Habitat Preferences of Cottontail Rabbits on an Intensive Farm and a Traditional Farm

Susan L. Allen, *Department of Zoology, North Carolina State University, Raleigh, NC 27650*

Richard A. Lancia, *Departments of Forestry and Zoology, North Carolina State University, Raleigh, NC 27650*

Carl W. Betsill, *North Carolina Wildlife Resources Commission, Raleigh, NC 27650*

Abstract: Home ranges and habitat preferences of radio-collared cottontail rabbits (*Sylvilagus floridanus*) on an intensive farm and a traditional farm were monitored during 1979–81 in eastern Wake County, North Carolina. On the traditional farm, mean home ranges of males (6.37 ha) were larger ($P < 0.05$) than those of females (3.15 ha). On the intensive farm, mean home ranges of males (2.60 ha) were not larger ($P > 0.05$) than those of females (2.11 ha). Home ranges of males on the traditional farm were larger ($P < 0.05$) than those of males on the intensive farm; however, home ranges of females on the 2 farms were not different ($P > 0.05$). On both farms, rabbits preferred brush to woodlots with understories, woodlots with negligible understories, and edge, and preferred fields the least. These data indicate that habitat preferences did not change with agricultural practices. Diurnal and nocturnal habitat preferences were similar.

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The cottontail rabbit (*Sylvilagus floridanus*) is an important game species in North Carolina. In 1976–77, the cottontail ranked third in importance in both number of hunters and number of trips per hunter (Betsill 1977, N.C. Wildl. Resour. Comm., Unpubl. Annu. Prog. Rep. XXX:193–209). Nevertheless, statewide harvests have declined during the past decade, causing concern over the status of this species (Baynes 1976, N.C. Wildl. Resour. Comm., Unpub. Rep.). One explanation for the decline in harvest may be a decrease in the availability of habitat due to modern agricultural practices.

The cottontail rabbit has traditionally been considered a farm game

species. Early investigators (Hendrickson 1938, Allen 1939, Dalke 1942, Lord 1963), using livetrapping and observation techniques, concluded cottontails preferred hedgerows, brushy areas, small woodlots, and the edges of woodlots. More recently, radio telemetry studies have confirmed these conclusions (Trent and Rongstad 1974, Anderson and Pelton 1977).

As early as 1939, concern was expressed about the effect "modern" farming was having on cottontails (Friley 1955). During 1939–42, a decline in the rabbit harvest in southern Michigan was noted after the removal of heavy fencerows, revamping of field boundaries and revitalizing of farm land (Friley 1955). Others similarly expressed concern that "clean" farming was decreasing the carrying capacity of the land for cottontails (Crawford 1945, Neely 1966, Hill 1972). Data from Vance (1976) and Sadler (1980) further suggested that improvements in farming efficiency and the corresponding increase in field size and decrease in fencerows and edges had a detrimental effect on cottontails.

The objective of this project was to compare habitat preferences of cottontail rabbits on an intensively farmed area (intensive farm) and on an area farmed in a less intensive, more traditional manner (traditional farm).

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Methods

The study was conducted on 2 farms located approximately 8 km apart in eastern Wake County, North Carolina. One was intensively farmed and the other more traditionally farmed. Soils on both farms were predominantly of the Appling series (Typic Hapludults) (Cawthorn 1970).

The intensive farm contained large expanses of field and grazed pastures ($\bar{x}_{\text{block size}} = 3.29$ ha, SD = 2.38 ha) with scattered small islands of brush ($\bar{x} = 0.16$ ha, SD = 0.30 ha) and woodlots ($\bar{x} = 2.57$ ha, SD = 4.44 ha) (Fig. 1). These islands of cover were usually found in association with field drainage systems and small ponds. Crops grown, in order of decreasing acreage, included tobacco, silage corn, wheat, and soybeans. All crops, except winter wheat, were harvested, and the stubble plowed under by October 15. Wheat was planted in late October and harvested in mid-May.

