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A HANDBOOK FOR TERRESTRIAL HABITAT EVALUATION IN CENTRAL MISSOURI

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FOREWORD

For many years, fishery and wildlife interest groups have recognized the need for sound methods of obtaining information about effects of water resource development projects on fish and wildlife. A major step to satisfy that need was passage of the Fish and Wildlife Coordination Act of 1934 (16 U.S.C. 661-666c; 48 Stat. 401) and an amendment in 1958 (P.L. 85-624; 72 Stat. 563). This Act mandated the Fish and Wildlife Service to represent fish and wildlife interests in water resource project planning. As amended, it further directed the Secretary of Interior to investigate all water resource projects built with Federal funds, and prepare a fish and wildlife report to be included as a part of the project planning document. The Act did not specify, however, how probable effects on fish and wildlife would be reconciled with other elements of the planning document.

By the 1960's, many flood control projects had been completed. As more projects entered the planning phase, groups interested in fish and wildlife actively sought better recognition of, and compensation for, the adverse impacts of these projects on fish and wildlife resources. A first effort to provide a means for the mitigation of wildlife losses was provided in 1962 by Senate Document 97 of the 87th Congress, which incorporated man-day-use estimates to express anticipated effects of the proposed water developments. Biologists felt that man-day-use was inadequate because it was limited in scope, made no provisions for inclusion of nongame wildlife species, and because it dealt with <u>use</u> of the resource, not with the resource itself.

"Principles and Standards for Planning Water and Related Land Resources" developed by the Water Resources Council (1973) paved the way for a new look at water resource planning and its effects on fish and wildlife. "Principles and Standards" provided that both non-monetary and monetary methods be used to display beneficial and adverse impacts and to determine means for mitigation or compensation for fish and wildlife losses.

In 1973 the Fish and Wildlife Service established a task force to develop the non-monetary and monetary systems required by "Principles and Standards." The non-monetary system selected for nationwide use was based on a modification of the procedures developed by the Missouri Department of Conservation and the U.S. Soil Conservation Service (Daniel and Lamaire 1974). The Missouri system was built on the following assumptions: (1) all lands, with or without project development, have some value to wildlife; (2) the expected effects of a water resource project on wildlife habitat can be expressed numerically as units of habitat value (gains or losses); and (3) professional biologists have the expertise to assign suitable numerical values. These assumptions prevailed in the task force's product, entitled "Ecological Planning and Evaluation Procedures" (Joint Federal-State-Private Conservation Organization Committee 1974). The habitat analysis portion was subsequently refined and published separately as "Habitat Evaluation Procedures" (HEP) (U.S. Fish and Wildlife Service 1976). HEP is currently in use by the Service for the evaluation of Federal water projects (Schamberger and Farmer 1978).

Handbooks such as the present one and its predecessor (Flood et al. 1977) were conceived as a means to strengthen the field aspect of the evaluation procedures by providing key habitat evaluation criteria. Many Federal and State wildlife agencies have found these handbooks valuable and endorse their use.

An important objective in the preparation of the present handbook was to provide a prototype for the development of handbooks for other areas. Such handbooks should foster uniformity in scoring by team members, particularly when the team is unfamiliar with the project area. Handbooks may ultimately stimulate uniformity in the scores for projects falling within the same ecoregion.

A Project Impact Evaluation (PIE) Team was established in 1977 by the Fish and Wildlife Service to provide a focal point for the Service's nationwide effort to further refine and implement the HEP. Through thoughtful and professional efforts such as those that produced

this handbook and the activities of the PIE Team, now the Habitat Evaluation Project, the long-sought equality for fish and wildlife concerns in water resource planning will eventually be achieved.

C. Daniel and J.P. Bachant
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INTRODUCTION

In 1977, the Missouri Cooperative Wildlife Research Unit published A Handbook for Habitat Evaluation Procedures as U.S. Fish and Wildlife Service Resource Publication 132 (Flood et al. 1977). Habitat criteria were developed specifically for the Meramec River basin in east-central Missouri, but they applied to a considerable portion of the hardwoods region of the eastern United States. This "Blue Handbook" was offered primarily as a prototype to illustrate criteria that could be adapted for use in many other localities. An excellent example is Bramble and Byrnes (1979). Although the Handbook contained its own habitat scoring scheme, it was not intended as a rival for other scoring systems. Rather, it provided ways to view habitats objectively as a complement to other more subjective schemes, particularly the widely used Habitat Evaluation Procedures adopted by the Fish and Wildlife Service (U.S. Fish and Wildlife Service 1976). We hoped that it could also be used in training programs for habitat evaluation.

As a prototype, the Blue Handbook enjoyed wide demand and distribution. However, when we employed it in detailed field tests of various habitat scoring systems (Ellis et al. 1979), we perceived problems that had not been apparent in the preliminary testing described by Flood (1977) and by Sparrowe and Sparrowe (1978). Because of this, and because we later developed criteria for nongame birds and mammals, we decided to replace the Blue Handbook. This new "Yellow Handbook" follows the format of its predecessor, but it is more than a revision. It is profoundly redesigned, rewritten, and new portions have been added. Specifically, the new handbook differs from the Blue Handbook as follows: (1) the project area includes 11 counties in central Missouri, rather than the Meramec River basin; (2) evaluation elements are individual species instead of combinations of species; (3) evaluation elements now include nongame mammals and birds; (4) evaluation criteria are less subjective in the new handbook; (5) instead of field estimates, use of aerial photographs for certain criteria (e.g., distance to water) is suggested; and (6) habitat types are classifed somewhat differently.

THE AREA

Central Missouri counties included in this handbook are Boone, Callaway, Cole, Cooper, Gasconade, Howard, Maries, Miller, Moniteau, Morgan, and Osage (Fig. 1).

In 6 of the 11 counties, 35-49% of the land area is forested; in 4 counties, 15-34%. Only one, Cooper County, has less than 15% forested land (Spencer and Essex 1976). White oak associations dominate the woodlands, followed by black-red oak and post-black jack oak associations. (Scientific names of plants are listed in Appendix I.)

HABITAT TYPES

The field forms include six habitat types:

(1) The Bottomland Hardwood type has mixed stands of hardwoods, largely silver maple, sycamore, black willow, cottonwood, elms, river birch, and green ash (Lewis 1967). Forests are usually dense and trees are often 30 cm or more dbh (diameter at breast height). Small trees, shrubs, and luxuriant vines are abundant.

(2) The Upland Hardwood type is dominated by white oak on north slopes and ridges (Braun 1950). Associated species are hickories, elms, and persimmon. Sugar maple and red oak associate with white oak on moist slopes. Common understory trees and shrubs include flowering dogwood, eastern redbud, hop hornbeam, and shadbush. Some species of the herbaceous layer in oak-hickory forest include wild oat grass, asters, bush clover, and tick trefoils. The post-black jack oak community is also a component of the Upland Hardwoods. It is commonly found on steep south- and west-facing slopes and on dry sandy ridges.

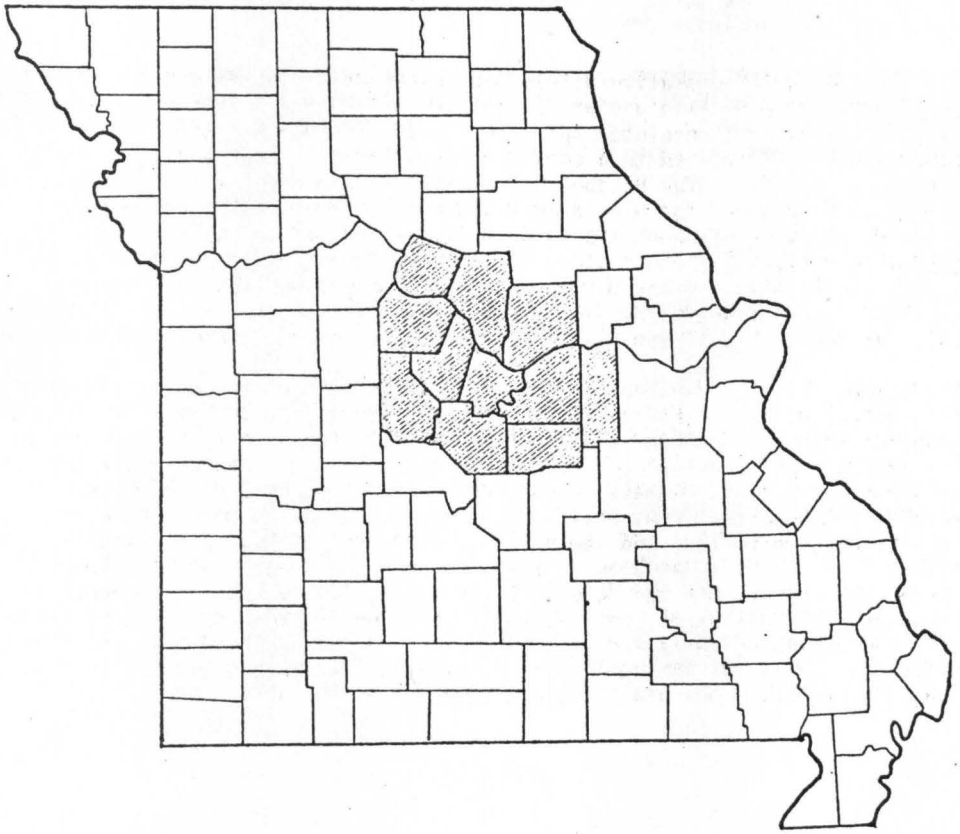

Fig. 1. Map of Missouri showing project area (patterned area).

(3) The Old Field habitat type consists of several seral stages beginning with annuals in recently abandoned cropland and progressing to woody vegetation. Yellow and green foxtail, crab grasses, and common ragweed are among the initial invading annuals (Lewis 1967). Perennials, often broom sedge, gradually become established two or three years after abandonment. Sassafras and persimmon are the dominant woody plants of old fields for as long as 20-30 years following abandonment. Red cedar invades on drier sites. Smooth and dwarf sumac are among the more abundant shrubs found on ungrazed sites (Drew 1942).

(4) The Cropland habitat type includes small grain and row crops. The major crops in the counties of the project are soybeans, winter wheat, grain corn, and grain sorghum (Bay and Nelson 1978).

(5) The Pasture and Hayland type. Hay (including fescues, timothy, red clover, and alfalfa), used both for forage and seed, is the major crop in central Missouri (Bay and Nelson 1978). To produce more cattle forage, farmers have increased deforestation practices and are seeding to domestic species, primarily fescues.

(6) The Grassland type includes grazed or ungrazed grasslands dominated by native warm-season grasses. Dominant plants are big bluestem, Indian grass, little bluestem, switchgrass, prairie dropseed, and sideoats grama. In this handbook, grassland is considered a separate type only for certain nongame birds and the prairie vole. For other wildlife species, the Pasture and Hayland type includes grassland.

On individual field scoring sheets, Old Field, Cropland, and Pasture and Hayland types are combined in various ways, reflecting habitat usage of the wildlife species. For example, Old Field and Pasture and Hayland are shown as one habitat type on the field sheets for the wild turkey, because these types fill similar needs for turkeys.

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Personnel of the Missouri Department of Conservation, U.S. Fish and Wildlife Service, and the University of Missouri-Columbia aided in the development of the handbook through critical review of earlier drafts and field testing. Several wildlife research biologists of the Missouri Department of Conservation were particularly helpful in reviewing sections on individual species. They include K.M. Babcock, D.M. Christisen, J.E. Rathert, C.W. and E.R. Schwartz, J.A. Stanford, and O. Torgerson. Other department biologists named in the species accounts coauthored certain sections of the handbook, as did University of Missouri-Columbia staff members. We acknowledge the reviews of E.K. Fritzell, University of Missouri-Columbia; and E. Multer and F.B. Samson, U.S. Fish and Wildlife Service. R.B. Kahl, Missouri Department of Conservation, M.D. Blenden, M.E. Clawson, K.W. Roberson, G.M. Sheets, and R.M. Skinner, School of Forestry, Fisheries and Wildlife aided in assembling, reviewing, and testing the Handbook. Finally, we acknowledge the expert help of L.J. Korschgen in compiling food lists, and the general guidance of C. Daniel and J.P. Bachant. These men are employees of the Missouri Department of Conservation.

DEFINITION OF TERMS

BROWSE--shoots, twigs, leaves, needles, flowers and buds produced by trees, shrubs, and woody vines.

CANOPY CLOSURE (TREES)--the degree to which foliage and branches of the forest overstory prevent sunlight from reaching the forest floor. (100% closure = complete canopy, no sunlight on forest floor.)

CHARACTERISTICS (OF HABITAT)--attributes of the habitat that may be critical to the survival, perpetuation, and abundance of an animal species (evaluation element).

COVER--vegetation or other shelter providing protection for wildlife from weather or predators.

DBH--tree diameter at breast height (1.35 m).

DRY WASH--gravel-strewn creek bed that contains water only during periods of heavy precipitation.

ECOTONE--see HABITAT EDGE

EVALUATION ELEMENT--a wildlife species for which habitat quality is evaluated.

FORB--a broad-leaved herbaceous plant.

HABITAT EDGE--transition zone between distinctly different habitats having some characteristics of each; or a narrow zone between habitat types with vegetation characteristics markedly different from each.

HABITAT TYPE--a kind of environment possessing specific structural characteristics and plant species composition.

HABITAT UNIT VALUE--a number, on a 1-10 scale, describing the quality of habitat for an evaluation element.

HERBACEOUS PLANTS--annual, biennial, or perennial plants whose exposed parts die down at the end of the growing season (forbs, grasses, and grasslike plants).

HOME RANGE--the area within which an individual animal lives.

INTERSPERSION--the degree to which habitat types are scattered among one another.

LEGUME--any plant of the superfamily Leguminosae (families Papilionacea, Caesalpinaceae, Mimosaceae).

MAST--fruit of oak, hickory, pecan, cherry, ash, and other trees and shrubs.

OPENING (FOREST)--a space in the forest canopy, up to 0.5 ha in size, with less than 10% canopy closure.

OVERGRAZING--reduction in density, height, and vigor of forage plants and an increase in unpalatable plants resulting from the foraging of domestic or wild animals.

OVERMATURE TREE--a tree that has passed maximum growth period and is cavity-prone.

PERMANENT RESIDENT--any animal species that remains in a region throughout the year.

PLANT DIVERSITY--a measure of the variety and abundance of plant species in a habitat type.

SERAL STAGE--a successional stage of plant community development in a particular location.

SINGING PERCH (SONG POST)--any point from which a male songbird sings its primary advertising song.

SOIL TEXTURE (based on Scrivner et al. 1970: 2,7)

SAND--more than 85% sand grains, little silt and clay, gritty, will not stick together when wet, very low capacity for holding moisture.

SANDY LOAM--more than 50% sand grains, but has more fine material than sand, barely holds together when wet, dries rapidly.

LOAM or SILT LOAM--less than 50% sand, less than 30% clay, smooth and velvety when wet.

CLAY LOAM or SILTY CLAY LOAM--27 to 40% clay, less than 45% sand, will press together into a firm ball when wet.

CLAY or SILTY CLAY--more than 40% clay, sticky and plastic when wet, high moisture-holding capacity.

SUCCESSION--the local replacement of plant and animal communities through an orderly progression to a stable state.

SUMMER (BREEDING) RESIDENT--a bird species that breeds in a given region and winters elsewhere.

TERRITORY--any area defended by one or more individual animals against intrusion by others of the same or different species.

TREE SIZE CLASS--a size category for a stand in which 50% or more of the trees fall within specific dbh limits.

INSTRUCTIONS AND INFORMATION

1. After selecting the evaluation elements (species) to be considered on each sample site, read the material in the handbook about life requirements for each species. Familiarize yourself with the field forms, and note special instructions provided in some instances. Foods listed for each species are the more common ones; more detailed information is given in the cited references.

2. Walk through the sample site, noting characteristics mentioned in the handbook. Familiarize yourself with the entire site, not just a portion. Using the field form, note the possible scores that could be given, then score each characteristic.

3. Some of the habitat characteristics listed in the field forms are deemed highly important; these have maximum scores of 10. For less critical characteristics, the maximum score is 5. Scoring ranges for each characteristic are shown on the field sheets.

   If a characteristic is not applicable, enter "NA" on the field form. DO NOT use "NA" simply because the score is very low.

4. Tree size classes based on dbh of overstory trees are evaluated for several wildlife species in forest sites. If no single class composes more than 50% of the overstory trees in a stand, and includes a sawtimber component, the stand is classified as "mixed" (M). As shown on the field forms, the size classes are considered in combination with various degrees of canopy closure when assigning scores.

5. Standard low altitude aerial photographs available from the Agricultural Stabilitization and Conservation Service (ASCS) are suggested for use with this handbook. Information about photographs and order forms are available from County or State ASCS offices. "Index to Missouri Aerial and Space Coverage" (Barney and Johannsen 1976) is also a good source of information.

   Measurements from aerial photographs are required to determine a Habitat Unit Value for most evaluation elements. They include:

   a. Distance to water
   b. Distance to cropland
   c. Distance to other woodlot
   d. Distance to forest
   e. Distance to other habitat type.

   All measurements should be made from the center of the site being evaluated. The accompanying conversion chart (Table 1) is provided as an aid for these calculations.

6. Compute a "Habitat Unit Value." Procedures are specific for each evaluation element in each habitat type and are provided at the end of each set of field forms. Do not use characteristics entered as "NA" in the computations.

7. Nomenclature for mammals follows Jones et al. (1975); for birds, American Ornithologists' Union (1957, 1973, 1976); and for plants, Steyermark (1963).

Table 1. Conversion Chart for Aerial Photographs. (After Avery 1962.)

