabbits (27 males, 35 females) were radio-tagged between May 1981 and April 1983 resulting in a total sample of 139 rabbit-seasons. A total of 16,785 radio locations were recorded, 9,316 during the monthly 72-hour tracking periods. Telemetry study area size was 644 ha, 77% of which was on the wildlife area. The 23% on private land was necessary because private land was included in portions of 18 rabbit ranges. Study area cover type availabilities did not vary among seasons and were: crop – 36%, old field – 18%, woodland – 12%, idle crop and miscellaneous – each 10%, briars – 9%, mowed – 4%, and warm season grass – 2%.

Use of Cover Types

Based on mean percentages ($n = 62$) of total locations, use of cover types was: briars – 29%, old field – 22%, idle crop – 15%, crop – 12%, mowed and warm season grass – each 6%, and woodland and miscellaneous each 5%.

Selection of Cover Types

The briars cover type was preferred over all others in most seasons (Table 1). Mowed and warm season grass ranked 2–3 and often were preferred equally. Idle crop (rank 4) and miscellaneous (rank 5) were preferred nearly equally, as were miscellaneous and old field. Woodland

and crop were the least preferred types. Values for F suggest that rabbits exhibited the greatest degree of selection during spring, the lowest during fall.

Year and Sex-class Effects. — Idle crop was the only cover type used differently (WRS, $P = 0.033$) between years (YR1, 12%; YR2, 21%). This difference appeared to result from a difference ($P = 0.030$) in use during fall. Use of cover types did not differ (WRS, $P \geq 0.092$) between sex-classes.

Age-class Effects. — Use differed (WRS, $P \leq 0.05$) between age-classes for briars, old field, and crop. Briars and crop were used more by AGE1 rabbits (33% vs. 24%, and 18% vs. 8%, respectively), whereas old field was used more by AGE0 rabbits (27% vs. 15%). AGE1 rabbits used briars more than AGE0 rabbits during all seasons except spring (Fig. 2, $P \leq 0.057$). Crop use differed only during fall (23% vs. 8%; $P = 0.049$). AGE0 rabbits appeared to use old field more than AGE1 rabbits during all seasons, but significance was approached only during summer (39% vs. 14%; $P = 0.094$).

Diurnal Effects. — Use differed (WMP, $P \leq 0.05$) between diurnal time periods for all types except old field and woodland. Briars and warm season grass were used more during day than night (33% vs. 25%, and 5% vs. 3%, respectively), whereas mowed, crop, idle crop, and miscellaneous exhibited the opposite pattern (5% vs. 7%, 12% vs. 15%, 15% vs. 18%, and 4% vs. 6%, respectively). Most differences in diurnal use occurred in winter and spring (Table 2).

Higher use of briars and warm season grass during day indicated that these types were most used as resting and escape cover, whereas higher use of mowed, crop, idle crop, and miscellaneous (primarily yards in residential areas) during night indicated that these types were most used as feeding cover.

Seasonal Effects. — Day use of briars and night use of woodland varied among seasons (KW, $df = 3$, $P \leq 0.05$) (Table 2). Day use of briars was higher (DMC, $P \leq 0.15$) in spring than summer or fall. Night use of woodland was higher (DMC, $P \leq 0.15$) in winter than summer.

Further analysis, considering all rabbits with a specific cover type in their home range, revealed that night use of warm season grass, day use of crop, and night use of idle crop, varied among seasons (KW, $df = 3$, $P \leq 0.05$). Night use of warm season grass was higher in winter than fall, day use of crop was higher in summer and fall than in spring, and night use of idle crop was higher in summer than in winter (DMC, $P \leq 0.15$).

Seasonal use of briars differed between age-classes. Day and night use of briars did not vary among seasons (KW, $df = 3$, $P \geq 0.153$) for AGE1 rabbits (grand means, $n = 75$, day = 35%, night = 30%), but did vary among seasons ($P \leq 0.05$) for AGE0 rabbits. Use in spring (day 40%, night 28%) was higher (DMC, $P \leq 0.15$) than in summer or fall (day = 15%, 17%, night = 3%, 12%, respectively). Young rabbits spent progressively more time in briars as seasons progressed from summer to spring. Rabbits that survived through spring in the year after their birth spent nearly a third of their time in briars during all seasons.