Woodlots were composed of loblolly pine (*Pinus taeda*) and mixed hardwoods. Basal areas for the woodlots averaged 14.3 m^2/ha. Understory species included Japanese honeysuckle (*Lonicera japonica*), greenbriar (*Smilax*

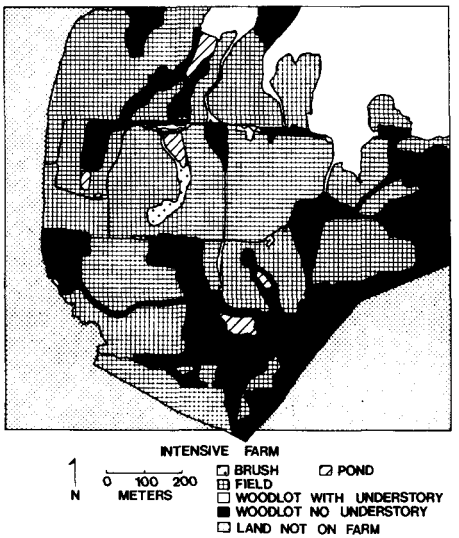

Figure 1. Intensive farm, eastern Wake County, North Carolina, 1981.

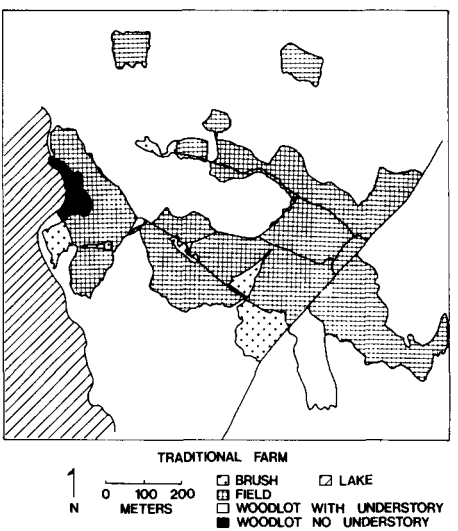

Figure 2. Traditional farm, eastern Wake County, North Carolina, 1981.

sp.), poison ivy (*Rhus radicans*), and muscadine grapes (*Vitis rotundifolia*). Japanese honeysuckle, blackberries (*Rubus* sp.), and pokeweed (*Phytolacca americana*) dominated the brushy areas. See Allen (1981) for detailed descriptions.

In contrast, the traditional farm contained small fields ($\bar{x}_{\text{block size}} = 1.89$ ha, SD = 1.70 ha) separated by large woodlots ($\bar{x} = 12.88$ ha, SD = 14.10 ha) and brushy areas ($\bar{x} = 0.33$ ha, SD = 0.36 ha) (Fig. 2). Abandonment of previously grazed and cropped areas was evident. Crops grown included approximately equal acreages of tobacco and soybeans. A vegetable garden occupied 1 small field. All crops were harvested by mid-October the first year of the study; however, the soybeans were not harvested in the second year due to an uncontrolled weed invasion. No winter cover crops were planted, and tobacco stubble was plowed under shortly after harvesting.

Principal tree species in woodlots with understories (% cover of the understory > 40%) were loblolly pine and tulip poplar (*Liriodendron tulipifera*). Woodlots with negligible understories (% cover of the understory <40%) were dominated by tulip poplar. Other tree species present were similar to those found on the intensive farm. Woodlot basal areas averaged 24.1 m^2/ha. The composition of the understory and brushy areas was also similar to that found on the intensive farm.

Rabbits were livetrapped in wooden box traps (Taber and Cowen 1971) on both farms in December 1979, March and September 1980, and only on the traditional farm in December 1980. Traps were distributed along field edges, in brushy areas, and in woodlots. Although trap placement was not systematic, traps were placed on or near habitat borders in an attempt to capture rabbits with an opportunity to use several habitat types. Apple juice was used as bait the first time traps were set each sample period. Traps were removed prior to beginning radio telemetry observations except in the fall 1980 when traps were closed but left in place on the traditional farm. Captured cottontails were weighed, sexed, tagged (both ears, #1 Monel tags) and fitted with radio collars (mean weight = 31.0 g, SD = 1.19 g, mean % of rabbit body weight = 2.7%). Rabbits were released where captured.