Representative fraction	m/cm	km/cm	ha/cm^2
1: 1,000	10	0.01	0.01
1: 2,000	20	0.02	0.04
1: 3,000	30	0.03	0.09
1: 4,000	40	0.04	0.16
1: 5,000	50	0.05	0.25
1: 8,000	80	0.08	0.64
1: 10,000	100	0.10	1.00
1: 15,000	150	0.15	2.25
1: 20,000	200	0.20	4.00
1: 25,000	250	0.25	6.25
1: 50,000	500	0.50	25.00
1: 75,000	750	0.75	56.25
1: 100,000	1,000	1.00	100.00
Method of Calculation	R.F.D.[a] / 100	R.F.D.[a] / 100,000	$(m/cm)^2$ / 10,000

[a] Representative fraction denominator

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WILDLIFE SPECIES ACCOUNTS AND SCORING SHEETS

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WHITE-TAILED DEER

(*Odocoileus virginianus*)

by

Michael J. Armbruster and Wayne R. Porath

Life Requirements

General Habitat

White-tailed deer usually inhabit timbered areas, but utilize edges, where the variety of food plants is greater than in dense, uniform timber stands (Schwartz and Schwartz 1959:325). The minimum annual home range in forested habitat in central Missouri averaged about 280 ha (Progulske and Baskett 1958), but is probably somewhat larger in more intensively farmed areas (Zwank 1974). The summer range is rather small and distinct, but winter ranges are generally larger. An interspersion of habitat types supplying both food and cover is required in all seasons (Schwartz and Schwartz 1959: 325; Halls 1978:60).

Summer Range

Before the fawning period in May and June, herds or winter associations break up and pregnant does seek seclusion, usually in the ecotone between forest and open fields (Zwank 1974). Apparently does do not select specific sites to drop their fawns; instead, they use cover encountered during regular daily activity. Fawning sites may include shrubby areas, thickets, heavily vegetated forest edges (Zwank et al. 1979) or even pastures and hayfields. Fawns remain in the vicinity of their birth sites until 3 to 4 weeks old (Schwartz and Schwartz 1959:328), at which time they begin to follow the doe, who makes maximum use of whatever cover is available. Where cover was limited, summer range was restricted to certain mixed bottomland hardwood areas, swampy areas, and small patches of timber and brush (Zwank et al. 1979).

Winter Range

Movement to the winter range begins in mid-September and may be precipitated by the breeding season (Zwank 1974) or the ripening of oak mast (Robb 1951:21). White-tailed deer in central Missouri tend to herd in winter (Zwank 1974), but do not "yard" as in northern States (Hosley 1956:216). Deer spend the daylight hours in thick cover, such as timbered creek bottoms, and feed in grain fields at night. Zwank (1974) thought that wintering areas might be determined more by tradition than by selection of habitats. In forested areas, deer use ridges and hillsides where mast is abundant (Robb 1951). In hilly forest areas, south-facing slopes and bottomlands are often used during severe weather (Hosley 1956:214).

Land Management

Land management practices that affect agricultural crops and timber stands contribute to the quality of white-tailed deer habitat. Most food habit studies indicate that where available, agricultural crops are readily eaten by deer. Where fall plowing is common, crop residues, a potential food source, are removed. Winter wheat is an important fall and winter food, but is usually not eaten after the jointing stage is reached in late spring. Legumes, in grass-legume pastures and hayfields, are also important foods. Unfortunately, when hayfields are first cut,

mowing machines may cause heavy fawn mortality. Overgrazing, especially of woodlands, lowers the quality of deer habitat by removing browse and mast. Modern timber management generally improves deer habitat by opening up extensive stands and releasing browse species (Halls 1978:61). However, excessive removal of bottomland timber and conversion to cropland eliminates critical cover and travel lanes.

Food and Water

The white-tailed deer is a browser, typically taking the tender tips of woody and herbaceous plants, and oak mast where available. Korschgen et al. (1976) ranked spring and summer foods: (1) woody plants, (2) broad-leaved herbaceous plants, and (3) grasses and sedges. Grapes, elms, sumacs, roses, and Virginia creeper were among the more important woody plants; legumes and composites were important herbaceous groups. Grasses are usually taken only in spring (Korschgen 1962) and are not generally used after the inflorescence appears (Dunkeson 1955). Fungi are readily taken when available (Dunkeson 1955). If available, acorn mast is used from September until May. According to Korschgen (1962), no preference for either the black or white oak groups is indicated. (In central Missouri, the black oak group includes red oak, pin oak, Shumard oak, black oak, black jack oak, and shingle oak. The white oak group includes white oak, bur oak, post oak, swamp white oak, and chinquapin oak.) In forested areas, deer use browse species heavily during poor mast years (Dalke 1941; Robb 1951:21; Dunkeson 1955). Pussy's toes is not used in summer, but may be the most commonly eaten green plant in winter (Dunkeson 1955). In agricultural areas where oak mast is limited, crops are important foods (Robb 1951). Corn, clovers, winter wheat, alfalfa, soybeans, sorghums, and almost any truck crop other than onions are readily taken (Hosley 1956:212; Korschgen 1962). Deer use free water when it is available but can go for extended periods without it (Halls 1978:58).

The following list of common plant foods was compiled from Dalke (1941), Robb (1951), Hosley (1956), Korschgen (1962), and Korschgen et al. (1976).

Important Foods of White-tailed Deer

(Listings reflect relative order of importance.)

NOTE: In tallying species of food plants, use lists from all seasons. On field form, base score on range given only for season in which evaluation is made.

Spring	Summer
Grapes	Korean lespedeza
Elms	Grapes
Virginia creeper	Sumacs
Clovers	Virginia creeper
Sumacs	Pokeweed
Lettuces	Lettuces
Cinquefoil	Blackberries
Fungi	Persimmon
Black haw	Roses
White dog-tooth violet	Asters
Greenbriers	Fleabanes
Maples	Fungi
Small-flowered crowfoot	Spurge
Post oak	Three-seeded mercury
Sour dock	Tick trefoils
Roses	Elms
Blue grasses	Greenbriers
Acorns (white oak group)	Coral berry
Acorns (black oak group)	Spotted touch-me-not
Agricultural crops	New Jersey tea
	Crotons
	Agricultural crops

Fall	Winter
Acorns (white oak group)	Acorns (white oak group)
Acorns (black oak group)	Acorns (black oak group)
Coral berry	Coral berry
Sumacs	Sumacs
Korean lespedeza	Pussy's toes
Persimmon	Honey locust
Greenbriers	Grapes
Tick trefoils	Greenbriers
Grapes	Maples
Roses	Roses
Agricultural crops	Hazelnut
	Dogwoods
	Asters
	Goldenrods
	Cedar
	Agricultural crops

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Evaluation Element: WHITE-TAILED DEER

Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE

I. Tree size class and canopy closure — I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1. 1, 2, 3-R; or 3-S; or 3-M 8-10
2. 2-S 7
3. 2-M 6
4. 1-S 5
5. 1-M 4
6. 3-P 3
7. 2-P 2
8. 1-P 1

II. Number of important food plant species comprising more than 1% of total plants present (see NOTE on food list) — II._____

Spring & Summer	Score	Fall & Winter
1. More than 19	8-10	More than 9
2. 10-19	4- 7	5- 9
3. Less than 10	1- 3	Less than 5

III. Plant food availability (stems/m^2, vegetation up to 1.5 m) — III._____

1. More than 29 8-10
2. 10-29 ..... 4- 7
3. Less than 10 ..... 1- 3

IV. Vegetative cover (shrubs and herbs) — IV._____

1. Covers more than 50% of forest floor 8-10
2. Covers 20-50% of forest floor 4- 7
3. Covers less than 20% of forest floor 1- 3

Evaluation Element: WHITE-TAILED DEER | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
V. Frequency, time, and duration of flooding		V._____
1. No flooding or occasional short-term dormant season flooding	4- 5	
2. Frequent short-term dormant season flooding, occasional short-term flooding during growing season, or long-term dormant season flooding	2- 3	
3. Long-term or frequent short-term flooding during the growing season	1	
VI. Habitat edge (width and extent of ecotone)		VI._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 30	5	
2. 15-30	3- 4	
3. 5-14	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	
(NOTE: Add A and B to obtain value for characteristic VI.)		
VII. Openings (less than 10% canopy closure)		VII._____
1. 15-30% of site	4- 5	
2. 5-14% or 31-45% of site	2- 3	
3. Less than 5% or more than 45% of site	1	
To Be Evaluated from Aerial Photographs		
VIII. Distance to cropland (km)		VIII._____
1. Less than 1	4- 5	
2. 1-3	2- 3	
3. More than 3	1	
IX. Distance to other habitat type (km)		IX._____
1. Less than 1	4- 5	
2. 1-3	2- 3	
3. More than 3	1	

Evaluation Element: WHITE-TAILED DEER

Habitat Type: BOTTOMLAND HARDWOOD

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 70

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: WHITE-TAILED DEER Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE

I. Tree size class and canopy closure I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1. 1, 2, 3-R; or 3-S; or 3-M 8-10
2. 2-S 7
3. 2-M 6
4. 1-S 5
5. 1-M 4
6. 3-P 3
7. 2-P 2
8. 1-P 1

II. Number of important food plant species comprising more than 1% of total plants present (see NOTE on food list) II._____

Spring & Summer	Score	Fall & Winter
1. More than 19	8-10	More than 9
2. 10-19	4- 7	5- 9
3. Less than 10	1- 3	Less than 5

III. Plant food availability (stems/m^2, vegetation up to 1.5 m) III._____

1. More than 29 8-10
2. 10-29 ..... 4- 7
3. Less than 10 ..... 1- 3

IV. Vegetative cover (shrubs and herbs) IV._____

1. Covers more than 50% of forest floor 8-10
2. Covers 20-50% of forest floor 4- 7
3. Covers less than 20% of forest floor 1- 3

Evaluation Element: WHITE-TAILED DEER | Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
V. Habitat edge (width and extent of ecotone)		V._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 30	5	
2. 15-30	3- 4	
3. 5-14	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	
(NOTE: Add A and B to obtain value for characteristic V.)		
VI. Openings (less than 10% canopy closure)		VI._____
1. 15-30% of site	4- 5	
2. 5-14% or 31-45% of site	2- 3	
3. Less than 5% or more than 45% of site	1	
To Be Evaluated from Aerial Photographs		
VII. Distance to cropland (km)		VII._____
1. Less than 1	4- 5	
2. 1-3	2- 3	
3. More than 3	1	
VIII. Distance to other habitat type (km)		VIII._____
1. Less than 1	4- 5	
2. 1-3	2- 3	
3. More than 3	1	
IX. Distance to permanent water (km)		IX._____
1. Less than 1	5	
2. 1-3	3- 4	
3. More than 3	1- 2	

Evaluation Element: WHITE-TAILED DEER Habitat Type: UPLAND HARDWOOD

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 70

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: WHITE-TAILED DEER Habitat Type: OLD FIELD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE

I. Number of important food plant species comprising more than 1% of total plants present (see NOTE on food list) I._____

Spring & Summer	Score	Fall & Winter
1. More than 19	8-10	More than 9
2. 10-19	4- 7	5- 9
3. Less than 10	1- 3	Less than 5

II. Plant food availability (stems/m^2, vegetation up to 1.5 m) II._____

1. More than 29 8-10
2. 10-29 ..... 4- 7
3. Less than 10 ..... 1- 3

III. Habitat edge (width and extent of ecotone) III._____

A. Average width (m) of habitat edge (see "Definition of Terms") A._____

1. More than 30 5
2. 15-30 ..... 3- 4
3. 5-14 2
4. Less than 5 1

B. Habitat edge (identifiable ecotone) surrounds: B._____

1. Entire site evaluated 5
2. 3/4 of site 3- 4
3. 1/2 of site 2- 3
4. 1/4 of site 1- 2
5. Less than 1/4 of site 1

(NOTE: Add A and B to obtain value for characteristic III.)

To Be Evaluated from Aerial Photographs

IV. Distance to cropland (km) IV._____

1. Less than 1 ..... 4- 5
2. 1-3 ..... 2- 3
3. More than 3 1

V. Distance to forest (km) V._____

1. Less than 1 ..... 4- 5
2. 1-3 ..... 2- 3
3. More than 3 1

Evaluation Element: WHITE-TAILED DEER Habitat Type: OLD FIELD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
VI. Distance to permanent water (km)		VI._____
1. Less than 1	4- 5	
2. 1-3	2- 3	
3. More than 3	1	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 45

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: WHITE-TAILED DEER | Habitat Type: CROPLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
To Be Determined from Landowner or Operator		
I. Land Management		I._____
1. Year-round cropping or no fall plowing or discing	8-10	
2. Chisel plowing or discing in fall	4- 7	
3. Fall moldboard plowing	1- 3	
II. Cropping practices		II._____
1. Cropped annually or with occasional one-year lapses; little or no herbicide application	5	
2. Usually cropped annually but with lapses of two or more consecutive years; little herbicide application	3- 4	
3. Usually cropped annually; heavy herbicide application	1- 2	
To Be Evaluated in Field		
III. Habitat edge (width and extent of ecotone)		III._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 30	5	
2. 15-30	3- 4	
3. 5-14	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	

(NOTE: Add A and B to obtain value for characteristic III.)

Evaluation Element: WHITE-TAILED DEER Habitat Type: CROPLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
To Be Evaluated from Aerial Photographs		
IV. Distance to other habitat type (km)		IV._____
1. Less than 1	4- 5	
2. 1-3	2- 3	
3. More than 3	1	
V. Distance to permanent water (km)		V._____
1. Less than 1	4- 5	
2. 1-3	2- 3	
3. More than 3	1	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 35

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: WHITE-TAILED DEER | Habitat Type: PASTURE & HAYLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Composition of pasture or hayland		I._____
1. More than 75% legumes	8-10	
2. 25-75% legumes	4- 7	
3. Less than 25% legumes	1- 3	
II. Habitat edge (width and extent of ecotone)		II._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 30	5	
2. 15-30	3- 4	
3. 5-14	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	
(NOTE: Add A and B to obtain value for characteristic II.)		
III. Grazing pressure (effects of grazing on understory or ground vegetation)		III._____
1. None or light during growing season only	4- 5	
2. Heavy during growing season only	2- 3	
3. Heavy throughout the year	1	
To Be Evaluated from Aerial Photographs		
IV. Distance to cropland (km)		IV._____
1. Less than 1	4- 5	
2. 1-3	2- 3	
3. More than 3	1	
V. Distance to forest (km)		V._____
1. Less than 1	4- 5	
2. 1-3	2- 3	
3. More than 3	1	

Evaluation Element: WHITE-TAILED DEER Habitat Type: PASTURE & HAYLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
VI. Distance to permanent water (km)		VI._____
1. Less than 1	4- 5	
2. 1-3	2- 3	
3. More than 3	1	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 40

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

EASTERN WILD TURKEY

(*Meleagris gallopavo silvestris*)

by

Michael J. Armbruster and John B. Lewis

Life Requirements

General Habitat

The eastern wild turkey prefers open mature forests (Markley 1967:215); however, openings in the forms of clearings, pastures, and fields are a necessary part of the year-round habitat requirements (Lewis 1967:395). Missouri habitats, especially forest types, are so intermingled within a given area that the daily range of a single flock may include most of these habitat types (Lewis 1967:376).

Turkeys are a highly mobile species with annual ranges exceeding 405 ha (Ellis and Lewis 1967). Mobility permits the use of different habitats to meet seasonal needs. Spring and summer ranges are used from late March or early April into November (Ellis and Lewis 1967), and are generally concentrated around open areas. During winter, turkeys range over a larger area, their movements dictated by food supply.

Summer Range

Pastures, old fields, and forest openings are used heavily for nesting and feeding during spring and summer. In southern Missouri Dalke et al. (1946:46) found nests in abandoned fields, grazed pastures, grassy glades, hayfields, and in all timber age classes except dense reproduction. Nests were always in or near some kind of opening. Hens move their broods to fields shortly after hatching (Korschgen 1967:143), and remain closely associated with pastures or the ecotone between pasture and forest (Hillestad and Speake 1970). The primary attraction of openings is abundant grasses and insects for food.

Most workers agree on the importance of openings in a forested area, but the amount required by wild turkeys is difficult to specify. Estimates range from a minimum of 5% (Dellinger 1973:237) to an "optimum" of 30% (Markley 1967:219). However, good populations can be maintained on areas with as little as 50% forest cover if habitat types are well interspersed and supplemental food sources are available during mast failures (Ellis and Lewis 1967). It appears that interspersion and quality of habitat types are more important than the proportion of forest lands made up of openings.

Lewis (1964) thought that turkeys in Tennessee preferred fields ranging in size from 4 to 8 ha. Even smaller fields, when closely associated, were adequate. The centers of large fields (12 to 24 ha) were not used unless a corridor of timber entered the field. Ellis and Lewis (1967) also noted the importance of timbered corridors.

Winter Range

The winter range of the eastern wild turkey is determined by food availability (Dalke et al. 1946:25; Ellis and Lewis 1967).

Acorn mast is a major natural winter food, and Dellinger (1973:238) recommended that at least 45% of the forest be producing mast. Christisen and Korschgen (1955) emphasized the

importance of maintaining a variety of oak species so that complete failures of acorn crops will be unlikely. They also noted that the black oak group should be included in the variety. "Acorns from these oaks do not germinate until spring, and therefore are available to wildlife throughout the winter when other foods are scarce" (Christisen and Korschgen 1955:353). Bottomland hardwoods and the adjacent slopes are often an important component of winter turkey range (Lewis 1963, 1964). In late frost years, ridge tops may be the only areas producing mast (Lewis 1967:375). As mast supplies decline in late winter, turkeys rely more on grain fields (Dalke et al. 1946:25). Ellis and Lewis (1967) observed that the winter range of three different turkey flocks overlapped in one bottomland cornfield.