Cover Type Associations

Eight cover type associations were used, three (briars—

TABLE 1

Cottontail rabbit cover type selections, Delaware Wildlife Area, OH, 1981–83.*

Code number	Cover type	Cover type code number							
		1	2	3	4	5	6	7	8
1	Briars		WSp S	WSp SF	WSp SF	WSp SF	WSp SF	WSp SF	WSp SF
2	Mowed				WSp	WSp SF	WSp SF	WSp SF	WSp SF
3	Warm season grass				WSp F	WSp SF	WSp SF	WSp SF	WSp SF
4	Idle crop					SF	Sp SF	WSp SF	WSp SF
5	Miscellaneous						Sp S	WSp SF	WSp SF
6	Old field							W SF	WSp SF
7	Woodland								WSp
8	Crop								

* Selections were determined with Johnson's (1980) PREFER® program. Tests of null hypothesis that all types were equally preferred: Winter (W), $n = 33$, $F(7,26) = 56.04$, $P < 0.01$; Spring (Sp), $n = 41$, $F(7,34) = 127.21$, $P < 0.01$; Summer (S), $n = 30$, $F(7,23) = 51.27$, $P < 0.01$; Fall (F), $n = 36$, $F(7,29) = 32.72$, $P < 0.01$. Read across row to determine for which season(s) the cover type on the left was more preferred ($P < 0.05$) than other types.

TABLE 2

Mean percentage of cottontail rabbit locations by cover type, diurnal time period, and season, Delaware Wildlife Area, OH, 1981–83.

Cover type	Diurnal time	Season*				P^{**} df=3
		Wi	Sp	Su	Fa	
Briars	Day	32	42***	30****	27****	0.016
	Night	26††	28†††	22†††	24	0.282
Old field	Day	25	18	17	24	0.232
	Night	28	19	19	21	0.306
Warm season grass	Day	10	7	1	2	0.313
	Night	5†	5	1	0	0.275
Mowed	Day	3	6	6	6	0.264
	Night	6†††	7	7	9	0.894
Crop	Day	9	8	17	16	0.084
	Night	12†	11†	21†	17	0.720
Idle crop	Day	11	10	23	18	0.319
	Night	10	17†††	25	20†	0.313
Woodland	Day	6	4	2	5	0.748
	Night	8***	4	2****	5	0.019
Miscellaneous	Day	5	5	3	3	0.521
	Night	5	10†††	4	4	0.234

* Rabbit $n = 33$ (Wi), 41 (Sp), 30 (Su), and 35 (Fa).

** P From Kruskal–Wallis test, to test null hypothesis that use of a type is equal among seasons.

*** and **** Within rows, *** value is higher than **** value, Dunn's multiple comparison test, $P \leq 0.15$.

† $P \leq 0.10$; †† $P \leq 0.05$; ††† $P \leq 0.01$; Day use value differs from night use value, Wilcoxon matched–pairs signed–ranks test.

TABLE 3

Tests of differences in frequencies of cottontail rabbit and random home ranges in cover type associations, Delaware Wildlife Area, OH, 1981–83.

Association*	Rabbit ranges Observed	Random ranges Expected**	χ^2	
			df = 5	df = 1
BHC	27	18.6	3.79	5.42
BHCW	16	14.9	0.08	0.11
BH	11	1.2	80.03	81.61
HC	2	8.1	4.59	5.28
C	0	5.6	5.60	6.16
Others***	6	13.6	1.93	2.32
Total = 96.02†††				

* B = brambles, H = herb-shrub, C = cropland, W = woodland.

** Expected frequencies were calculated by multiplying percentage of random ranges in each association by the number of rabbit ranges ($n = 62$).

*** Rabbit ranges = BHW (2), HW (2), BCW, and HCW; random ranges = BHW (3.7), HW (3.7), BCW (3.1), HCW (1.9) and CW (1.2).

† $P \leq 0.05$; †† $P \leq 0.001$.