Locations on all rabbits were taken every 2 hours during continuous 10-hour blocks. A total of 12, 10-hour blocks spanning 4 weeks yielded 60 locations per rabbit. A monitoring schedule for 4 sample periods (winter 1979–80, spring 1980, fall 1980, and winter 1980–81) was established in an attempt to distribute the frequency of telemetry fixes approximately equally throughout the 24-hour day. Due to rabbit mortality, occasional poor readings or inability to obtain readings, the goal of 60 locations per rabbit per sample period was not always attained. Rabbits surviving more than 1 sample period with a functional radio collar were considered to be independent samples each sample period.

For a telemetry fix, a maximum of 15 min. between bearings and an intersection angle of 60–120° were permitted. Bearings were taken with both handheld and vehicle-mounted receiving systems. The loudest signal method was used to determine telemetry bearings (Springer 1979). To derive an estimate of the telemetry error, field data on a stationary transmitter of unknown location were collected in the same manner as data collected on live animals. Mean linear error distance was estimated to be 37.9 m (SD = 21.22 m).

Rabbit locations for the first 2 sample periods were plotted manually on aerial photographs using a Silva ranger compass. Rabbit locations for the second 2 sample periods were calculated using the TELEM computer program (Koeln 1980). In addition, home ranges using the minimum-area method (Mohr 1947) and area in each vegetation type within home ranges were calculated using TELEM for all rabbits.

Relative habitat preferences were determined using the Preference Assessment Program (PREFER) described by Johnson (1980). Within an animal's home range, the number of locations per habitat type and the area of each habitat type were calculated. Numbers of locations in each habitat were used in the PREFER program as usage values, and areas of each habitat type within the home ranges were used as availability measures. Because PREFER subtracted relativized usage from relativized availability, a negative preference value indicated a preferred habitat type relative to those habitat types exhibiting positive preference values. Relative habitat preference, as calculated using the PREFER program, is defined as a choice made given equal availabilities of the different habitat types. Thus, if the relative availability of a habitat type is less than the relative usage, the habitat is preferred regardless of the amount of that habitat type within the home range. For the relative preference analyses, night was defined as occurring 1 hour prior to official

Table 1. Vegetation Classification Scheme for the Traditional and Intensive Farms, Eastern Wake County, North Carolina, 1981

Habitat Type	Description	% Overstory[a]	% Understory[a]
W w/o U	Woodlot—negligible understory	75–100	<40
W with U	Woodlot with understory	75–100	>40
Brush	Unpenetrable tangle of dense shrubs and woody vines	0	>95
Field	Crops, bare soil or pasture	0	Seasonally variable
Edge	Interface of woodlot and field		>100

[a] % cover of the vegetation in summer.

Table 2. Mean Number of Locations Per Rabbit by Season on the Traditional and Intensive Farms, Eastern Wake County, North Carolina, 1979–81

Season	Traditional Farm		Intensive Farm	
	Mean No. Locations	No. of Animals	Mean No. Locations	No. of Animals
Winter 1	56 (19.4)[a]	4	66 (6.0)	5
Spring	59 (2.0)	6	57 (6.0)	6
Fall	58 (0.8)	4	55 (10.2)	6
Winter 2	60 (0.8)	7	48 (14.8)	2

[a] Standard deviation in parentheses.

sunset to 1 hour following official sunrise, with day being defined as all other times.

All other statistical analyses were performed using the general linear models procedure of the Statistical Analysis System (SAS) computer package (SAS Institute, Inc. 1979).

Vegetation was sampled on both farms in August 1980, using a modification of the Daubenmire method (Daubenmire 1959), a glass wedge prism, and a spherical densitometer. The vegetation classification scheme devised for the 2 study areas, and habitat type abbreviations, are described in Table 1. All areas designated as an edge habitat type, by definition, had understories more dense than those of adjacent woodlots. As a result, a majority of the field and woodlot borders were not considered to be edge habitat types.

Results and Discussion

Fifteen rabbits (6 males, 9 females) were monitored for 1 sample period, 11 (1 male, 10 females) for 2 sample periods, and 1 male for 3 sample periods, resulting in a total of 40 sample rabbits. Mean number of locations per rabbit per season on the 2 farms ranged from 48 to 66 (Table 2) (see Allen 1981 for individual values). On both farms more females than males were trapped and monitored during all 3 seasons sampled, except for the first winter on the traditional farm.