Land Management

Certain land management practices affect the quality of various habitat types used by wild turkeys and should be considered in evaluations for this species. To remain attractive, openings should be grazed, mowed, burned, or otherwise managed (Dellinger 1973:237) or they will pass into seral stages such as broom sedge, which are unattractive to turkeys (Lewis 1967:377). Turkeys were observed in Michigan using fields with heavy grass cover much more frequently than fields with dense woody vegetation such as sumac, sassafras, and blackberry (Lewis 1964). Poults have difficulty moving through dense vegetation. In Alabama, hens nested outside a grazed study area, but fed and loafed primarily in pastures and woods which were grazed (Hillestad and Speake 1970). Controlled grazing assists in maintaining close cropped pasture vegetation which facilitates poult movement and stimulates new plant growth. This new plant growth is favored by insects and also supplies high quality forage for poults (Hillestad and Speake 1970). Moderate grazing of forests may benefit turkeys by opening up the understory and creating favorable feeding conditions (Korschgen 1967:147). Overgrazing of woodlands lowers the quality of turkey habitat by removal of fallen mast, and reduction or elimination of native legumes and other important plant foods (Holbrook and Lewis 1967:359). Hens and poults respond favorably to pasture mowing (Hillestad and Speake 1970), but if done before the peak hatch period (20 May-10 June in southern Missouri; Dalke et al. 1946:49), such mowing removes potential nesting habitat and destroys existing nests. Extensive burning suppresses desirable perennial ground cover (Dalke et al. 1946:16), but controlled burning in early spring may enhance production of some food species (Lewis et al. 1964).

Agricultural crops, though generally less important to turkeys because of their habitat preferences (Korschgen 1967:153), supply valuable supplemental foods during critical periods. Corn is commonly eaten but its availability is dependent upon cultivation practices. Fall plowing, a common practice in central Missouri, removes this valuable food source. Winter wheat is important in late winter when other green plants are not available.

Food and Water

Turkeys are opportunists (Bailey and Rinell 1967:87) and their diet closely reflects the seasonal availability of various plant and animal foods (Dalke et al. 1942). Principal foods can be broadly categorized as mast, seeds and green material of herbaceous plants, and animal foods.

Acorns were the most important single food item in a Missouri study; they were eaten in every month of the year (Korschgen 1967:157). Amounts ranged from a trace in July to 73.3% in January, and made up more than 68% of the diet each month from November through March. Acorns used by turkeys include those from black, black jack, red, post, white, and pin oak (Dalke et al. 1942). In poor mast years turkeys seek alternate foods such as winter wheat and waste corn. The green leaves and seeds of many native and introduced grasses are important foods. Grass leaves are heavily used in winter and spring, but the principal use of grasses coincides with seed maturity in summer and early fall. Korschgen (1967:161) found that grasses averaged 25.8% of all foods year-round, with blue grasses and crab grasses among the most heavily used. Corn may be consumed every month of the year, but like native foods, its importance is dependent upon availability. When available, winter wheat is an important source of succulent green food during the critical late winter and early spring months (Lewis 1967:394).

Animal foods are taken throughout the year; utilization reflects availability. Dalke et al. (1942) found that beetles, grasshoppers, and ants comprised nearly four-fifths of all animal foods. The greatest consumption of insects (more than 30% of the diet) occurred in April, June, and October. Insects are extremely important to the hen during egg laying and to the growing poults (Korschgen 1967:143).

Well-distributed sources of permanent water are essential for good turkey habitat (Dalke et al. 1946:55). Wild turkeys require a minimum of one source of permanent water per 259 ha (Dellinger 1973:237). Permanent water located near clearings enhances habitat quality (Lewis 1967:395).

The following food lists were compiled from Dalke et al. (1942), Schorger (1966), Korschgen (1967, 1973), and Murphy and Crawford (1970). No attempt was made to list all foods; instead, only those most commonly occurring in central Missouri are included.

Most information about wild turkey food habits in Missouri pertains to forested portions of the Ozarks and the food lists reflect this. However, agricultural crops can be important, and where crops are available, extra credit should be given on scoring sheets when judgments are made about preferred food species.

Important Foods of Eastern Wild Turkey

(Listings reflect relative order of importance.)

NOTE: In tallying species of food plants, use lists from all seasons. On field form, base score on range given only for season in which evaluation is made.

Spring	Summer
Acorns	Native grasses
Native grasses[a]	Sheep sorrel
Dogwoods	Sedges
Sumacs (fragrant and dwarf)	Buttercups
Buttercups	Strawberry
Sedges	Blackberries, dewberry, raspberries
Yellow nut grass	Crotons
Grapes	Smartweeds
Cherries	Bedstraws
Hackberry	Wild beans
Dandelion	Cherries
Wild geranium	Grapes
Crotons	Acorns
Wood sorrel	Agricultural crops
Agricultural crops[b]	

[a] As available: the leaves, seeds and spikelets of blue grasses, bluestems, crab grasses, dropseeds, foxtails, love grasses, muhly grasses, paspalums, wild oat grass, purpletop, barnyard grass, wild ryes, panic grasses, and others.

[b] Corn, sorghums, soybean, wheat, oats, clovers, lespedezas, and others.

Fall	Winter
Acorns	Acorns
Native grasses	Native grasses
Tick trefoils	Grapes
Ragweeds	Dogwoods
Goldenrods	Cherries
Sunflowers	Sumacs (including poison ivy)
Poison ivy	Roses
Wild beans	Korean lespedeza
Crotons	Tick trefoils
Sheep sorrel	Crotons
Grapes	Hawthorns
Cherries	Hackberry
Agricultural crops	Hop hornbean
	Agricultural crops

Animal Foods

Short-horned grasshoppers
Ground beetles
Walking sticks
Stink bugs
Weevils
Scavenger beetles
Ants
Horned beetles
Ichneumon wasps
Flies
Leaf beetles
Snails
Millipedes
Centipedes
Plant galls

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Evaluation Element: EASTERN WILD TURKEY | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Tree size class and canopy closure		I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1. 2-S 9-10
2. 3-S 8- 9
3. 1-S; or 2-M 7- 8
4. 3-M; or 3-P 6- 7
5. 1-M; or 2-P 5- 6
6. 1-P 4- 5
7. 2-R 3- 4
8. 3-R 2- 3
9. 1-R 1- 2

(NOTE: Assign the higher score if percent canopy closure is near the lower limit of the appropriate range.)

II. Tree species II._____

(NOTE: Score Part A or B, but not both.)

A. Predominant forest tree species (alluvial bottoms) A._____

1. More than 80% pin oak or mixture of pin oak, swamp white oak, pecan, green ash 8-10
2. 50-80% of above mixture; balance of silver maple, elms, cottonwood, sycamore, or other 3- 7
3. More than 80% silver maple, elms, cottonwood, sycamore, or other 1- 2

B. Predominant forest tree species (narrow drainages) B._____

1. More than 80% chinquapin oak, white oak 8-10
2. 50-80% chinquapin oak, white oak; balance silver maple, elms, cottonwood, sycamore, or other 3- 7
3. More than 80% silver maple, elms, cottonwood, sycamore, or other 1- 2

Evaluation Element: EASTERN WILD TURKEY | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
III. Number of important food plant species comprising more than 1% of total plants present (see NOTE on "Food List")		III._____

Spring & Summer	Score	Fall & Winter
1. More than 9	8-10	More than 4
2. 5-9	4- 7	3- 4
3. Less than 5	1- 3	Less than 3

IV. Vegetative cover provided by major food species (grasses, sedges, grapes, sumacs, ferns, roses, collectively or separately)		IV._____
1. Covers more than 50% of forest floor	8-10	
2. Covers 20-50% of forest floor	4- 7	
3. Covers less than 20% of forest floor	1- 3	
V. Habitat edge (width and extent of ecotone)		V._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 30	5	
2. 15-30	3- 4	
3. 5-14	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	

(NOTE: Add A and B to obtain value for characteristic V.)

VI. Grazing pressure (effects of grazing on understory or ground vegetation)		VI._____
1. None or light during growing season	3- 5	
2. Heavy during growing season	1- 2	

Evaluation Element: EASTERN WILD TURKEY | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
VII. Frequency, time, and duration of flooding		VII._____
1. No flooding, or occasional short-term, dormant-season flooding	4- 5	
2. Frequent short-term dormant-season flooding, occasional short-term flooding during growing season or long-term dormant-season flooding	2- 3	
3. Long-term or frequent short-term flooding during growing season	1	
VIII. Openings (less than 10% canopy closure)		VIII._____
1. 10-30% of site	4- 5	
2. 3-9% or 31-45% of site	2- 3	
3. Less than 3% or more than 45% of site	1	
To Be Evaluated from Aerial Photographs		
IX. Distance to cropland (km)		IX._____
1. Less than 0.5	5	
2. 0.5-1.0	3- 4	
3. More than 1.0	1- 2	
X. Distance to old field, pasture, or hayland (km)		X._____
1. Less than 0.5	5	
2. 0.5-1.0	3- 4	
3. More than 1.0	1- 2	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 75

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: EASTERN WILD TURKEY

Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE

I. Tree size class and canopy closure I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1. 2-S 9-10
2. 3-S 8- 9
3. 1-S; or 2-M 7- 8
4. 3-M; or 3-P 6- 7
5. 1-M; or 2-P 5- 6
6. 1-P 4- 5
7. 2-R 3- 4
8. 3-R 2- 3
9. 1-R 1- 2

(NOTE: Assign the higher score if percent canopy closure is near the lower limit of the appropriate range.)

II. Dominant tree species II._____

1. 20-40% white oak; 80-60% black oak group + post oak 8-10
2. 41-75% white oak; 59-25% black oak group + post oak 5- 7
3. 81-100% black oak group + post oak 2- 4
4. 76-100% white oak 1- 2
5. Other tree species dominant 1

III. Number of important food plant species comprising more than 1% of total plants present (see NOTE on "Food List") III._____

Spring & Summer	Score	Fall & Winter
1. More than 9	8-10	More than 4
2. 5-9	4- 7	3- 4
3. Less than 5	1- 3	Less than 3

Evaluation Element: EASTERN WILD TURKEY Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
IV. Vegetative cover provided by major food species (grasses, sedges, grapes, sumacs, ferns, roses, collectively or separately)		IV._____
1. Covers more than 50% of forest floor	8-10	
2. Covers 20-50% of forest floor	4- 7	
3. Covers less than 20% of forest floor	1- 3	
V. Habitat edge (width and extent of ecotone)		V._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 30	5	
2. 15-30	3- 4	
3. 5-14	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	
(NOTE: Add A and B to obtain value for characteristic V.)		
VI. Grazing pressure (effects of grazing on understory or ground vegetation)		VI._____
1. None or light during growing season	3- 5	
2. Heavy during growing season	1- 2	
VII. Openings (less than 10% canopy closure)		VII._____
1. 10-30% of site	4- 5	
2. 3- 9% or 31-45% of site	2- 3	
3. Less than 3% or more than 45% of site	1	
To Be Evaluated from Aerial Photographs		
VIII. Distance to cropland (km)		VIII._____
1. Less than 0.5	8-10	
2. 0.5-1.0	4- 7	
3. More than 1.0	1- 3	

Evaluation Element: EASTERN WILD TURKEY | Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
IX. Distance to permanent water (km)		IX._____
1. Less than 0.5	5	
2. 0.5-1.0	3- 4	
3. More than 1.0	1- 2	
X. Distance to old field, pasture, or hayland (km)		X._____
1. Less than 0.5	5	
2. 0.5-1.0	3- 4	
3. More than 1.0	1- 2	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 80

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: EASTERN WILD TURKEY Habitat Type: OLD FIELD & PASTURE & HAYLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Number of important food plant species comprising more than 1% of total plants present (see NOTE on "Food List")		I._____

Spring & Summer	Score	Fall & Winter
1. More than 14	8-10	More than 7
2. 8-14	4- 7	4- 7
3. Less than 8	1- 3	Less than 4

II. Habitat edge (width and extent of ecotone)		II._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 30	5	
2. 15-30	3- 4	
3. 5-14	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	

(NOTE: Add A and B to obtain value for characteristic II.)

III. Nesting cover		III._____
1. 10-15% woody, forbs and grasses abundant	4- 5	
2. 5- 9% woody, forbs and grasses abundant	2- 3	
3. Less than 5% or more than 15% woody; or dense grass stand	1	
IV. Grazing pressure (effects of grazing on shrubs and ground vegetation)		IV._____
1. None or light during growing season	3- 5	
2. Heavy during growing season	1- 2	

Evaluation Element: EASTERN WILD TURKEY Habitat Type: OLD FIELD & PASTURE & HAYLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
To Be Evaluated from Aerial Photographs		
V. Distance to permanent water (km)		V._____
1. Less than 0.5	5	
2. 0.5-1.0	3- 4	
3. More than 1.0	1- 2	
VI. Distance to forest (km)		VI._____
1. Less than 0.5	8-10	
2. 0.5-1.0	4- 7	
3. More than 1.0	1- 3	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 45

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: EASTERN WILD TURKEY | Habitat Type: CROPLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
To be Determined from Landowner or Operator		
I. Land management		I._____
1. Year-round cropping or no fall plowing or discing	8-10	
2. Chisel plowing or discing in fall	4- 7	
3. Fall moldboard plowing	1- 3	
II. Cropping practices		II._____
1. Cropped annually or with occasional one-year lapses; little or no herbicide application	5	
2. Usually cropped annually but with lapses of two or more consecutive years; little herbicide application	3- 4	
3. Usually cropped annually; heavy herbicide application	1- 2	
To Be Evaluated in Field		
III. Habitat edge (width and extent of ecotone)		III._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 30	5	
2. 15-30	3- 4	
3. 5-14	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	

(NOTE: Add A and B to obtain value for characteristic III.)

Evaluation Element: EASTERN WILD TURKEY | Habitat Type: CROPLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
To Be Evaluated from Aerial Photographs		
IV. Distance to permanent water (km)		IV._____
1. Less than 0.5	5	
2. 0.5-1.0	3- 4	
3. More than 1.0	1- 2	
V. Distance to forest (km)		V._____
1. Less than 0.5	8-10	
2. 0.5-1.0	4- 7	
3. More than 1.0	1- 3	
VI. Distance to old field, pasture, and hayland (km)		VI._____
1. Less than 0.5	5	
2. 0.5-1.0	3- 4	
3. More than 1.0	1- 2	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 45

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

FOX SQUIRREL

(*Sciurus niger*)

by

Diana L. Hallett

Life Requirements

General Habitat

Mixed hardwood forests, principally oaks and hickories, are primary habitat for both fox squirrels and Eastern gray squirrels (*Sciurus carolinensis*) in Missouri. Gray squirrels usually predominate in or near lowlands, and fox squirrels along ridges (Schwartz and Schwartz 1959:145). In Illinois forests, small openings, particularly those in early successional stages, are advantageous to fox squirrels because they provide alternate cover and food resources (Brown and Yeager 1945:520).

In prairie areas, fox squirrels utilize Osage orange hedges, timbered fencerows, small wooded bottoms, and farm woodlots (Brown and Yeager 1945:490; Schwartz and Schwartz 1959:145). In Indiana, Allen (1954:52) noted that openings of forests and interspersion of crops aided the spreading of fox squirrels into parts of the State where they were unknown in primitive time; with planting of hedges and windbreaks, this pattern was repeated elsewhere (reviewed by Madson 1964:8-9).

Cover

Squirrels utilize leaf nests as well as tree cavities for shelter, but when available, cavities may be used more in winter and for nurseries (Schwartz and Schwartz 1959:146). Suitable cavity trees in Missouri include white oak, sugar maple, American elm, chinquapin oak, basswood, and sycamore (Terrill 1941:115). Oaks were the most important den-tree group in Illinois, and four or five usable cavities per 0.4 ha were ample for a permanent squirrel population there (Brown and Yeager 1945:513). In Ohio, nests were usually 9 to 12 m above the ground (Baumgartner 1943).

Reproduction

Squirrels may have litters in every month of the year; however, peak reproductive activity occurs around late December, and late May to early July (Schwartz and Schwartz 1959:140). Usually two litters are produced annually. The young are weaned when about 8 or 10 weeks old at which time they forage.

Food and Water

"The primary factor influencing the size of our annual squirrel crops in Missouri seems to be the abundance of acorns in the fall immediately preceding squirrel production" (Christisen and Korschgen 1955:350). Squirrel populations in southeastern Ohio also fluctuated mainly in response to the mast crop of the preceding fall (Nixon et al. 1975). Uneven-age timber stands are the best consistent food producers for squirrels (Burns et al. 1954). However, fox squirrels are not dependent on natural food production in areas where approximately 40% of the land is farmed (D.M. Christisen, personal communication). Fox squirrels utilize farm crops when native foods are limited. Corn is of outstanding importance and field crops adjoining wood lots or other timbered area are used most often (Brown and Yeager 1945:507).

In a 3-year study in Missouri, Korschgen (1979) found that flowers and seeds or nuts of hardwoods, especially elms, hickories, oaks, and maples were consumed by adult squirrels in late winter and spring. During both of these seasons, black walnuts were eaten most often and in greater amounts than all other individual foods, followed closely by Osage orange seeds and corn grain throughout winter. In summer, shagbark hickory nuts made up the main bulk of the diet, followed in importance by nuts of other hardwoods, mulberries, and fungi. White oak acorns were most important in fall (Korschgen 1979), and Short (1976) thought they were usually preferred over other acorns.

Fox squirrels will inhabit areas lacking water; however, water is often an attractive feature of squirrel habitat (Allen 1943:180; Allen 1954:54). Some evidence is available that succulent fruits serve as water sources for Illinois fox squirrels (Brown and Yeager 1945:510). Terrill (1941:97) found that hot, dry weather concentrated both gray and fox squirrels around open water sources.

The list of important foods, which follows, is based on Korschgen's (1979) study. Foods are listed in descending order of aggregate volume.

Important Foods of Fox Squirrel

(Listings reflect relative order of importance.)