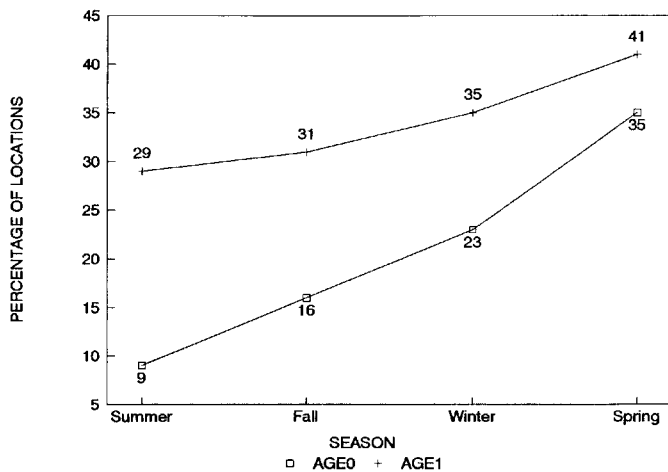


FIGURE 2. Percentage of cottontail rabbit locations in briars, by age-class and season, Delaware Wildlife Area, OH, 1981–83. AGE1 rabbits used briars more than AGE0 rabbits during all seasons except spring ($P \leq 0.057$).

herb-shrub—cropland, briars—herb-shrub—cropland—woodland, and briars—herb-shrub) accounting for 87% of all home ranges (Table 3). Briars—herb-shrub and briars—herb-shrub—cropland associations were preferred, and herb-shrub—cropland, and cropland associations were avoided (χ^2 , $df = 1$, $P \leq 0.05$).

DISCUSSION

Cover type availability, age-class, and diurnal and seasonal time were important factors affecting cottontail habitat use. No important differences were found in cover type use between sexes, a finding supported by Swihart and Yahner (1982a,b) and Althoff (1983).

Winter has generally been considered to be the most habitat-limiting time of year for rabbits (Allen 1984), but results from the present study, inferred from the degree of selection exhibited in different seasons, reveal that spring

also may be an important limiting period.

No single cover type met all seasonal and diurnal cover type requirements, as total home ranges included two to four types. Although multiple types of cover appear to be important to rabbits, briars and herb-shrub could be considered essential types, as 92% of ranges contained briars, 98% contained herb-shrub, and 90% contained both.

The importance of dense woody vegetation, as provided by briars, brushpiles, vine entanglements, and small conifers, is well supported by previous investigations (Trent and Rongstad 1974; Anderson and Pelton 1976; Allen et al. 1982; Swihart and Yahner 1982a,b, 1984; Althoff 1983; Morgan and Gates 1983). Results from the present study demonstrate the importance of briars as daytime resting cover through most of the year, particularly for rabbits that survive the stresses of winter and spring. We conclude that rabbit managers must place additional emphasis on briar management to improve effectiveness of rabbit management.

Throughout the year approximately one-third of adult rabbit locations were in briars, whereas only 9% of the study area was in this type. Increasing the area percentage of briars would greatly increase quality of habitat—in terms of protective cover. Increased rabbit survival rates should result. Edwards et al. (1981) and Chapman et al. (1982) concluded that managing for enhanced survival should be the primary emphasis in cottontail management.

Managers need to provide an interspersed of open sites, dense grass stands, and reverting areas when managing for the herb-shrub cover type. Grass stands should be blocks not exceeding 1 to 2 ha; Lord (1963) found low rabbit use in a large block of grassland vegetation. He also found that mowing strips through the large block resulted in more rabbits there. Morgan and Gates (1983) also demonstrated the value of mowing strips, particularly adjacent to dense escape cover.

Use of cropland in the present study was higher than reported by Trent and Rongstad (1974) and Althoff (1983),

for areas of more intensive cropland management. This difference may indicate that rabbits are attracted to vegetation resulting from cropland management practices on DWA (1-year idle fields, 10% of crop unharvested, and no fall plowing or pesticide use). The 1-year idle cover type ranked higher than other cropland types in preference comparisons.

Crop harvest is an obvious cause for decreased cover value and use of cropfields in winter and spring (Anderson and Pelton 1976; Swihart and Yahner 1982a,b). However, there also was a decrease in usage of the idle crop type, which remained undisturbed during this time, revealing that cover in the dominantly annual and biennial vegetation is insufficient for maintaining use during winter and spring.

Woodland, as defined in this study, received low use throughout the study and was a least-preferred type. Allen et al. (1982) and Althoff (1983) also documented the low value of this type.

Based on cover type use measurements obtained in the present study, rabbit populations could be improved on DWA if percentage of area in each of briars, herb-shrub, and cropland was 25–35%; and 0–10% in woodland. In addition, the combination of briars and herb-shrub should approximate 60% of an area, whereas the combination of cropland and woodland should not exceed 40%. Other areas being managed for cottontails should also benefit from implementation of these guidelines.

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