Home Range

On the traditional farm, home ranges of males during the first winter ($\bar{x} = 9.06$ ha, SD = 0.20 ha) exceeded the range of literature values summarized by Chapman et al. (1980) for the winter season. Home range sizes for the other sample periods were similar to results of previous studies. Home ranges of males ($\bar{x} = 6.37$ ha, SD = 2.86 ha) were larger ($P < 0.05$) than those of females ($\bar{x} = 3.15$ ha, SD = 1.57 ha).

On the intensive farm, mean home ranges of males (2.60 ha, SD = 1.37 ha) were slightly larger ($P > 0.05$) than those of females ($\bar{x} = 2.11$ ha, SD = 1.66 ha) during the same season. This absence of a significant difference in home range size between males and females may be due to the small number of males sampled ($N = 3$) on the intensive farm.

Home ranges of males on the traditional farm were larger ($P < 0.05$) than home ranges of males on the intensive farm; however, home ranges of females on the 2 farms were not different ($P > 0.05$). Overall mean home ranges (both sexes combined) on the traditional farm (4.38 ha, SD = 2.69 ha) were larger ($P < 0.05$) than overall mean home ranges on the intensive farm (2.19 ha, SD = 1.59 ha). The difference in home range sizes between the farms probably was due more to the greater number of males (with larger home range sizes) monitored on the traditional farm than to an actual difference in home ranges between the 2 farms.

Home ranges of females on both farms did not differ ($P > 0.05$) between seasons, nor did home ranges of males on the intensive farm. Home ranges of males on the traditional farm did differ ($P < 0.05$) by season. Data from the 2 winter sample periods, however, were markedly different, with first winter ranges nearly 3 times as large as second winter ranges. Presumably, male home ranges would be largest in spring when males are sexually active (Haugen 1942, Trent and Rongstad 1974); however, first winter home range values exceeded the spring values. No plausible biological explanation for these large winter home ranges is available. Consequently, the second winter data were assumed to be more representative of the season. See Allen (1981) for further discussion.

A linear regression analysis with home range size as the dependent variable, and acreages of habitat blocks in the home range as independent variables, was performed to determine if home range size could be predicted by the amount of contiguous cover (woodlot with understory and brush) within an animal's home range (i.e., a larger home range would be expected to contain disproportionately larger blocks of cover than a smaller home range). The analysis revealed that acreages of contiguous W with U (woodlot with understory), W w/o U (woodlot-negligible understory), brush, and field were all significant variables ($P < 0.01$). Consequently, we concluded that larger home ranges contained proportionately greater amounts of all of the habitat types present, and that the amount of contiguous cover alone (W with U and brush) was not a good predictor of home range size.

Habitat Preference

Habitat preferences were analyzed separately for the 2 farms. The data then were subdivided into diurnal and nocturnal categories. Preference analy-

ses also were performed after subdividing the field habitat type into bare soil and crop categories.

For diel observations on the traditional farm, the average difference in rank (mean rank of availability minus mean rank of usage) for the 5 habitat components was significant ($P < 0.05$) (Table 3). However, only W w/o U was preferred over field based on a Waller-Duncan comparison with a K ratio equal to 100 (Waller and Duncan 1969). Although significant, we believe this difference was not representative of W w/o U in general since only 4 of the 21 rabbits monitored on the traditional farm included W w/o U in their home range (composing only 1.6% to 8.0% of the animals' total home ranges) and only 5.5% (13 of 235) of the total telemetry fixes for the 4 animals combined fell in this habitat type. Therefore, the difference in preference between W w/o U and field is likely due to unique characteristics of a particular small strip of W w/o U (Fig. 2) and may not indicate W w/o U was a generally preferred habitat type on the traditional farm.

The relative ranking of the remaining habitat types and corresponding algebraic signs of the ranks indicated 1) a preference for brush and edge over the other types, 2) neither preference nor avoidance of W with U, and 3) avoidance of fields.

On the traditional farm, diurnal habitat preferences also were different ($P < 0.01$) (Table 3). Disregarding W w/o U, edge and brush were preferred over W with U and field. Analysis of the nocturnal data produced the same preference ranks and level of significance demonstrated by the diel data (Table 3).