Shagbark hickory
Black walnut
Pecan
White oak
Black oak
Corn
Osage orange
Pin oak
American elm
Red mulberry
Fungi
Silver maple
Post oak
Red oak
River-bank grape
Big shellbark hickory
Bitternut hickory
Chinquapin oak

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Evaluation Element: FOX SQUIRREL

Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Tree size class and canopy closure		I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1.	3-S; or 2-S; or overmature trees	10
2.	1-S; or 2-M	8- 9
3.	3-M	6- 7
4.	1-M	3- 5
5.	3-P; or 2-P; or 2-R	2
6.	3-R; or 1-P; or 1-R	1

II. Number of important food plant species comprising more than 1% of total plants present — II._____

1.	More than 9	8-10
2.	5-9	4- 7
3.	Less than 5	1- 3

III. Number of tree cavities per 0.5 ha — III._____

1.	More than 3	6-10
2.	2-3	3- 5
3.	Less than 2	1- 2

IV. Vegetative cover (shrubs and herbs) — IV._____

1.	Covers 20-50% of the forest floor	8-10
2.	Covers 5-19% of the forest floor	4- 7
3.	Covers less than 5% or more than 50% of the forest floor	1- 3

Evaluation Element: FOX SQUIRREL | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
V. Frequency, duration, and seasons of flooding		V._____
1. No flooding, or occasional short-term flooding during late winter and early spring	5	
2. Occasional long-term flooding during late summer and fall	3- 4	
3. Frequent long-term flooding during late summer and fall	1- 2	

To Be Evaluated from Aerial Photographs

VI. Distance to cropland (km)		VI._____
1. Less than 0.2	4- 5	
2. 0.2-0.4	2- 3	
3. More than 0.4	1	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 50

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: FOX SQUIRREL

Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Tree size class and canopy closure		I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)
	No Size Class Predominant in Overstory
	M=mixed (must include sawtimber component)

1.	3-S; or 2-S; or overmature trees	10
2.	1-S; or 2-M	8- 9
3.	3-M	6- 7
4.	1-M	3- 5
5.	3-P; or 2-P; or 2-R	2
6.	3-R; or 1-P; or 1-R	1

II. Number of important food plant species comprising more than 1% of total plants present — II._____

1.	More than 9	8-10
2.	5-9	4- 7
3.	Less than 5	1- 3

III. Number of tree cavities per 0.5 ha — III._____

1.	More than 3	6-10
2.	2-3	3- 5
3.	Less than 2	1- 2

IV. Vegetative cover (shrubs and herbs) — IV._____

1.	Covers 20-50% of the forest floor	8-10
2.	Covers 5-19% of the forest floor	4- 7
3.	Covers less than 5% or more than 50% of the forest floor	1- 3

Evaluation Element: FOX SQUIRREL

Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
To Be Evaluated from Aerial Photographs		
V. Distance to cropland (km)		V._____
1. Less than 0.2	4- 5	
2. 0.2-0.4	2- 3	
3. More than 0.4	1	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 45

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

WHITE-FOOTED MOUSE

(*Peromyscus leucopus*)

by

Deretha A. Darrow and Diana L. Hallett

Life Requirements

General Habitat

The white-footed mouse is the ubiquitous small mammal of woodlots and woody fencerows (Beckwith 1954; Getz 1961). In much of Missouri, this mouse prefers woods, brushy or weedy borders, and fencerows (Schwartz and Schwartz 1959:187). In southwestern Missouri white-footed mice are abundant on cedar glades if brush mice (*P. boylii*) are absent (Brown 1964a).

White-footed mice are often associated with upland forests. In southern Michigan, Burt (1940) found them inhabiting oak-hickory forests with forb ground cover; in central New York, they prefer warm, dry, deciduous forests with plants typical of the climax oak forest (Klein 1960). However, they are not confined to such locations. In Maryland, Stickel (1948) caught 2.5 to 8 times as many white-footed mice in bottomland hardwoods as in upland forests.

P. leucopus seem to be attracted to habitat edge. They frequent the area between floodplains and bluffs in Tennessee (Calhoun 1941). Nicholson (1941) captured twice as many near the forest edge as in the interior. The attraction to edges may relate to character of the vegetation there (Jackson 1952; Stickel and Warbach 1960). In the latter study, preferred woodlot edges had denser undergrowth and more deciduous trees than did the interior.

Cover

Cover often affects local distribution of *P. leucopus*. Important cover includes debris, fallen trees, decaying logs, and brush piles (Ruffer 1961; review by Stickel 1968).

Mice build runways and nests about roots of trees, beneath logs or in tunnels no longer occupied by other small mammals. White-footed mice construct two types of nests: (1) leaf litter nests to raise young and (2) feeding platforms above ground. *P. leucopus* use and maintain several different refuges in their home range and frequently shift from one to another (Stickel 1968).

Home Range

The size of the home range of *P. leucopus* is a function of food supply (Stickel 1968). White-footed mice have a smaller home range in fall during the period of food abundance than in spring. In Missouri, adult *P. maniculatus*, a species with similar habits, spend their entire lives in localities 0.2-0.6 ha in size (Schwartz and Schwartz 1959:183). Will (1962) reported the home range of *P. leucopus* to be between 70 and 74 m in diameter in upland deciduous forests of Illinois. In bottomland hardwoods of Ohio *P. leucopus* traveled within 0.08 ha (Ruffer 1961).

Flooding

Some *P. leucopus* habitat is subject to flooding. Flash floods or small-scale annual floods have little effect on population of this species. The animals tend to remain within

their established home ranges, using peripheral portions or islands of vegetation within them (Stickel 1948; Yeager 1949; Ruffer 1961).

Food

Seed and fruit production by preferred food plants are important factors affecting the abundance and population fluctuation of *Peromyscus* spp. (Jameson 1955). In a controlled experiment, food supply regulated the abundance of *P. leucopus* by affecting death rate and possibly birth rate (Bendell 1959). Preferred foods of *P. leucopus* and *P. maniculatus* in Missouri include wild seeds, nuts, domestic grains, insects, fruits, and some leafy vegetation. Occasional foods are fungi, snails, spiders, and dead mice (Schwartz and Schwartz 1959:184). Seeds and nuts are stored in fall. *P. leucopus* studied by Drickamer (1970) ate corn, sunflower seeds, and multiflora rose seeds in large quantities. Minor food items included elm and maple seeds.

Reproduction

Spring (February-April) and fall (September-November) are principal breeding periods of *Peromyscus* in Missouri (Schwartz & Schwartz 1959:184; Brown 1964b). Brown believed that a lack of free water in oak-hickory forests inhibited summer reproduction.

Important Foods of White-Footed Mouse

NOTE: In tallying species of food plants, use lists from all seasons. On field form, base score on range given only for season in which evaluation is made.

Spring & Summer

Poison ivy
Spotted touch-me-not
Milk purslane
Wheat
Bluestems
Brome grasses

Fall & Winter

Hickories
Pecan
Acorns
Multiflora rose
Sunflowers
Elms
Silver maple
Little bluestem
Panic grasses
Blue grasses
Oats
Wheat
Tick trefoils
Fescues

Animal Foods

Ground beetles
Japanese beetles
Wood cockroach
Dung beetles
Millipedes
Snails
Butterfly pupae

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Evaluation Element: WHITE-FOOTED MOUSE Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE

I. Tree size class and canopy closure I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1. 2-M; or 3-M 9-10
2. 2-S; or 3-S; or overmature trees 7- 8
3. 1-M; or 1-S 6
4. 3-P; or 2-P 5
5. 1-P; or 1-R 3- 4
6. 3-R; or 2-R 1- 2

II. Vegetative cover (shrubs and herbs) II._____

1. Covers more than 50% of forest floor 8-10
2. Covers 20-50% of forest floor 4- 7
3. Covers less than 20% of forest floor 1- 3

III. Debris: fallen trees, decaying logs, brushpiles (number per 0.5 ha) III._____

1. More than 14 8-10
2. 6-14 ..... 4- 7
3. Less than 6 ..... 1- 3

IV. Number of important food plant species comprising more than 1% of total plants present (see NOTE on "Food List") IV._____

Spring & Summer	Score	Fall & Winter
1. More than 7	4-5	..... More than 3
2. 5-7	2-3	..... 2- 3
3. Less than 5	1	..... Less than 2

Evaluation Element: WHITE-FOOTED MOUSE

Habitat Type: **UPLAND HARDWOOD**

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
To Be Evaluated from Aerial Photographs		
V. Distance to cropland (m)		V._____
1. Less than 50	4- 5	
2. 50-75	2- 3	
3. More than 75	1	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 40

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ **HABITAT UNIT VALUE**

BOBWHITE

(*Colinus virginianus*)

by

Michael J. Armbruster and Paul A. Korte

Life Requirements

General Habitat

During one season or another, bobwhites utilize every seral stage from recently disturbed ground to climax oak-hickory forest (Ellis et al. 1969). However, early successional stages are most important (Stanford 1964a), and common ragweed is a good indicator species of critical habitat (Ellis et al. 1969). Habitat quality begins to decline 5 to 8 years following disturbance, when dense woody growth replaces shade-intolerant, food-producing annuals (Stanford 1964a; Ellis et al. 1969) and grasses used for nesting (Klimstra and Roseberry 1975). Because of the low mobility of this species (Murphy and Baskett 1952; Lewis 1954), good interspersion of habitat types is essential.

Cover

Quail require a combination of cropland, woodland, grassland, and rough land or brushland for cover. Cover can be too dense, as quail require open ground for scratching, dusting, and feeding. In Illinois, quail avoided areas too thick to allow access to bare or nearly bare ground (Klimstra and Roseberry 1975). During adverse weather quail require woodland or brush-pile cover (Stanford 1964b). In Maryland, Burger and Linduska (1967) found winter cover more critical than winter food.

Ellis et al. (1969) found quail night-roosts most frequently in cover taller than 25 cm, with ideal conditions at 30-60 cm. Roost sites had sparse vegetation (low stem density) and occurred most commonly on bare ground, or on a light layer of duff. Roosts were usually more than 15 m from field borders.

Quail nests are bowl-shaped and grass-roofed and are generally located in intermediate successional stages. In Illinois, Klimstra and Roseberry (1975: 17) found prime nesting cover "typified by scattered shrubs and briars interspersed with a moderately dense stand of herbaceous and grassy vegetation such as goldenrods, panic grasses, cheat, broomsedge and bluegrass." This pattern occurred most frequently in idle fields during the latter part of the perennial weed and early-shrub and bramble successional stages. Grasses were the principal nest material in 88% of nests. Mean height of surrounding cover was 49.5 cm and mean stem density was 1048 stems/m^2. Sixty percent of all nests were within 5 m of an edge (Klimstra and Roseberry 1975).

Food and Water

Quail food consists principally of annual plant seeds (Korschgen 1952; Stanford 1964b). Korean lespedeza, common ragweed (Ellis et al. 1969), corn, and yellow foxtail (Korschgen 1952) are staple foods. Native legumes are often important foods (Rosene 1969). Stoddard (1931:129) considered legumes so important that their absence or abundance could be used as an index to quail populations. Periodic disturbances are required to maintain the most productive seral stages for food production (Ellis et al. 1969).

Foods taken in various seasons demonstrate the importance of both seasonally abundant and residual seeds. Korschgen (1958) found an average of 114 kg/ha of select seeds (those commonly used by game birds) in fall topsoil samples from northern Missouri, but only 62 kg/ha from southern Missouri. Cornfields, pastures, and soybean fields were the heaviest producers of select seeds in northern Missouri, whereas pastures, fallow-waste areas, and small grain fields were the best producers in southern Missouri. The importance of residual seed use by quail presents a special problem in habitat evaluation for this species. Important food plants may not have germinated in the current growing season when the evaluation is conducted. The evaluator must therefore become familiar with major food plant residues persisting from the previous growing season, and use these as clues to the availability of both residual and future quail foods.

Animal foods, primarily insects, form a minor proportion of the bobwhite's diet. Korschgen (1952) found that quail consumed the most insects in October when short-horned grasshoppers made up 4.0% of food by volume. Young quail use a much higher proportion of insect food for the first 2-3 weeks, then progressively change to the seed-dominated diet of the adults (Handley in Stoddard 1931:161).

Water requirements are usually met by intake of green plants, food, insects, dew, and snow (Stanford 1964b), but drought conditions may concentrate quail near permanent water. All requirements, including permanent water, should be available within 0.4 to 0.8 km, based on lifetime cruising radii in central Missouri as determined by Murphy and Baskett (1952).

The following food lists were compiled from Korschgen (1952).

Important Foods of Bobwhite

(Listings reflect relative order of importance.)

NOTE: In tallying species of food plants for field form, use lists from all seasons.

Plant

Spring	Summer
Korean lespedeza	Yellow foxtail
Corn	Fall panic grass
Crotons	Corn
Common ragweed	Crab grasses
Yellow foxtail	Common ragweed
Lance-leaf ragweed	Poison ivy
Sumacs	Tick trefoils
Sorghums	Korean lespedeza
Fall panic grass	Paspalums
False buckwheat	Wheat
Tick trefoils	
Acorns	
Wheat	

(continued)

Fall	Winter
Common ragweed	Korean lespedeza
Corn	Common ragweed
Fall panic grass	Crotons
Yellow foxtail	Acorns
Crotons	Corn
Korean lespedeza	Sassafras
Sorghums	Wheat
Soybean	Beggar ticks
Tick trefoils	Yellow foxtail
Beggar ticks	Lance-leaf ragweed
Wild beans	Sorghums
Lance-leaf ragweed	Ashes
Acorns	Wild beans
Crab grasses	Soybean
Poison ivy	Grapes
Sassafras	
Wheat	

Animal

Short-horned grasshoppers
Ground beetles
Stink bugs
Ants

References

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Evaluation Element: BOBWHITE | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Frequency and duration of flooding		I._____
1. No flooding	5	
2. Occasional short-term flooding	2- 4	
3. Frequent or extended periods of flooding	1	

(NOTE: If characteristic I is scored as 1, disregard other criteria, and enter 1 on line (8) as Habitat Unit Value for Bottomland Hardwood.)

II. Tree size class and canopy closure — II._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)
	No Size Class Predominant in Overstory
	M=mixed (must include sawtimber component)

1. 3-S; or 3-M	8-10
2. 2-S; or 2-M	6- 7
3. 3-P; or 3-R	4- 5
4. 2-P; or 2-R	2- 3
5. 1-S; or 1-M; or 1-P; or 1-R	1

(NOTE: Assign the higher score if percent canopy closure is near the lower limit of the appropriate range.)

III. Number of important food plant species comprising more than 1% of total plants present (see NOTE on "Food List") — III._____

1. More than 7	7-10
2. 4-7	4- 6
3. Less than 4	1- 3

Evaluation Element: BOBWHITE | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
IV. Habitat edge (width and extent of ecotone)		IV._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 15	5	
2. 10-15	3- 4	
3. 5- 9	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	
(NOTE: Add A and B to obtain value for characteristic IV.)		
V. Vegetative escape and concealment cover (shrubs and herbs)		V._____
1. Covers more than 50% of forest floor	5	
2. Covers 20-50% of forest floor	2- 4	
3. Covers less than 20% of forest floor	1	
To Be Evaluated from Aerial Photographs		
VI. Distance to cropland (km)		VI._____
1. Less than 0.4	7-10	
2. 0.4-0.8	4- 6	
3. More than 0.8	1- 3	
VII. Distance to old field, pasture, or hayland (km)		VII._____
1. Less than 0.4	5	
2. 0.4-0.8	3- 4	
3. More than 0.8	1- 2	

Evaluation Element: BOBWHITE

Habitat Type: BOTTOMLAND HARDWOOD

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 55

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: BOBWHITE | Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Tree size class and canopy closure		I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1.	3-S; or 3-M	8-10
2.	2-S; or 2-M	6- 7
3.	3-P; or 3-R	4- 5
4.	2-P; or 2-R	2- 3
5.	1-S; or 1-M; or 1-P; or 1-R	1

(NOTE: Assign the higher score if percent canopy closure is near the lower limit of the appropriate range.)

II. Number of important food plant species comprising more than 1% of total plants present (see NOTE on "Food List") II._____

1.	More than 7	7-10
2.	4-7	4- 6
3.	Less than 4	1- 3

III. Habitat edge (width and extent of ecotone) III._____

A. Average width (m) of habitat edge (see "Definition of Terms") A._____

1.	More than 15	5
2.	10-15	3- 4
3.	5- 9	2
4.	Less than 5	1

B. Habitat edge (identifiable ecotone) surrounds: B._____

1.	Entire site evaluated	5
2.	3/4 of site	3- 4
3.	1/2 of site	2- 3
4.	1/4 of site	1- 2
5.	Less than 1/4 of site	1

(NOTE: Add A and B to obtain value for characteristic III.)

Evaluation Element: BOBWHITE

Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
IV. Vegetative escape and concealment cover (shrubs and herbs)		IV._____
1. Covers more than 50% of forest floor	5	
2. Covers 20-50% of forest floor	2- 4	
3. Covers less than 20% of forest floor	1	
To Be Evaluated from Aerial Photographs		
V. Distance to cropland (km)		V._____
1. Less than 0.4	7-10	
2. 0.4-0.8	4- 6	
3. More than 0.8	1- 3	
VI. Distance to old field, pasture, or hayfield (km)		VI._____
1. Less than 0.4	5	
2. 0.4-0.8	3- 4	
3. More than 0.8	1- 2	
VII. Distance to permanent water (km)		VII._____
1. Less than 0.4	5	
2. 0.4-0.8	3- 4	
3. More than 0.8	1- 2	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 55

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: BOBWHITE Habitat Type: OLD FIELD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Distance (km) from center of plot to nearest bare or sparsely vegetated ground		I._____
1. Less than 0.4	7-10	
2. 0.4-0.8	3- 6	
3. More than 0.8	1- 2	
(NOTE: If characteristic I is scored as 1, disregard other criteria, and enter 1 on line (8) as Habitat Unit Value for Old Field.)		
II. Number of important food plant species comprising more than 1% of total plants present (see NOTE on "Food List")		II._____
1. More than 7	7-10	
2. 4-7	4- 6	
3. Less than 4	1- 3	
III. Habitat edge (width and extent of ecotone)		III._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 15	5	
2. 10-15	3- 4	
3. 5- 9	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	
(NOTE: Add A and B to obtain value for characteristic III.)		
IV. Vegetative escape and concealment cover (shrubs and forbs)		IV._____
1. Covers more than 60% of field	5	
2. Covers 30-60% of field	2- 4	
3. Covers less than 30% of field	1	

Evaluation Element: BOBWHITE

Habitat Type: OLD FIELD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
To Be Evaluated from Aerial Photographs		
V. Distance to cropland (km)		V._____
1. Less than 0.4	7-10	
2. 0.4-0.8	4- 6	
3. More than 0.8	1- 3	
VI. Distance to forest (km)		VI._____
1. Less than 0.4	5	
2. 0.4-0.8	3- 4	
3. More than 0.8	1- 2	
VII. Distance to permanent water (km)		VII._____
1. Less than 0.4	5	
2. 0.4-0.8	3- 4	
3. More than 0.8	1- 2	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 55

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: BOBWHITE | Habitat Type: CROPLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
To Be Determined from Landowner or Operator		
I. Land management		I._____
1. Year-round cropping or no fall plowing or discing	8-10	
2. Chisel plowing or discing in fall	4- 7	
3. Fall moldboard plowing	1- 3	
II. Cropping practices		II._____
1. Cropped annually or with occasional one-year lapses; little or no herbicide application	5	
2. Usually cropped annually but with lapses of two or more consecutive years; little herbicide application	3- 4	
3. Usually cropped annually; heavy herbicide application	1- 2	
To Be Evaluated in Field		
III. Vegetative escape and concealment cover: shrubs and herbs (pockets of vegetation)		III._____
1. Covers more than 20% of ground	5	
2. Covers 5-20% of ground	2- 4	
3. Covers less than 5% of ground	1	
IV. Habitat edge (width and extent of ecotone)		IV._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 15	5	
2. 10-15	3- 4	
3. 5- 9	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	

(NOTE: Add A and B to obtain value for characteristic IV.)

Evaluation Element: BOBWHITE

Habitat Type: CROPLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
To Be Evaluated from Aerial Photographs		
V. Distance to forest (km)		V._____
1. Less than 0.4	5	
2. 0.4-0.8	3- 4	
3. More than 0.8	1- 2	
VI. Distance to old field, pasture, or hayland (km)		VI._____
1. Less than 0.4	5	
2. 0.4-0.8	3- 4	
3. More than 0.8	1- 2	
VII. Distance to permanent water (km)		VII._____
1. Less than 0.4	5	
2. 0.4-0.8	3- 4	
3. More than 0.8	1- 2	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 45

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: BOBWHITE | Habitat Type: PASTURE & HAYLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Distance (km) from center of plot to nearest bare or sparsely vegetated ground		I._____
1. Less than 0.4	7-10	
2. 0.4-0.8	3- 6	
3. More than 0.8	1- 2	
(NOTE: If characteristic I is scored as 1, disregard other criteria, and enter 1 on line (8) as Habitat Unit Value for Pasture and Hayland.)		
II. Management practices		II._____
(NOTE: Score Part A or Part B, not both.)		
A. Pasture management		A._____
1. Unimproved pasture, lightly grazed	7-10	
2. Unimproved pasture, heavily grazed	5- 6	
3. Improved pasture, monotype, lightly grazed	3- 4	
4. Improved pasture, monotype, heavily grazed	1- 2	
B. Hayfield management		B._____
1. Hayfield species mixed with more than 50% miscellaneous grasses and forbs; lightly cropped	8-10	
2. Hayfield species mixed with 25-50% miscellaneous grasses and forbs; lightly cropped	4- 7	
3. Hayfield monotype or less than 25% miscellaneous grasses and forbs; heavily cropped	1- 3	
III. Habitat edge (width and extent of ecotone)		III._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 15	5	
2. 10-15	3- 4	
3. 5- 9	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	
(NOTE: Add A and B to obtain value for characteristic III.)		

Evaluation Element: BOBWHITE

Habitat Type: PASTURE & HAYLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
IV. Vegetative escape and concealment cover: shrubs and herbs (in hayland, vegetation that is not cropped)		IV._____
1. Covers more than 20% of ground	5	
2. Covers 5-20% of ground	2- 4	
3. Covers less than 5% of ground	1	
To Be Evaluated from Aerial Photographs		
V. Distance to cropland (km)		V._____
1. Less than 0.4	7-10	
2. 0.4-0.8	4- 6	
3. More than 0.8	1- 3	
VI. Distance to water (km)		VI._____
1. Less than 0.4	5	
2. 0.4-0.8	3- 4	
3. More than 0.8	1- 2	
VII. Distance to forest (km)		VII._____
1. Less than 0.4	5	
2. 0.4-0.8	3- 4	
3. More than 0.8	1- 2	
VIII. Distance to old field (km)		VIII._____
1. Less than 0.4	5	
2. 0.4-0.8	3- 4	
3. More than 0.8	1- 2	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

(1) Maximum possible score for form	(1)	60
(2) Total maximum possible score(s) for characteristic(s) tallied as NA	(2)	_____
(3) Corrected maximum possible score: (1) - (2)	(3)	_____
(4) Total actual scores	(4)	_____
(5) (4) ÷ (3) x 10	(5)	_____ HABITAT UNIT VALUE

EASTERN COTTONTAIL

(*Sylvilagus floridanus*)

by

Diana L. Hallett, K.C. Sadler, and P.A. Korte

Life Requirements

General Habitat

Cottontails in central Missouri use open, brushy fields or forest border habitat. Sadler (1976) reported that well-distributed protective cover, rather than food, was the most critical element for survival and reproduction of rabbits in Missouri. Rabbits in southern Illinois avoided large open areas of a single principal ground cover (Lord 1963). Areas with an interspersion of grasses, forbs, shrubs, and all-aged timber were best for cottontails in Iowa (Hendrickson 1947). Bare ground is important to cottontails for sunning and drying after rains or heavy dew (Sadler 1972).

Cover

Cottontails need cover for nesting, escape from predators, and shelter from weather. In Missouri, preferred cover includes brushy or weedy fencerows, idle farmland, brush piles, and multiflora rose hedges (Schwartz and Schwartz 1959:100). Irregular topography such as grassy gully banks or shrubbery on terraces were areas of high cottontail use in Iowa (Hendrickson 1947) and Illinois (Lord 1963). Cover must be on well-drained soil so that rabbits are not driven from the area after heavy rains (Schwartz and Schwartz 1959:100; Lord 1963). During most of the year rabbits in Missouri rest in a "form" concealed in dense clumps of grass or in brushpiles. In winter, cottontails also use brushpiles or abandoned woodchuck burrows for protection (Hendrickson 1947; Dusi 1952).

Food and Water

Cottontails eat mostly plants. Their preferred foods vary seasonally. Herbaceous plants are eaten during most of the year and woody plants are used when snow covers herbaceous vegetation (Dusi 1952). In Missouri, Kentucky blue grass was eaten more than other grasses in all seasons except summer. In summer, wheat, white clover, Korean lespedeza, and crab grasses were preferred (L.J. Korschgen, personal communication). Some studies indicate that rabbits favor plants in early growth stages (Cook and Harris 1968; Heeney and Kotich 1968). Adequate nutrition of young rabbits can be assured by establishing polytypic stands of wild forbs in which the variety of species provides some plants in a stage of vigorous growth throughout the growing season (Bailey 1969). Rabbits obtain moisture from their succulent diet, dew, snow, and surface water (Schwartz and Schwartz 1959:102).

The list of important foods, which follows, is adapted from Korschgen (1980). Foods are listed in descending order of aggregate volume.

Movements

Cottontail movements are restricted by available cover. Food plants must be near protective cover if they are to be useful (Sadler 1976). Schwartz (1941) found home ranges averaging 0.56 ha

for adult males and 0.48 ha for adult females in central Missouri. The mean home range of male and female rabbits in southern Illinois was 0.95 ha (Lord 1963).

Reproduction

The cottontail breeding season in Missouri begins in February (Conaway et al. 1963; Sadler and Conaway 1971) and ends in September (Schwartz 1942; Evans et al. 1965). Well-drained sites are chosen for nesting. The nest consists of a cavity in the ground hidden by grass and lined with dead grass and fur. Young rabbits usually leave the nest at about 11-12 days (Henry 1974:34; Knauer 1974:43), but may nurse away from the nest until at least 25 days of age (Knauer 1974:45).

Important Foods of Eastern Cottontail

(Listings reflect relative order of importance.)

NOTE: In tallying species of food plants, use lists from all seasons. On field form, base score on range given only for season in which evaluation is made.

Spring	Summer & Fall	Winter
Kentucky blue grass	White clover	Kentucky blue grass
Wheat	Korean lespedeza	Wheat
Japanese chess	Wheat	Timothy
White clover	Small crab grass	Chess
Chess	Common crab grass	Corn
Dandelion	Kentucky blue grass	Multiflora rose
Red clover	Timothy	Fescues
Downy chess	Red clover	Smooth sumac
Timothy	Prickly mallow	Sorghums
Giant ragweed	Fescues	Horse nettle
	Nodding foxtail	Three-seeded mercury
	Japanese chess	Poison ivy
	Chess	Downy chess
	Giant ragweed	Japanese chess
	Multiflora rose	Daisy fleabane
	Daisy fleabane	White clover
	Dandelion	Sedges
	Knotweed	Whitetop fleabane
	Slippery elm	Hairy chess
	Rugel plantain	Tall thistle
	Fall panic grass	Red clover
	Goose grass	English plantain
		White heath aster
		Asters
		Common ragweed

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Evaluation Element: EASTERN COTTONTAIL Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Tree size class and canopy closure		I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1.	3-R	10
2.	3-M; or 3-S	9
3.	3-P	8
4.	2-R	7
5.	2-M; or 2-S	5- 6
6.	2-P	4
7.	1-R	3
8.	1-M; or 1-S	2
9.	1-P	1

II. Number of important food plant species comprising more than 1% of total plants present (see Note on "Food List") II._____

	Winter	Spring	Summer & Fall	
1.	More than 9	More than 7	More than 11	7-10
2.	5-9	5-7	6-11	4- 6
3.	Less than 5	Less than 5	Less than 6	1- 3

III. Habitat edge (width and extent of ecotone) III._____

A. Average width (m) of habitat edge (see "Definition of Terms") A._____

1.	More than 15	5
2.	10-15	3- 4
3.	5- 9	2
4.	Less than 5	1

Evaluation Element: EASTERN COTTONTAIL | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	
(NOTE: Add A and B to obtain value for characteristic III.)		
IV. Escape and concealment cover: fallen trees, logs, burrows, crevices, and brush piles (number per 0.5 ha)		IV._____
1. 4 or more	3- 5	
2. Less than 4	1- 2	
V. Frequency, time, and duration of flooding		V._____
1. No flooding or occasional flooding during the dormant season	4- 5	
2. Frequent short-term dormant-season flooding, occasional short-term flooding during growing season, or long-term dormant-season flooding	2- 3	
3. Long-term or frequent short-term flooding during the growing season	1	
VI. Distance to cropland (m)		VI._____
1. Less than 75	7-10	
2. 75-150	4- 6	
3. More than 150	1- 3	
VII. Distance to old field (m)		VII._____
1. Less than 75	5	
2. 75-150	2- 4	
3. More than 150	1	
VIII. Distance to pasture or hayland (m)		VIII._____
1. Less than 75	5	
2. 75-150	2- 4	
3. More than 150	1	

Evaluation Element: EASTERN COTTONTAIL Habitat Type: BOTTOMLAND HARDWOOD

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 60

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: EASTERN COTTONTAIL Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE

I. Tree size class and canopy closure I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1.	3-R	10
2.	3-M; or 3-S	9
3.	3-P	8
4.	2-R	7
5.	2-M; or 2-S	5- 6
6.	2-P	4
7.	1-R	3
8.	1-M; or 1-S	2
9.	1-P	1

II. Number of important food plant species comprising more than 1% of total plants present (see Note on "Food List") II._____

	Winter	Spring	Summer & Fall	
1.	More than 9	More than 7	More than 11	7-10
2.	5-9	5-7	6-11	4- 6
3.	Less than 5	Less than 5	Less than 6	1- 3

III. Habitat edge (width and extent of ecotone) III._____

A. Average width (m) of habitat edge (see "Definition of Terms") A._____

1.	More than 15	5
2.	10-15	3- 4
3.	5- 9	2
4.	Less than 5	1

Evaluation Element: EASTERN COTTONTAIL | Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	
(NOTE: Add A and B to obtain value for characteristic III.)		
IV. Escape and concealment cover: fallen trees, logs, burrows, crevices, and brush piles (number per 0.5 ha)		IV._____
1. 4 or more	3- 5	
2. Less than 4	1- 2	
V. Distance to cropland (m)		V._____
1. Less than 75	7-10	
2. 75-150	4- 6	
3. More than 150	1- 3	
VI. Distance to old field (m)		VI._____
1. Less than 75	5	
2. 75-150	2- 4	
3. More than 150	1	
VII. Distance to pasture or hayland (m)		VII._____
1. Less than 75	5	
2. 75-150	2- 4	
3. More than 150	1	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

(1) Maximum possible score for form	(1)	55
(2) Total maximum possible score(s) for characteristic(s) tallied as NA	(2)	_____
(3) Corrected maximum possible score: (1) - (2)	(3)	_____
(4) Total actual scores	(4)	_____
(5) (4) ÷ (3) x 10	(5)	_____ HABITAT UNIT VALUE

Evaluation Element: EASTERN COTTONTAIL Habitat Type: OLD FIELD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE

I. Number of important food plant species comprising more than 1% of total plants present (see NOTE on "Food List") I._____

	Winter	Spring	Summer & Fall	
1.	More than 7	More than 9	More than 11	7-10
2.	5-7	5-9	6-11	4- 6
3.	Less than 5	Less than 5	More than 6	1- 3

II. Distance from center of plot to nearest bare ground (m) II._____

1. Less than 40 8-10
2. 40-70 ..... 4- 7
3. More than 70 ..... 1- 3

III. Escape and concealment cover: dense brushy areas, brush piles, or log piles (number per 0.5 ha) III._____

1. More than 4 6-10
2. 1-4 ..... 2- 5
3. Less than 1 1

IV. Habitat edge (width and extent of ecotone) IV._____

A. Average width (m) of habitat edge (see "Definition of Terms") A._____

1. More than 15 5
2. 10-15 ..... 3- 4
3. 5- 9 2
4. Less than 5 1

B. Habitat edge (identifiable ecotone) surrounds: B._____

1. Entire site evaluated 5
2. 3/4 of site 3- 4
3. 1/2 of site 2- 3
4. 1/4 of site 1- 2
5. Less than 1/4 of site 1

(NOTE: Add A and B to obtain value for characteristic IV.)

V. Distance to cropland (m) V._____

1. Less than 75 7-10
2. 75-150 ..... 4- 6
3. More than 150 ..... 1- 3

Evaluation Element: EASTERN COTTONTAIL Habitat Type: OLD FIELD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
VI. Distance to forest (m)		VI._____
1. Less than 75	5	
2. 75-150	2- 4	
3. More than 150	1	
VII. Distance to pasture or hayland (m)		VII._____
1. Less than 75	5	
2. 75-150	2- 4	
3. More than 150	1	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 60

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: EASTERN COTTONTAIL Habitat Type: CROPLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
To Be Determined from Landowner or Operator		
I. Land management		I._____
1. Year-round cropping or no fall plowing or discing	8-10	
2. Chisel plowing or discing in fall	4- 7	
3. Fall moldboard plowing	1- 3	
II. Cropping practices		II._____
1. Cropped annually or with occasional one-year lapses; little or no herbicide application	5	
2. Usually cropped annually but with lapses of two or more consecutive years; little herbicide application	3- 4	
3. Usually cropped annually; heavy herbicide application	1- 2	
To Be Evaluated in Field		
III. Habitat edge (width and extent of ecotone)		III._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 15	5	
2. 10-15	3- 4	
3. 5- 9	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	
(NOTE: Add A and B to obtain value for characteristic III.)		
IV. Escape and concealment cover: dense brushy areas, brush piles, or log piles (number per 0.5 ha)		IV._____
1. 3 or more	3- 5	
2. Less than 3	1- 2	

Evaluation Element: EASTERN COTTONTAIL Habitat Type: CROPLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
V. Distance to old field (m)		V._____
1. Less than 75	7-10	
2. 75-150	4- 6	
3. More than 150	1- 3	
VI. Distance to forest (m)		VI._____
1. Less than 75	5	
2. 75-150	2- 4	
3. More than 150	1	
VII. Distance to pasture or hayland (m)		VII._____
1. Less than 75	5	
2. 75-150	2- 4	
3. More than 150	1	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 50

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: EASTERN COTTONTAIL Habitat Type: PASTURE & HAYLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Number of important food plant species comprising more than 1% of total plants present (see NOTE on "Food List")		I._____

	Winter	Spring	Summer & Fall	
1.	More than 9	More than 7	More than 11	7-10
2.	5-9	5-7	6-11	4- 6
3.	Less than 5	Less than 5	Less than 6	1- 3

II. Habitat edge (width and extent of ecotone)		II._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 15	5	
2. 10-15	3- 4	
3. 5- 9	2	
4. Less than 5	1	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	

(NOTE: Add A and B to obtain value for characteristic II.)

III. Distance from center of plot to nearest bare ground (m)		III._____
1. Less than 40	4- 5	
2. 40-70	2- 3	
3. More than 70	1	
IV. Grazing pressure (effects of grazing on ground vegetation)		IV._____
1. None or light during growing season	3- 5	
2. Heavy during growing season	1- 2	
V. Escape and concealment cover: dense brushy areas, brush piles, or log piles (number per 0.5 ha)		V._____
1. 4 or more	3- 5	
2. Less than 4	1- 2	

Evaluation Element: EASTERN COTTONTAIL

Habitat Type: PASTURE & HAYLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
VI. Distance to cropland (m)		VI._____
1. Less than 75	7-10	
2. 75-150	4- 6	
3. More than 150	1- 3	
VII. Distance to forest (m)		VII._____
1. Less than 75	5	
2. 75-150	2- 4	
3. More than 150	1	
VIII. Distance to old field (m)		VIII._____
1. Less than 75	5	
2. 75-150	2- 4	
3. More than 150	1	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 55

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

PRAIRIE VOLE

(*Microtus ochrogaster*)

by

Diana L. Hallett

Life Requirements

General Habitat

The distribution and population levels of *Microtus ochrogaster* are determined by many factors (Dice 1922; Martin 1956:408-410). Some critical factors affecting prairie vole distribution include production of grasses, seral stage of herbaceous species, and amount of debris and ground cover (Martin 1956:369). Early successional stages do not supply food or cover necessary to maintain vole populations. Not until an understory of grasses is established can a vole population be maintained (Dice 1922; Martin 1956:371). Birney et al. (1976) stated that "even the most naive student of mammalogy traps for *Microtus* in dense grassy vegetation." A mixed stand of grasses, with a weedy component, can support a larger vole population than either a pure grass stand or a typical early seral stage dominated by forbs (Martin 1956:371).