Subdivision of the field habitat into bare soil and crop categories yielded slightly different preference ranks (Table 4). Habitat preferences were not different ($P > 0.05$); however, brush and crops had low negative values indicating they may be preferred relative to the other habitat types. Due to the total lack of weed control in crops grown on the traditional farm, a dense growth of cockleburs (*Xanthium strumarium*) and other vines and weeds provided cover similar in structure to that found in the brushy areas.

In contrast to the traditional farm, rabbits on the intensive farm did not show significant habitat preferences, except during daylight hours (Table 3). When day and night data were pooled, brush was the only preferred habitat relative to the others.

Analyzing diurnal and nocturnal periods separately yielded different results. Brush, W with U, and W w/o U were preferred during the day, whereas edge was neither preferred nor avoided. Nocturnal preferences on the intensive farm were similar to diurnal preferences, with the exception of W w/o U which was less preferred during the night than during the day. Nocturnal habitat preferences were not different ($P > 0.05$).

When the data were analyzed subdividing the field habitat into bare soil

Table 3. Average Difference in Preference Ranks for Habitat Components on the Traditional and Intensive Farms (Subdividing the Data into Diel, Diurnal, and Nocturnal Classifications), Eastern Wake County, North Carolina, 1979–81

	Traditional Farm						Intensive Farm					
	Diel[a]		Diurnal[b]		Nocturnal[a]		Diel		Diurnal[a]		Nocturnal	
Habitat Type	Rank[c]	Value[d]	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value
W w/o U	1	−0.19A	1	−0.55A	1	−0.24A	4	+0.05A	3	−0.05AB	4	+0.13A
W with U	4	0.00AB	4	+0.05B	4	+0.12AB	2	+0.03A	2	−0.10A	2	−0.03A
Brush	2	−0.19AB	3	−0.07AB	2	−0.24AB	1	−0.39A	1	−0.37A	1	−0.37A
Edge	3	−0.07AB	2	−0.21AB	3	−0.12A	3	+0.03A	4	0.00A	3	0.00A
Field	5	+0.45B	5	+0.79	5	+0.48B	5	+0.29A	5	+0.53B	5	+0.26A

[a] Preferences significantly different ($P < 0.05$).
[b] Preferences significantly different ($P < 0.01$).
[c] Relative preference rank, 1 = most preferred, 5 = least preferred.
[d] Value = Mean rank of availability minus mean rank of usage. Values followed by the same letter were not significantly different ($P > 0.05$). Differences between habitat types were computed by comparing each habitat type with the other 4 and were not computed in a simultaneous test.

Table 4. Average Difference in Diel Preference Ranks for Habitat Components (Subdividing Field into Field/Bare Soil and Field/Crops) on the Traditional and Intensive Farms, Eastern Wake County, North Carolina 1979–81

Habitat Type	Traditional Farm		Intensive Farm	
	Rank[a]	Value[b]	Rank	Value
W w/o U	1	−0.12	4	+0.13
Brush	2	−0.09	1	−0.45
Field/Crops	3	−0.07	6	+0.26
W with U	4	0.00	3	0.00
Edge	5	+0.07	2	−0.16
Field/Bare Soil	6	+0.21	5	+0.21

[a] Relative preference rank, 1 = most preferred, 5 = least preferred.
[b] Value = Mean rank of availability minus mean rank of usage. No values were significantly different ($P > 0.05$).

and crops, brush and edge were preferred relative to W with U, bare soil, and crops, although none of the habitat types were significantly different (Table 4). Herbicides were applied for weed control to all crops grown on the intensive farm, therefore, the crop vegetation type on the intensive farm was not similar to the overgrown crop type present on the traditional farm. Thus, whereas fields with crops were preferred on the traditional farm, they were avoided on the intensive farm and had a preference value similar to fields with bare soil.

Habitat preferences of cottontail rabbits were similar on the 2 farms. In the analysis of diel data, rabbits preferred brush relative to the other types on both farms (disregarding W w/o U on the traditional farm). Likewise, rabbits on both farms least preferred (avoided) fields. The edge habitat type was preferred on the traditional farm, however, but not on the intensive farm, possibly because all of the edge habitat on the traditional farm bordered W with U, a type neither preferred nor avoided. Thus, rabbits already in W with U could travel to edge without crossing any avoided habitat types. Conversely, all of the edge on the intensive farm bordered W w/o U, a type which was not preferred. Consequently, rabbits in brushy areas (the preferred type) would have been forced to cross otherwise avoided areas to use edge.