In Missouri, prairie voles live in herbaceous fields, grasslands, thickets, fallow fields, and along fencerows (Schwartz and Schwartz 1959:208). Voles avoid not only forest edge, but they shift their centers of activity away from single trees or clumps of shrubby plants (Martin 1956:372). Rocky outcroppings and bare ground are also avoided. Prairie voles are generally characteristic of drier upland sites (Getz 1962). However, during a population decline they were trapped more frequently in low, wet sites (Getz 1970). Lewin (1968) reported that prairie voles in central Illinois selected dry habitats when competing with meadow voles (*M. pennsylvanicus*). In a Kansas study, excessive moisture after a heavy rainfall killed a large percentage of juvenile voles (Martin 1956:378). Good soil drainage may be favorable for prairie voles, even though Krebs et al. (1971) could see no clear association of either *M. ochrogaster* or *M. pennsylvanicus* with physiographic soil classes.

Runways and Home Range

Surface and underground runways function as protection from predators, feeding trails, and travel lanes for *M. ochrogaster*. Voles construct surface runways under a mat of debris; where debris is scanty, runways are absent (Martin 1956:398). Jameson (1947) found that voles in alfalfa fields do not necessarily build runways because the vegetation provides sufficient shelter. Voles use underground tunnels to reach root systems of plants on which they feed (Martin 1956:398). Runways and tunnels often connect with aboveground chambers and underground nests (Martin 1956:398-400).

Runway systems and burrows are used by groups of voles (colonies) rather than individuals (Schwartz and Schwartz 1959:209). Their home range includes several systems of overlapping runways (Martin 1956:398). Getz (1961) discovered voles have larger home ranges when population densities are low. Prairie voles in Missouri usually live within 0.03 ha (Schwartz and Schwartz 1959:209).

Food

Prairie voles are grazers. Their diet includes tender stems, leaves, roots, tubers, flowers, seeds and fruits of grasses, sedges, and succulent plants (Fisher 1945; Martin 1956:397).

They generally choose plants according to growth stage (young and growing portions) rather than species (Martin 1956: 397; Fleharty and Olson 1969). Insects, snails, and crayfish are eaten by voles when other foods become scarce (Schwartz and Schwartz 1959:209). Succulent vegetation is an important water source (Martin 1956:398).

In spring and summer, prairie voles eat brome grasses, clovers, alfalfa, pokeberry, blackberries, forbs (mainly leaves of giant ragweed and dandelion), and insects (Jameson 1947; Martin 1956:397). Foods stored in the fall include roots, tubers, and bulbs which are placed underground in chambers near the nest or aboveground in hollow stumps (Fisher 1945). Both Fisher (1945) and Martin (1956:398) found large caches of horse nettle fruit. In winter, underground plant parts are reached by tunneling.

Reproduction

Prairie voles in Missouri are able to breed throughout the year except during extreme winter conditions (Fisher 1945). Spring and fall are two peak breeding periods (Schwartz and Schwartz 1959:210). The young are weaned between 12 and 21 days, but remain with the female until the next brood is produced. Juveniles attain adult size in 3 months.

Important Foods of Prairie Vole

White clover
Alfalfa
Red clover
Dandelion
Horsetails
Horse nettle
Kentucky blue grass
Timothy
Smooth brome
Foxtails
Quack grass
Reed canary grass
Fescue
Big bluestem
Sedges
Spike rush
Goldenrods
Little bluestem
Pokeweed
Blackberries
Giant ragweed

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Evaluation Element: PRAIRIE VOLE

Habitat Type: OLD FIELD & GRASSLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Grass and forb cover		I._____
1. Covers more than 70% of ground	8-10	
2. Covers 30-70%	4- 7	
3. Covers less than 30%	1- 3	
II. Shade-producing woody invaders (average number of trees and clumps of shrubs per $50m^2$)		II._____
1. Less than 3	8-10	
2. 3-6	3- 7	
3. More than 6	1- 2	
(NOTE: If average tree canopy diameters or shrub clumps exceed 5 m, decrease the value of characteristic II.)		
III. Average litter depth (cm)		III._____
1. 4-12	8-10	
2. More than 12	5- 7	
3. Less than 4	1- 4	
IV. Size of old field		IV._____
1. More than 0.6 ha	5	
2. 0.2 to 0.6 ha	3- 4	
3. Less than 0.2 ha	1- 2	
V. Number of important food plant species comprising more than 1% of total plants present		V._____
1. More than 12	5	
2. 7-12	3- 4	
3. Less than 7	1- 2	
VI. Soil texture: internal drainage (see "Definition of Terms")		VI._____
1. Sandy loam or loam	5	
2. Clay loam or silty clay loam	3- 4	
3. Clay or silty clay	1- 2	

Evaluation Element: PRAIRIE VOLE

Habitat Type: OLD FIELD & GRASSLAND

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 45

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

RACCOON

(*Procyon lotor*)

by

Diana L. Hallett and David W. Erickson

Life Requirements

General Habitat

Forests or timber stands near water are important components of most raccoon habitats. Many workers in the 1930's and 1940's considered wooded areas essential for raccoons (Bennitt and Nagel 1937:143; Brown and Yeager 1943). However, intrusion of raccoons into prairie environments and the continued presence of raccoons in deforested areas have shown that trees, though often important, are not required. For example, raccoons were once restricted to wooded valleys, but now are common throughout all habitat types in North Dakota (Fritzell 1978).

In Missouri, raccoons frequent hardwood-timbered habitat bordering watered areas (Schwartz and Schwartz 1959:274). Bottomland timber along the Mississippi River basin was select habitat in Illinois (Yeager and Rennels 1943).

Dens and Resting Sites

Dens are important during reproductive and young-rearing periods in spring and summer, and also during severe winter weather. Many authors (reviewed by Mech et al. 1966) state that raccoons usually den in hollow trees. Bennitt and Nagel (1937:144) even considered the presence of den trees to be a limiting factor for raccoons in Missouri. However, the raccoon is highly adaptable, and "if the favorite tree type of den is not available, a home is made in a fallen log, a crevice of rocky outcroppings, or in a ground hole" (Stuewer 1943:220). Extensive use of rock dens and ground dens in the Midwest has been noted (Giles 1942; Stains 1956). In both instances, potential tree den sites were available. In an Ohio marsh, Urban (1970) found 89% of his tagged raccoons denning in muskrat (*Ondatra zibethicus*) houses. In Missouri, raccoons use caves, abandoned woodchuck (*Marmota monax*) and other burrows, cavities in tree roots, squirrel nests, muskrat houses, and vacant buildings, all of these in addition to hollow trees. Although many other den sites are used, tree dens are most common in many situations (Schwartz and Schwartz 1959:275).

Using recorders, Berner and Gysel (1967) measured raccoon activity at tree dens and ground burrows in Michigan. They found two annual periods of low activity at mouths of dens. One was in midwinter, when low temperatures apparently caused raccoons to become inactive and stay within dens for short periods. A summer low occurred when weather was mild and food plentiful. At this time raccoons used temporary forms of shelter, such as squirrel nests, and nests in cattail and other herbaceous growth (Berner and Gysel 1967). In autumn, Mech et al. (1966) found numerous ground beds in marshy areas in Minnesota; these sites were shifted almost daily, with no discernible pattern.

Water

Raccoons are normally closely associated with water: streams, drainage ditches, lakes, ponds, or marshes. In the 1930's, regional raccoon density in Missouri was correlated with the mileage of permanent streams in each respective region except the Mississippi lowland (Bennitt

and Nagel 1937:142). Den trees in Michigan were located within 0.4 km of water (Stuewer 1943:237). Yeager and Rennels (1943) believed an increase in the number of shallow water pools along streams heightened raccoon activity in response to increased crayfish availability.

Foods

Raccoons are omnivorous. They use foods available in a wide range of habitats, and adjust to seasonal changes in food availability. The effect of availability, seasonal or otherwise, was clearly apparent in the kinds of food taken by raccoons in Missouri (Schwartz and Schwartz 1959:275) and in Illinois (Yeager and Rennels 1943). Corn was important in agricultural habitats (Giles 1940; Yeager and Rennels 1943; Stains 1956; Ellis 1964), but it diminished in importance as natural foods became available.

In Missouri predominant wild plant foods include grapes, persimmon, blackberries, and Osage orange (Schwartz and Schwartz 1959:275). In east-central Illinois raccoon diets included corn, fruit, crayfish, and insects (Yeager and Rennels 1943). Giles (1940) reported spring and summer foods in Iowa were raspberries, grasshoppers, and beetles. In Illinois and Iowa, the plant portions were 77% and 75%, respectively. Plant material comprised 87% of the raccoon's diet in Missouri (L.J. Korschgen, personal communication).

Home Range

Home range studies in the United States show great differences according to geographic location, sex and age groups, and methods of investigation and analysis (reviewed by Lotze 1979). In general, adult males have much larger home ranges than females and young (Fritzell 1978, Lotze 1979). Raccoons are mobile animals, and published mean home range sizes are as large as 2,560 ha for nine adult males in North Dakota (Fritzell 1978). In the lower Midwest Ellis (1964; Illinois) and Shirer and Fitch (1970, Kansas) found mean home ranges of 110 ha or less.

Reproduction

In Illinois, the mean birth date for 20 litters conceived in the wild ranged from 9 March to 24 June (Sanderson and Nalbandov 1973). In more southern latitudes breeding generally occurs later (Johnson 1970). Young remain in the dens 8-10 weeks before beginning to forage with the mother (Schwartz and Schwartz 1959:276).

Important Foods of Raccoon

(Listings reflect relative order of importance.)

NOTE: In tallying species of food plants, use lists from all seasons. On field form, base score on range given only for season in which evaluation is made.

Food Plants

Summer & Fall

Corn
Grapes
Pokeweed
Persimmon
Raccoon grape
Cherries
Blackberries
Sycamore
Chess
Bristly greenbrier
Oats
Wild plum

Winter & Spring

Corn
Acorns
Pokeweed
Bristly greenbrier
Johnson grass
Sycamore
Osage orange
Chess
Oats
Pigweed

Animal Foods

Short-horned grasshoppers
Crayfish
Ground beetles
Rabbit
June and dung beetles
Spiders
White-footed mice
Fish
Snails
Clams
Long-horned grasshoppers
Caterpillars
Stink bugs

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Evaluation Element: RACCOON | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Tree size class and canopy closure		I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)
	No Size Class Predominant in Overstory
	M=mixed (must include sawtimber component)

1. 1-S	9-10
2. 1-M, 2-S	7- 8
3. 2-M, 3-S	5- 6
4. 3-M	3- 4
5. 1, 2, 3-P or 1, 2, 3-R	1- 2

II. Available den sites: fallen trees, burrows, rock crevices, brush piles (number per 0.5 ha) II._____

1. More than 4	7-10
2. 3-4	4- 6
3. Less than 3	1- 3

III. Water availability III._____

(NOTE: Use aerial photographs if necessary.)

A. Distance to water (km) A._____

1. Less than 0.5	5
2. 0.5-1.0	3- 4
3. More than 1.0	1- 2

B. Type of water B._____

1. Streams, rivers with consistently flowing water	5
2. Streams with intermittent flow but with permanent pools	4
3. Lakes and permanent ponds	3
4. Ephemeral waters (temporary pools, dry washes, etc.)	1- 2

(NOTE: Add A and B to obtain value for characteristic III.)

Evaluation Element: RACCOON | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE

IV. Number of important food plant species comprising more than 1% of total plants present (see NOTE on food list) IV._____

Summer & Fall	Score	Winter & Spring
1. More than 10	5	More than 6
2. 6-10	3-4	4- 6
3. Less than 6	1-2	Less than 4

V. Potential cavity trees (species present ≥ 50 cm dbh) V._____

1. Sycamore, silver and red maple	5
2. Bur and swamp white oaks	4
3. Red oak	3
4. Cottonwood, green ash	2
5. Black willow, river birch, American and red elm	1

VI. Concealment (thick, brushy cover, downed trees, and rock formations with crevices) VI._____

1. Covers more than 60% of forest floor	5
2. Covers 30-60% of forest floor	3- 4
3. Covers less than 30% of forest floor	1- 2

VII. Habitat edge (width and extent of ecotone) VII._____

A. Average width (m) of habitat edge (see "Definition of Terms") A._____

1. More than 15	5
2. 8-15	3- 4
3. Less than 8	1- 2

B. Habitat edge (identifiable ecotone) surrounds: B._____

1. Entire site evaluated	5
2. 3/4 of site	3- 4
3. 1/2 of site	2- 3
4. 1/4 of site	1- 2
5. Less than 1/4 of site	1

(NOTE: Add A and B to obtain value for characteristic VII.)

To Be Evaluated from Aerial Photographs

VIII. Distance to cropland (km) VIII._____

1. Less than 1.0	5
2. 1.0-1.5	3- 4
3. More than 1.5	1- 2

Evaluation Element: RACCOON Habitat Type: BOTTOMLAND HARDWOOD

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 60

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: RACCOON Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Tree size class and canopy closure		I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1. 1-S	9-10
2. 1-M, 2-S	7- 8
3. 2-M, 3-S	5- 6
4. 3-M	3- 4
5. 1, 2, 3-P or 1, 2, 3-R	1- 2

II. Available den sites: fallen trees, burrows, rock crevices, brush piles (number per 0.5 ha) II._____

1. More than 4	7-10
2. 3-4	4- 6
3. Less than 3	1- 3

III. Water availability III._____

(NOTE: Use aerial photographs if necessary.)

A. Distance to water (km) A._____

1. Less than 0.5	5
2. 0.5-1.0	3- 4
3. More than 1.0	1- 2

B. Type of water B._____

1. Streams, rivers with consistently flowing water	5
2. Streams with intermittent flow but with permanent pools	4
3. Lakes and permanent ponds	3
4. Ephemeral waters (temporary pools, dry washes, etc.)	1- 2

(NOTE: Add A and B to obtain value for characteristic III.)

Evaluation Element: RACCOON | Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
IV. Number of important food plant species comprising more than 1% of total plants present (see NOTE on food list)		IV._____

Summer & Fall	Score	Winter & Spring
1. More than 10	5	More than 6
2. 6-10	3-4	4- 6
3. Less than 6	1-2	Less than 4

V. Potential cavity trees (species present ≥ 50 cm dbh)		V._____
1. Sycamore, silver maple	5	
2. Bur oak, basswood	4	
3. Red oak	3	
4. White oak	2	
5. American elm	1	
VI. Concealment (thick, brushy cover, downed trees, and rock formations with crevices)		VI._____
1. Covers more than 60% of forest floor	5	
2. Covers 30-60% of forest floor	3- 4	
3. Covers less than 30% of forest floor	1- 2	
VII. Habitat edge (width and extent of ecotone)		VII._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 15	5	
2. 8-15	3- 4	
3. Less than 8	1- 2	
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	

(NOTE: Add A and B to obtain value for characteristic VII.)

To Be Evaluated from Aerial Photographs

VIII. Distance to cropland (km)		VIII._____
1. Less than 1.0	5	
2. 1.0-1.5	3- 4	
3. More than 1.5	1- 2	

Evaluation Element: RACCOON Habitat Type: UPLAND HARDWOOD

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 60

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: RACCOON Habitat Type: OLD FIELD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Water availability		I._____
(NOTE: Use aerial photographs if necessary.)		
A. Distance to water (km)		A._____
1. Less than 0.5	5	
2. 0.5-1.0	3- 4	
3. More than 1.0	1- 2	
B. Type of water		B._____
1. Streams, rivers with consistently flowing water	5	
2. Streams with intermittent flow but with permanent pools	4	
3. Lakes and permanent ponds	3	
4. Ephemeral waters (temporary pools, dry washes, etc.)	1- 2	
(NOTE: Add A and B to obtain value for characteristic I.)		
II. Number of important food plant species comprising more than 1% of total plants present (see NOTE on food list)		II._____

Summer & Fall	Score	Winter & Spring
1. More than 6	5	More than 6
2. 4-6	3-4	3- 4
3. Less than 4	1-2	Less than 3

III. Concealment (thick, brushy cover, downed trees, and rock formations with crevices)		III._____
1. More than 60% of ground covered	5	
2. 30-60% ground covered	3- 4	
3. Less than 30% of ground covered	1- 2	
IV. Habitat edge (width and extent of ecotone)		IV._____
A. Average width (m) of habitat edge (see "Definition of Terms")		A._____
1. More than 15	5	
2. 8-15	3- 4	
3. Less than 8	1- 2	

Evaluation Element: RACCOON | Habitat Type: OLD FIELD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
B. Habitat edge (identifiable ecotone) surrounds:		B._____
1. Entire site evaluated	5	
2. 3/4 of site	3- 4	
3. 1/2 of site	2- 3	
4. 1/4 of site	1- 2	
5. Less than 1/4 of site	1	

(NOTE: Add A and B to obtain value for characteristic IV.)

To Be Evaluated from Aerial Photographs

V. Distance to cropland (km)		V._____
1. Less than 1.0	5	
2. 1.0-1.5	3- 4	
3. More than 1.5	1- 2	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 35

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

BEAVER

(*Castor canadensis*)

by

Diana L. Hallett and David W. Erickson

Life Requirements

General Habitat

In central Missouri, beavers are associated with streams, rivers, marshes, and small lakes. Beavers routinely establish bank dens in this region because of the nature of the streams--often deep, with swift currents, and having a tendency to flood (Schwartz and Schwartz 1959:165). However, lodges may be constructed where there is permanently deep water, with a slight gradient and few fluctuations (Twichell 1951). Water for beaver habitation must be deep enough to prevent freezing to the bottom in winter and drying during drought conditions. Den entrances are usually under water. Dams may be built across small streams (Schwartz and Schwartz 1959:166).

Early invader tree stages are optimum habitat for the beaver. Although specific data from Missouri are not available, other workers have found that trees felled by beavers average about 5 cm in diameter (Bradt 1938; Erickson 1939; Shadle 1954).

Foods

Beavers in Missouri prefer bark and the cambium layer of willows and cottonwood (Atwood 1938; Dalke 1947; Schwartz and Schwartz 1959:167). Other food plants eaten by central Missouri beavers include river birch, ashes, elms, and silver maple (L.J. Korschgen, personal communication). Corn, from the milk stage on, is eaten wherever available (Atwood 1938). In winter, beavers rely heavily on preferred woody plants stored in a food cache near the bank den. In summer, various herbaceous plants supplement the beaver's diet. These include arrowheads, yellow pond lily, bur-reeds, and water willow (Schwartz and Schwartz 1959:168). The scarcity of herbaceous vegetation along a stream may adversely affect stability of colonies (Bennitt and Nagel 1937:138-139).

Preferred foods are actively sought even when not abundant (Shadle and Austin 1939; Brenner 1962; Crawford et al. 1976). As preferred foods are severely depleted, a shift to less desirable foods occurs (Shadle et al. 1943).

Movements

Beavers may range 50 to 75 m from water (Crawford et al. 1976), or move as much as 200 m to cut trees (Bradt 1938).

When habitat deteriorates, beavers move up to 13 km along streams to relocate (Knudsen and Hale 1965). Townsend (1953) found that they abandon a site because of diminished food supply, population pressure, or the death of the breeding females.

Reproduction

The young are born between April and June. They remain dependent on the female until weaning at about 6 weeks of age. After they are weaned, their diet is similar to that of the adults (Schwartz and Schwartz 1959:168).

Important Foods of Beaver

(Listings generally reflect relative order of importance.)

NOTE: In tallying species of food plants for field form, use lists from all seasons.

Fall & Winter & Spring	Summer
Willows	Willows
Cottonwood	Cat-tails
Ashes	Blackberries
River birch	Yellow pond lily
Elms	Arrowheads
Silver maple	Goldenrods
Black cherry	Eelgrass
Hackberry	Bur-reeds
Dogwoods	Waterweed
White oak	Watercress
Corn	Duckweeds

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Evaluation Element: BEAVER

Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Distance to permanent water (m)		I._____
1. Less than 75	7-10	
2. 75-200	2- 6	
3. More than 200	1	
(NOTE: If characteristic I is scored as 1, disregard other criteria, and enter 1 on line (8) as Habitat Unit Value for Bottomland Hardwood.)		
II. Bank den characteristics		II._____
A. Soil texture (see "Definition of Terms")		A._____
1. Clay or silty clay	5	
2. Loam, clay loam, or silty clay loam	3- 4	
3. Sand or sandy loam	1- 2	
(NOTE: If soil is more than 80% sand or stone, enter 1 for characteristic II and go directly to characteristic III.)		
B. Slope of bank		B._____
1. More than 60°	5	
2. 30-60°	3- 4	
3. Less than 30°	1- 2	
(NOTE: Add A and B to obtain value for characteristic II.)		
III. Species composition of 40% or more of the forest		III._____
1. Willows, cottonwood, ashes	7-10	
2. River birch, elms, red maple, silver maple	4- 6	
3. Black cherry, dogwoods, hackberry, white oak, and others	1- 3	
IV. Number of important food plant species comprising more than 1% of total plants present (See NOTE on "Food List")		IV._____
1. More than 7	5	
2. 5-7	2- 4	
3. Less than 5	1	

Evaluation Element: BEAVER

Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
V. Tree size class		V._____

Code

Size Class (dbh) of Trees Composing
Predominant Foliage Layer (Overstory)

S=sawtimber (more than 23 cm)
P=poles/small trees (5-23 cm dbh)
R=reproduction (less than 5 cm dbh)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1.	R	5
2.	P	3- 4
3.	M, S	1- 2

VI. Distance to cropland (m)		VI._____

1.	Less than 15	5
2.	15-30	3- 4
3.	More than 30	1- 2

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1)	Maximum possible score for form	(1)	45
(2)	Total maximum possible score(s) for characteristic(s) tallied as NA	(2)	_____
(3)	Corrected maximum possible score: (1) - (2)	(3)	_____
(4)	Total actual scores	(4)	_____
(5)	(4) ÷ (3) x 10	(5)	_____ HABITAT UNIT VALUE

Evaluation Element: BEAVER Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Distance to permanent water (m)		I._____
1. Less than 75	7-10	
2. 75-200	2- 6	
3. More than 200	1	
(NOTE: If characteristic I is scored as 1, disregard other criteria, and enter 1 on line (8) as Habitat Unit Value for Upland Hardwood.)		
II. Bank den characteristics		II._____
A. Soil texture (see "Definition of Terms")		A._____
1. Clay or silty clay	5	
2. Loam, clay loam, or silty clay loam	3- 4	
3. Sand or sandy loam	1- 2	
(NOTE: If soil is more than 80% sand or stone, enter 1 for characteristic II and go directly to characteristic III.)		
B. Slope of bank		B._____
1. More than 60°	5	
2. 30-60°	3- 4	
3. Less than 30°	1- 2	
(NOTE: Add A and B to obtain value for characteristic II.)		
III. Species composition of 40% or more of the forest		III._____
1. Ashes	7-10	
2. River birch, elms, red maple, silver maple	4- 6	
3. Black cherry, dogwoods, hackberry, white oak, and others	1- 3	
IV. Number of important food plant species comprising more than 1% of total plants present (see NOTE on "Food List")		
1. More than 7	5	
2. 5-7	2- 4	
3. Less than 5	1	

Evaluation Element: BEAVER

Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
V. Tree size class		V._____

Code

Size Class (dbh) of Trees Composing
Predominant Foliage Layer (Overstory)

S=sawtimber (more than 23 cm)
P=poles/small trees (5-23 cm dbh)
R=reproduction (less than 5 cm dbh)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1. R	5	
2. P	3- 4	
3. M, S	1- 2	

VI. Distance to cropland (m)		VI._____
1. Less than 15	5	
2. 15-30	3- 4	
3. More than 30	1- 2	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1)	Maximum possible score for form	(1)	45
(2)	Total maximum possible score(s) for characteristic(s) tallied as NA	(2)	_____
(3)	Corrected maximum possible score: (1) - (2)	(3)	_____
(4)	Total actual scores	(4)	_____
(5)	(4) ÷ (3) x 10	(5)	_____ HABITAT UNIT VALUE

WOOD DUCK

(*Aix sponsa*)

by

Diana L. Hallett and Leigh H. Fredrickson

Life Requirements

General Habitat

Wood ducks require shallow or quiet waters in or near deciduous or mixed woodlands. Swamplands, lowland hardwoods, forested floodplains, and brushy timbered sloughs or marshes are readily used (McGilvrey 1968; Hester and Dermid 1973:25; Bellrose 1976:178). In southeastern Missouri, they use relatively open forests which are subject to flooding and contain a large number of mature or overmature trees (Weier 1966). Optimum wood duck habitat is provided by inundated floodplains and millponds in North Carolina (Hester and Dermid 1973:26). Bottomland lakes flanking the Illinois River and bordered by buttonbush, black willow, and emergents are also excellent habitat (Benson and Bellrose 1964:93). Along the Mississippi River in Iowa, wood ducks use mature timber on river bluffs as well as bottomlands (Hein 1965).

Broods and roosting wood ducks require protective cover. Tangles of downed timber serve as year-round cover (Webster and McGilvrey 1966). Shrubs and clumps of grasses and sedges are secondary cover. Interspersed low bars, logs, and muskrat houses are important for loafing and drying (Hester and Dermid 1973:28). Cover plants include dense, spreading, low growths of buttonbush, yellow pond lily, American lotus, arrowheads, and soft rush.

Water

Wood ducks frequent habitat subject to dynamic water fluctuations such as pools adjacent to streams recharged with spring floodwaters, backwaters, oxbows, and beaver ponds. Hardwood stands with high groundwater tables are subject to repeated flooding and wood ducks use these sites when surface water is available. Invertebrates and plant foods important to wood ducks are produced in these seasonally flooded habitats. Mast usually is made available to wood ducks by shallow flooding (Bellrose 1976:194; Drobney 1977), but acorns may be consumed on dry land some distance (200 m) from water (K.M. Babcock, personal communication).

Food

A key to wood duck presence is the availability of foods that meet the changing energy and nutritional requirements throughout the year. High protein foods such as aquatic invertebrates physically prepare hens for reproduction as well as meeting nutritional needs of broods that are less than 6 weeks old. Plant foods are important for broods nearing flight stage and for adults during nonbreeding periods.

Invertebrate foods such as aquatic coleopterans, dipterans, crustaceans, spiders, and snails provided the protein necessary for egg laying (Drobney and Fredrickson 1979). Plant foods accounted for about 65% of the diet for breeding males and for both sexes after breeding in southeastern Missouri. In the fall, acorns and seeds of water-shield made up 44% of the diet. Plant foods generally consumed include wild water pepper, buckwheat, corn, grapes, buttonbush, and common millet (Martin and Uhler 1939; Korschgen 1955, Drobney 1977).

During the first 6 weeks of life young feed predominantly on dipterans and coleopterans, but gradually switch from invertebrate to plant foods (Hocutt and Dimmick 1971; Bellrose 1976:194). Juvenile wood ducks also consume fennel-leaved pondweed and duckweeds (McGilvrey 1966; Hocutt and Dimmick 1971).

Nesting

Lack of nest sites can be a limiting factor for wood ducks (Bent 1923; Hawkins and Bellrose 1941; Grice and Rogers 1965; Weier 1966). Most nest sites are located less than 1.0 km from brood habitats. Nesting habitat as defined by Dill (1966) is 10% hardwood timber averaging at least 45 cm dbh, and within 0.8 km of water. Nest sites along tributaries of the Mississippi River were located near meanders and oxbow swamps and along downstream portions where turbulence and velocity of streamflow were low (Hein 1965).

Wood ducks nest in cavities in large, old trees. The best cavity-producing trees in both lowland and upland areas in southeastern Missouri are American elm, sweetgum, and red maple (Hansen 1966). Also in southeastern Missouri, Weier (1966) discovered successful nests in willow oak, pin oak, white oak, slippery elm, and sycamore. In central Illinois, black oaks formed suitable nesting cavities more readily than any other species (Bellrose et al. 1964); suitable cavities in black oaks in woodlots numbered about one per 2 ha.

Wood ducks will use cavities in any tree species close to water if cavity dimensions are suitable. Most nests are within 1.0 km of water. Few cavity nests have entrance holes smaller than 10 x 10 cm, and minimum interior size is 14 x 14 cm (Gigstead 1938; Hawkins and Bellrose 1941; Bellrose et al. 1964). Overlarge cavities, very shallow ones, and those with large entrances are rejected (Bellrose et al. 1964).

Nest cavities used by wood ducks in South Carolina were usually 9 m or more above ground (McGilvrey 1968). In Massachusetts, nests averaged 5.2 m above the ground (Grice and Rogers 1965).

Brood Habitat

Optimum brood habitat is a mixture of fallen timber, early leafing shrubs and herbs, and emergent cover interlaced with a network of open water passageways (Webster and McGilvrey 1966). Large downed trees are used for loafing by broods (Beard 1964). The arrangement of scattered emergents is more important than the species composing emergent cover (Hester and Dermid 1973:73). Quiet sloughs, and secluded swamps and marshes fulfill these requirements (Hein 1965). Beaver-created impoundments, particularly connected networks of ponds, are valuable wood duck brooding areas in South Carolina (Hepp and Hair 1977).

Land Management Practices

Breeding hens home precisely to nesting areas used previously (Bellrose 1955; Hester 1962). Because of this behavior, land-use practices greatly affect wood duck breeding habitat. Stream channelization, bottomland clearing for agriculture, logging, and conversion of hardwoods to pine reduce wood duck habitat (Hester and Dermid 1973:128). Lumbering is detrimental to nesting habitat because opening canopies reduces shade, and shading is a key to cavity formation (Brakhage 1966; Weier 1966).

Important Foods of Wood Duck

(Listings reflect relative order of importance.)

NOTE: In tallying species of food plants, use lists from all seasons. On field form, base score on range given only for season in which evaluation is made.

Spring		Fall	
Animal	Plant[a]	Animal	Plant[a]
Scavenger beetles	Maples	Small moths	Water-shield
Diving beetles	Elms	Leafhoppers	Pin oak
Adult midges	Buttonbush	Dragonfly naiads	Red oak
Crane flies	Fennel-leaved pondweed	Crickets	White oak
Horse flies	Duckweeds	Long-horned grasshoppers	Wild water pepper
Water striders		Midges	Grapes
Damselflies			Buttonbush
Isopods			Beggar ticks
Slugs			Common millet
Spiders			Buckwheat
			Corn

[a] As available: primarily the seeds and fruits of plants listed.

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Evaluation Element: WOOD DUCK | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE

To Be Evaluated from Aerial Photographs

I. Distance to permanent water (km) I._____

1. Less than 0.5 6-10
2. 0.5-1.0 ..... 3- 5
3. More than 1.0 ..... 1- 2

(NOTE: If characteristic I is scored as 1, disregard other criteria and enter 1 on line (8) as Habitat Unit Value for Bottomland Hardwood.)

II. Tree size class and canopy closure II._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1. 2-S; or 3-S 9-10
2. 1-S 7- 8
3. 1-M; or 2-M; or 3-M 5- 6

(NOTE: If 1, 2, 3-P or 1, 2, 3-R, disregard other criteria, and enter 1 on line (8) as Habitat Unit Value for Bottomland Hardwood.)

III. Size and composition of forest III._____

A. Size of forested area (ha) A._____

1. 4 or more 3- 5
2. Less than 4 ..... 1- 2

Evaluation Element: WOOD DUCK | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
B. Food-producing tree species present (>30 cm dbh); if none greater than 30 cm dbh, enter 1		B._____

Group:

Early Season Fruit or Mast Producers	Late Season Fruit or Mast Producers
a. At least 3 of these species: elms, maples, ashes, basswood	b. Red oak & pin oak
	d. Red oak or pin oak
c. Only 1 or 2 of the above species	

1. Group a and b 4- 5
2. Group c and d 2- 3
3. Group c only or group d only 1

(NOTE: Add A and B to obtain value for characteristic III.)

IV. Evidence of regular flooding — IV._____

1. Annual recharge of oxbows, old channels, or vernal ponds 6-10
2. Irregular or no annual recharge 1- 5

V. Vegetative cover: fallen timber, emergents in flooded areas (breeding and brood cover) — V._____

1. Covers more than 30% of forest floor 7-10
2. Covers 10-30% of forest floor 3- 6
3. Covers less than 10% of forest floor 1- 2

VI. Tree species present (>50 cm dbh) suitable for nest sites; if none greater than 50 cm dbh, enter 1 — VI._____

1. Sycamore, cottonwood, river birch 7-10
2. White oak, black oak, maples 3- 6
3. Pin oak, red oak 1- 2

VII. Number of loafing sites (downed timber, bars, clumps of vegetation) per 0.5 ha — VII._____

1. More than 7 5
2. 5-7 ..... 3- 4
3. Less than 5 ..... 1- 2

Evaluation Element: WOOD DUCK Habitat Type: BOTTOMLAND HARDWOOD

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 65

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

Evaluation Element: WOOD DUCK

Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE

To Be Evaluated from Aerial Photographs

I. Distance to permanent water other than small farm ponds (km) I._____

1. Less than 0.5 6-10
2. 0.5-1.0 ..... 3- 5
3. More than 1.0 ..... 1- 2

(NOTE: If characteristic I is scored as 1, disregard other criteria and enter 1 on line (8) as Habitat Unit Value for Bottomland Hardwood.)

II. Tree size class and canopy closure II._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)
	No Size Class Predominant in Overstory
	M=mixed (must include sawtimber component)

1. 2-S; or 3-S 9-10
2. 1-S 7- 8
3. 1-M; or 2-M; or 3-M 5- 6

(NOTE: If 1, 2, 3-P or 1, 2, 3-R, disregard other criteria, and enter 1 on line (8) as Habitat Unit Value for Bottomland Hardwood.)

III. Size and composition of forest III._____

A. Size of forested area (ha) A._____

1. 4 or more 3- 5
2. Less than 4 ..... 1- 2

B. Food-producing tree species present (>30 cm dbh); if none greater than 30 cm dbh, enter 1. B._____

1. Red oak and pin oak 3- 5
2. White oak and black oak 1- 2

(NOTE: Add A and B to obtain value for characteristic III.)

Evaluation Element: WOOD DUCK | Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
IV. Tree species present (>50 cm dbh) suitable for nest sites; if none greater than 50 cm dbh, enter 1.		IV._____
1. Black gum, white oak	7-10	
2. Red oak	4- 6	
3. Pin oak	1- 3	
V. Vegetative cover: fallen timber, forbs, and grasses/ sedges (foraging cover)		V._____
1. Covers less than 20% of forest floor	5	
2. Covers 20-50% of forest floor	3- 4	
3. Covers more than 50% of forest floor	1- 2	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 45

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

NONGAME BIRDS AS HABITAT EVALUATION ELEMENTS

by

William R. Eddleman

GENERAL

Individual songbird species are often associated with a single habitat type or seral stage. In this respect they differ from many game species, which are often habitat generalists. Many nongame birds are conspicuous, relatively easy to count, and one species or another occurs in almost every habitat type (Graber and Graber 1976:2-3).

For all these reasons, particularly their habitat specificity, nongame birds may be useful as habitat evaluation elements. It appears possible to check closely the efficacy of habitat criteria and evaluation procedures against actual nongame bird population data.

Avian species use mainly visual cues in selecting habitats (Lack 1937; Karr and Roth 1971; Balda 1975). Among these cues are available nesting sites, song perches, feeding and drinking sites, and the presence of competitors (Hilden 1965). An individual bird settles at a given site if the sum of these stimuli exceeds a "settling threshold" (Hilden 1965:71). As habitats become more complex, these stimuli increase, and the numbers of species using them also increase.