Analyzing night data, rabbits on both farms preferred brush, although W with U was preferred on the intensive farm and not preferred on the traditional farm. W with U on the intensive farm was preferred during both the day and night when analyzed separately (value = −0.10 and −0.03, respectively), but not preferred relative to other habitat types when the day and night data were pooled (value = +0.03). Overall, these results suggest that W with U was neutral to mildly preferred by rabbits on the intensive farm, and not avoided as indicated by the pooled analysis.

This presumed difference in preference for W with U on the 2 farms may be due to their different distribution patterns on the farms. W with U was the predominant woodlot type on the traditional farm and occurred in large continuous blocks. Moreover, at least one side of all of the brushy areas was bordered by W with U. As a result, rabbits on the traditional farm could travel freely through continuous cover of W with U to brushy areas or woodlot edges, thereby encompassing large acreages of W with U in their home ranges and increasing the availability measure. An increase in the availability measure relative to the usage measure would subsequently decrease the preference status.

In contrast, W w/o U was the predominant woodlot type on the intensive farm and the W with U type occurred only in isolated blocks and small scattered islands. In no case did W with U border brush on the intensive farm, and in all cases W with U was bordered by field on at least one side. Therefore, rabbits on the intensive farm did not have large expanses of W with U cover available to them to encompass in their home ranges. Thus, availability measures were smaller relative to usage, resulting in a higher preference status. In addition, any rabbit leaving W with U on the intensive farm would be forced to cross open fields to get to the more preferred brush vegetation. In most cases, rabbits did not cross open fields to get from W with U to another vegetation type, which further increased the preference status by increasing usage.

Analyzing diurnal data, edge and brush were preferred over the other habitat types on the traditional farm, whereas brush, W with U and W w/o U were preferred on the intensive farm, with edge being neither preferred nor avoided.

Brush Habitat.—Rabbits on both the traditional and intensive farms preferred brush over the other habitat types available. Forty percent (6 of 15) of the rabbits trapped on the intensive farm were caught on the periphery of a densely vegetated, 0.4 ha, brush island located in a drainage feature separating 2 large cultivated fields. Apparently, the island had been cleared of overstory trees and allowed to revert to native brush that was effective in erosion control and as a wind break, in addition to providing rabbit habitat. This area, ranging from 16 to 40 m wide, accounted for most of the dense cover available on the intensive farm.

Five of the 6 rabbits trapped on the brush island were radio-collared and monitored. Eighty-two percent of 512 locations were in or near the island. In addition, 2 rabbits during a spring monitoring period and 1 during a winter period were never located outside the brush island. The home range for 1 individual using the area in the spring was 0.24 ha, suggesting suitable rabbit habitat can be provided by a small, but very dense, brushy island bordered by cultivated fields.

Management Recommendations

Evidence from this study demonstrates that small areas of brush, even when isolated from other suitable habitat, can provide rabbit habitat. We recommend providing brushy habitat in strips 30 m wide. In addition to providing rabbit habitat, these strips 1) reduce erosion and are less expensive to establish than grassed waterways, 2) are effective windbreaks, and 3) are a source of firewood. However, the brushy strips we suggest are 1) considerably wider than most grassed waterways, 2) impossible to drive over with equipment, and 3) in need of periodic removal or felling of large trees.

An alternative suggestion is to establish brushy areas where fields abut woodlots by felling trees within 10 m of the edge of the woods. Our results suggest, however, that narrow brushy field borders may be useless as rabbit habitat if the adjacent woodlot provides only minimal or poor habitat. In this situation, wide strips of brushy habitat (30 m wide strips suggested earlier) should be established along field/woodlot borders. In addition to providing rabbit habitat, these brushy field edges may reduce competition for nutrients and moisture between woodlots and adjacent crops, thereby improving crop yields. Although brush piles along field edges are not a new concept in wildlife management, we stress the importance of the density and width of the brushy strips.

In addition to preferring brush, rabbits on both farms least preferred (avoided) fields. The apparent avoidance of cultivated fields with complete weed control may be an important factor in understanding the impact of clean farming on rabbit habitat. On the intensive farm, in addition to larger field size, elimination of idle areas and clean ditch banks, the crops themselves seem to be less desirable rabbit habitat.

A quantitative loss of habitat can be offset by qualitative improvements. Management practices should be aimed at improving the quality of the remaining habitat. We believe good rabbit habitat can coexist with efficient farming practices, even on today's modern, "clean" farms.

Literature Cited

Allen, D. L. 1939. Michigan cottontails in winter. J. Wildl. Manage. 3:307–322.

Allen, S. L. 1981. Habitat preferences of cottontail rabbits on an intensive farm and a traditional farm. M. S. Thesis. N.C. State Univ. 73pp.

Anderson, B. F., and M. R. Pelton. 1977. Movements, home range, and cover use: Factors affecting the susceptibility of cottontails to hunting. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 30:525–535.

Cawthorn, J. W. 1970. Soil survey of Wake County, North Carolina. USDA Soil Conserv. Serv. in coop. with N.C. Agric. Exp. Sta., Washington, D.C. 118pp.

Chapman, J. A., J. G. Hockman, and M. M. Ojeda C. 1980. *Sylvilagus floridanus.* Mammalian species 136. Am. Soc. of Mammal. 8pp.

Crawford, B. T. 1945. Hedge fences and prairie wildlife. The Mo. Conserv. 6(6): 10–12.

Dalke, P. D. 1942. The cottontail rabbits in Connecticut. Conn. Geol. and Nat. Hist. Survey Bull. 65. 97pp.

Daubenmire, R. 1959. A canopy coverage method of vegetation analysis. Northwest Sci. 33:43–61.

Friley, C. E., Jr. 1955. A study of cottontail habitat preferences on a southern Michigan farming area. Mich. Dep. Conserv. Final Rep. Fed. Aid Proj. No. W-48-R. 38pp.

Haugen, A. O. 1942. Home range of the cottontail rabbit. Ecol. 23:354–367.

Hendrickson, G. O. 1938. Winter food and cover of Mearn's cottontail. Trans. North Am. Wildl. Conf. 3:787–793.

Hill, E. P. 1972. The cottontail rabbit in Alabama. Agric. Exp. Sta./Auburn Univ. Bull. 440. 103pp.

Johnson, D. H. 1980. The comparison of usage and availability measures for evaluating resource preference. Ecol. 6:65–71.

Koeln, G. T. 1980. A computer technique for analyzing radio telemetry data. Pages 262–271 *in* J. M. Sweeney, ed. Proc. of the Fourth Natl. Wildl. Turkey Symp. Ark. Chapter, The Wildl. Soc. 292pp.

Lord, R. D., Jr. 1963. The cottontail rabbit in Illinois. Ill. Dep. Conserv. Tech. Bull. 3. 94pp.

Mohr, C. O. 1947. Table of equivalent populations of North American small mammals. Am. Midl. Nat. 37:223–249.

Neely, R. A. 1966. The influence of saturation stocking and cover manipulation on the cottontail rabbit (*Sylvilagus floridanus*). M.S. Thesis, Va. Polytech. Inst., Blacksburg. 46pp.

Sadler, K. 1980. Of rabbits and habitat: A long term look. Pa. Game News 51(10): 7–11.

SAS Institute, Inc. 1979. SAS user's guide. SAS Institute, Inc., Cary, N.C. 494pp.

Springer, J. T. 1979. Some sources of bias and sampling error in radio triangulation. J. Wildl. Manage. 43:926–935.

Taber, R. D., and I. McT. Cowan. 1971. Capturing and marking wild animals. Pages 277–317 in R. H. Giles, ed. Wildlife management techniques, 3rd ed., Rev. The Wildl. Soc., Washington, D.C. 633pp.

Trent, T. T., and O. J. Rongstad. 1974. Home range and survival of cottontail rabbits in southwestern Wisconsin. J. Wildl. Manage. 38:459–472.

Vance, D. R. 1976. Changes in land use and wildlife populations in southeastern Illinois. Wildl. Soc. Bull. 4:11–15.

Waller, R. A., and D. B. Duncan. 1969. A Bayes rule for the symmetric multiple comparisons problem. J. Am. Stat. Assoc. 64:1484–1503.