To avoid complications related to the migratory habits of many nongame birds, we have selected only species nesting in central Missouri as evaluation elements. Thus, habitat characteristics used in the field sheets in this Handbook refer to breeding habitats. Numerous vegetative characteristics have been measured to determine habitat requirements of breeding bird communities (James 1971; Anderson and Shugart 1974; Giessman 1976; Whitmore 1977). Most of the evaluation criteria used here are vegetative characteristics, and we have emphasized those that can be measured year-round, even when breeding birds are absent. In several instances, our criteria for nongame bird habitats are based on unpublished Missouri data gathered for this project. For Henslow's and grasshopper sparrows, criteria are based, in part, on unpublished data provided by R.M. Skinner.

For convenience, references for the nongame bird evaluation elements are consolidated in a single list beginning on page 139.

BLUE-WINGED WARBLER

(*Vermivora pinus*)

Life Requirements

General Habitat

The blue-winged warbler is a fairly common breeding bird, widely distributed in Missouri (Widmann 1907:216; Bennitt 1932:53). In a New York study, this species used abandoned fields containing shrubs and small trees and bordered by taller deciduous trees (Ficken and Ficken 1968). Blue-winged warblers also occupy open, swampy thickets (Chapman 1907:67); dry, brushy hillsides and shrubby woodlands (Mengel 1965:395); and neglected pastures (Bent 1953:58). In general, preferred habitat is an early successional stage with heavy woody plant invasion (Meyerriecks and Baird 1968). In Missouri, this may include cedar trees (Missouri Cooperative Wildlife Research Unit, unpubl. data).

Food and Water

Blue-winged warblers are insectivorous and forage primarily at the tops of small trees and shrubs. Preferred foraging trees include apples, black cherry and hawthorns (Ficken and Ficken 1968). The diet consists of small beetles, ants, spiders, and caterpillars (Griscom and Sprunt 1957:62). Young are fed mainly larvae and eggs of Lepidoptera (Chapman 1907:69).

Most breeding populations of blue-winged warblers are located in upland habitat near streams or other water sources. Often, a water source is within the same open field that the breeding birds occupy (Ficken and Ficken 1968).

Breeding and Nesting

This warbler nests close to the ground in small trees or on the ground among tufts of grass, ferns, vines, or forbs (Bent 1953:59; Griscom and Sprunt 1957:62). Nests are usually placed at the edge of the field near adjoining woodlands (Ficken and Ficken 1968). Nests are composed of an outer cup of maple, cherry, or oak leaves mixed with grape bark and broad, coarse grass blades and lined with fine bark, split grape stems or hair (Chapman 1907:21; Griscom and Sprunt 1957:62).

Song perches used by male blue-winged warblers are usually less than 9 m high, and in any available tree (Missouri Cooperative Wildlife Research Unit, unpubl. data).

Important Foods of Blue-winged Warbler

(Listings reflect relative order of importance.)

Beetles
Ants
Spiders
Caterpillars
Lepidoptera (larvae, eggs)

Evaluation Element: BLUE-WINGED WARBLER Habitat Type: OLD FIELD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Woody invasion: tree and shrub canopy		I._____
1. Foliage covers 10-50% of the ground	8-10	
2. Foliage covers 51-75% of the ground	4- 7	
3. Foliage covers less than 10 or more than 75% of the ground	1- 3	
II. Average height of tallest trees or shrubs (m)		II._____
1. 6 to 8	4- 5	
2. 3 to 5, or 8 to 11	2- 3	
3. Less than 3, or more than 11	1	
III. Herbaceous canopy (forbs and grasses)		III._____
1. Covers more than 80% of the ground	4- 5	
2. Covers 60-80% of the ground	2- 3	
3. Covers less than 60% of the ground	1	
IV. Depth of deepest litter (cm)		IV._____
1. 4 to 6	5	
2. 7 to 10	3- 4	
3. Less than 4, or more than 10	1- 2	
To Be Evaluated from Aerial Photographs		
V. Distance to forest (km)		V._____
1. Less than 0.25	5	
2. 0.25-0.50	3- 4	
3. More than 0.50	1- 2	
VI. Distance to permanent water (km)		VI._____
1. Less than 0.25	5	
2. 0.25-0.50	3- 4	
3. More than 0.50	1- 2	

Evaluation Element: BLUE-WINGED WARBLER Habitat Type: OLD FIELD

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 35

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

GRASSHOPPER SPARROW

(*Ammodramus savannarum*)

Life Requirements

General Habitat

The grasshopper sparrow is a fairly common summer resident in Missouri; it is most abundant in the prairie and Ozark border region (Widmann 1907:177; Bennitt 1932:62-63). Moderately to heavily grazed prairie is used by this sparrow in Missouri (Skinner 1975). Cultivated grasslands of orchard grass, alfalfa, or red clover are favored breeding areas throughout the range (Smith 1963). Sparrows in Georgia use old fields dominated by sparse herbaceous growth but with little shrub coverage (Johnston and Odum 1956). Grasshopper sparrows breed in natural clearings and sparsely wooded areas in Minnesota and Michigan (Roberts 1936:387; Walkinshaw 1940). In Pennsylvania grasslands managed in ways that prevent woody invasion are preferred habitat (Smith 1963).

Cover

Grassy areas with abundant small forbs and moderate to sparse grass densities are preferred cover (Johnston and Odum 1956; Shugart and James 1973). Grazing of grasslands in Missouri creates an interspersion of grass heights, providing both foraging areas and nesting sites (Skinner 1975). Some suitable cover in Arkansas is produced when fields are mowed, or grassy areas burned (Shugart and James 1973). Throughout their range, grasshopper sparrows avoid dense grass (Smith 1963; Shugart and James 1973; Skinner 1975).

Food and Water

Grasshopper sparrows generally forage in open areas within 5 cm of the ground (Wiens 1969:69, 1973). Insects, especially grasshoppers and their nymphs, are eaten in summer. In fall and winter, sparrows prefer seeds of waste grains and grasses (Judd 1901:63). Most of the water required by grasshopper sparrows is obtained from insect food. Some free water may be needed since birds in Kansas were observed near streams off their territories (W.R. Eddleman, personal observation).

Breeding and Nesting

Nests are built in partially open sites under clumps of litter or grass. Total litter is low and forb densities and heights are high in the vicinity of grasshopper sparrow nests (Wiens 1969:76-77). The nest, usually concealed by a dome of stems and blades of grasses, is lined with fine grass and rootlets (Smith 1968).

Males require song perches in their territories. Song perches may be heavy-stemmed forbs, shrubs, fences, posts or utility wires (Smith 1963; Wiens 1969:72).

Land Management

Grassland management has varied effects on habitat of grasshopper sparrows. Haying reduces grass height, but exposes nests to predators and weather (Smith 1963). Moderate grazing results in high grasshopper densities in Missouri (Skinner 1975). Burning of prairies maintains grassland habitat, but may stimulate plant growth, producing grass stands too dense for grasshopper sparrows. Nest sites and nesting material may be temporarily eliminated by fire (Eddleman 1974).

Important Foods of Grasshopper Sparrow

(Listings reflect relative order of importance.)

Animal	Plant (seeds)
Short-horned grasshoppers	Waste grains
Long-horned grasshoppers	Wood sorrel
Caterpillars	Giant ragweed
Click beetles	Foxtails
Ground beetles	Panic grasses
Weevils	Smartweeds
Leaf beetles	Purslane
Ants	Plantains
Dung beetles	
Spiders	
Snails	

Evaluation Element: GRASSHOPPER SPARROW Habitat Type: GRASSLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Average height of vegetation (cm)		I._____
1. 10-19.9	9-10	
2. 2- 9.9; or 20-30	3- 8	
3. Less than 2, or more than 30	1- 2	

(NOTE: If average height of vegetation in characteristic I is less than 5 cm, enter 1 for characteristic II and go directly to III.)

II. Diversity of vegetation heights		II._____
1. Not uniform: height of less than 50% of vegetation within 5 cm of average height	4- 5	
2. Uniform: height of more than 50% of vegetation within 5 cm of average height	1- 3	
III. Shade-producing woody invasion (average number of trees and clumps of shrubs per 50 m^2)		III._____
1. Less than 3	8-10	
2. 3-6	3- 7	
3. More than 6	1- 2	
IV. Litter depth (cm)		IV._____
1. 0.5-1.5	4- 5	
2. Less than 0.5, or more than 1.5	1- 3	
V. Forb canopy		V._____
1. Covers 10-25% of the ground	5	
2. Covers 26-50% of the ground	3- 4	
3. Covers less than 10% or more than 50% of the ground	1- 2	

To Be Evaluated from Aerial Photographs

VI. Distance to water (km)		VI._____
1. Less than 0.25	5	
2. 0.25-0.50	3- 4	
3. More than 0.50	1- 2	

Evaluation Element: GRASSHOPPER SPARROW Habitat Type: GRASSLAND

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 40

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

HENSLOW'S SPARROW

(*Ammodramus henslowii*)

Life Requirements

General Habitat

Henslow's sparrow is an uncommon summer resident in Missouri, confined to northern and western prairies in the State (Widmann 1907:178; Bennitt 1932:63). Preferred habitat throughout the bird's range consists of tall, dense grass (Skinner 1974:35) within neglected grassy fields, pastures, and marshy openings in woodlands (Graber 1968). Henslow's sparrow in Kentucky uses low-lying, damp prairies (Mengel 1965:485-486). Habitat characteristics in Michigan include dense stands or patches of sedges or grasses, moderate moisture, some litter, and suitable song perches (Robins 1971). Areas with a large proportion of forbs with high stem densities are avoided.

Cover

Henslow's sparrows use dense ground vegetation for escape and concealment. Most activity was at heights 60-100 cm above ground level in a Wisconsin study (Wiens 1969:73). In northern Missouri prairies, Skinner (1974:36) found that abundance of Henslow's sparrows increased markedly as grass heights exceeded 15 cm. The vertical vegetation profile should be tall and dense (Wiens 1969: 73). These requirements are satisfied by cord grass stands in Michigan (Hyde 1939:30), and unburned, ungrazed, or lightly grazed prairie in Missouri (Skinner 1975).

Food and Water

Insects and arachnids are the principal summer foods of Henslow's sparrow (Judd 1901:63-64). This sparrow forages in taller grass stands than do most grassland sparrows (Wiens 1969:73). Henslow's sparrows use habitats of intermediate moisture range in the Midwest and free water may sometimes be required for individual birds (Robins 1971).

Breeding and Nesting

Territorial males sing from forbs, strong grass stems of previous years' growth, or invading woody species (Wiens 1969:73; Robins 1971). Nests are constructed in clumps of grass stems, and rest on previous years' litter (Hyde 1939:36; Robins 1971). Nests are built of large, coarse grass stems and forb leaves, and are lined with smaller stems of grass or hair. Most nesting material is gathered within 15 m of the nest site (Hyde 1939:35). Because grass height is a critical factor (Skinner 1975), Henslow's sparrows do not breed in recently mowed (Smith 1963), heavily grazed, or recently burned grasslands (Eddleman 1974).

Important Foods of Henslow's Sparrow

(Listings reflect relative order of importance.)

Animal	Plant (seeds)
Short-horned grasshoppers	Grasses
Ground beetles	Sedges
Crickets	Giant ragweed
Katydids	Smartweeds
Leaf beetles	Blackberries
Caterpillars	
Click beetles	
Weevils	
Soldier bugs	
Flies	
Lacewings	
Spiders	
Snails	

Evaluation Element: HENSLOW'S SPARROW Habitat Type: GRASSLAND

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Average height of vegetation (cm)		I._____
1. More than 30	8-10	
2. 20 to 30	6- 7	
3. 10 to 19	3- 5	
4. Less than 10	1- 2	

(NOTE: If average height of vegetation in characteristic I is less than 10 cm, enter 1 for characteristic II and go directly to III.)

II. Diversity of vegetation heights		II._____
1. Not uniform: height of less than 50% of vegetation within 10 cm of the average height	4- 5	
2. Uniform: height of more than 50% of the vegetation within 10 cm of the average height	1- 3	
III. Shade-producing woody invasion (average number of trees and clumps of shrubs per 50 m^2)		III._____
1. Less than 3	8-10	
2. 3-6	3- 7	
3. More than 6	1- 2	
IV. Average litter depth (cm)		IV._____
1. 2-4	4- 5	
2. Less than 2, or more than 4	1- 3	
V. Forb canopy		V._____
1. Covers 10-25% of the ground	5	
2. Covers 26-50% of the ground	3- 4	
3. Covers less than 10% or more than 50% of the ground	1- 2	

To Be Evaluated from Aerial Photographs

VI. Distance to water (km)		VI._____
1. 0.25 or less	3- 5	
2. More than 0.25	1- 2	

Evaluation Element: HENSLOW'S SPARROW Habitat Type: GRASSLAND

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 40

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

PILEATED WOODPECKER

(*Dryocopus pileatus*)

Life Requirements

General Habitat

The pileated woodpecker is an uncommon permanent resident throughout Missouri (Bennitt 1932:41), and is most common in the southern half of the state (Widmann 1907: 123). It was once considered to inhabit extensive mature forests exclusively, whether deciduous or mixed with conifers (Bent 1939:165). Now it is known to adapt to second-growth forests as trees become mature (Christy 1939; Hoyt 1957), and will breed where young trees surround remnants of older stands (Christy 1939). Large trees are necessary to provide nesting and roosting cavities (Hoyt 1957). In Maryland, pileated woodpeckers were seen repeatedly in forested tracts as small as 40 ha (C.S. Robbins, personal communication). Territory size was given as 70 ha by Evans and Conner (1979). In Missouri, a pair of woodpeckers often uses several small woodlots for foraging (J.E. Rathert, personal communication).

Food and Water

The woodpecker's primary foods are insects found in fallen or standing timber. Termites, bark beetles, ground beetles, and ants are preferred foods (Beal 1911:33-35; Kilham 1976), but berries and acorns are also eaten in fall and winter (Christy 1939). Birds forage on recently dead trees by removing outer bark. They also feed from bark crevices and dead limbs of live trees; or rotting logs, stumps, and fallen branches (Kilham 1976). Young are fed carpenter ants, caterpillars, beetles, and flies.

Pileated woodpeckers usually nest near a permanent water source (Christy 1939; Hoyt 1957; Conner et al. 1975), but the importance of water to the bird is not known. A captive bird used free water for bathing, but obtained drinking water from crevices in trees and from insects (Hoyt 1957).

Breeding, Nesting, and Roosting

Male woodpeckers require several solid dead limbs scattered throughout their territory for use as drumming sites during courtship (Hoyt 1957). Pileated woodpeckers prefer to nest in cavities excavated in dead trees or large dead limbs of living trees (Christy 1939). Cavities are excavated in oaks, hickories, sugar and red maples, white ash, American elm, and basswood. Birds drilled cavities in hackberry and sycamore trees in Kentucky (Mengel 1965:293). Cavity trees were most frequently located in valleys or lowlands, and nest heights averaged 13.5 m (range: 4.5 to 21.0 m; Hoyt 1957). In Virginia, nest trees in forested sites ranged from 33-91 cm dbh, and averaged 55 cm; in woodlots and suburban areas, they averaged 48 cm (Conner et al. 1975).

Individual woodpeckers drill cavities for night roosts (Hoyt 1957). These cavities are usually more than 18 m from the ground in living trees, and are used from August to the next nesting season.

Important Foods of Pileated Woodpecker

(Listings reflect relative order of importance.)

Animal	Plant
Carpenter ants (larvae and adults)	Greenbriers
Wood-boring and bark beetle larvae	Sassafras
Termites	Blackberries
Moths	Sumacs
Flies	Poison ivy
Mosquitoes	Grapes
Wood cockroach	Virginia creeper
Sawflies	Dogwoods
	Persimmon
	Common elderberry
	Viburnums
	Acorns
	Pecan

Evaluation Element: PILEATED WOODPECKER

Habitat Type: UPLAND HARDWOOD & BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Tree size class and canopy closure		I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (More than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)
	No Size Class Predominant in Overstory
	M=mixed (must include sawtimber component)

1.	1-S; or 1-M; or overmature trees	10
2.	2-S	9
3.	2-M	8
4.	3-S	7
5.	3-M	6
6.	1-P	5
7.	2-P	4
8.	3-P	3
9.	1-R	2
10.	2-R; or 3-R	1

II. Canopy height (m) II._____

1.	More than 15	8-10
2.	10 to 15	4- 7
3.	Less than 10	1- 3

III. Number of tree species present (>30 cm dbh) suitable for nest sites III._____

1.	More than 5	5
2.	3-5	3- 4
3.	Less than 3	1- 2

(NOTE: If any species is abundant, increase the value of characteristic III.)

IV. Number of dead or partially dead sawtimber trees (per ha) IV._____

1.	More than 3	4- 5
2.	2-3	2- 3
3.	Less than 2	1

Evaluation Element: PILEATED WOODPECKER

Habitat Type: UPLAND HARDWOOD & BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
V. Number of important food plant species comprising more than 1% of total plants present		V._____
1. More than 6	5	
2. 4-6	3- 4	
3. Less than 4	1- 2	
To Be Evaluated from Aerial Photographs		
VI. Distance to permanent water (km)		VI._____
1. Less than 0.5	5	
2. 0.5-1.0	3- 4	
3. More than 1.0	1- 2	
VII. Size or arrangement of forested tract		VII._____
(NOTE: Score Part A if forested tract evaluated is larger than 40 ha; score Part B if tract evaluated is smaller than 40 ha.)		
A. Size of forested tract (ha)		A._____
1. More than 70	5	
2. 51-70	3- 4	
3. 41-50	1- 2	
B. Distance to other woodlot (km)		B._____
1. Less than 0.5	5	
2. 0.5-1.0	2- 4	
3. More than 1.0	1	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 45

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

BLACK-AND-WHITE WARBLER

(*Mniotilta varia*)

Life Requirements

General Habitat

The black-and-white warbler is an uncommon to fairly common summer resident in Missouri (Widmann 1907:212; Bennitt 1932:52). It is most abundant in bluff and Ozark border areas in the southern half of the State (Easterla and Anderson 1971). Mature woodlands with thick leaf litter are preferred habitat. In North America, the black-and-white warbler breeds in the ecotone between mesic and xeric forests, on leaf-strewn, dry, rocky hillsides or in dry portions of shady swamps (Tyler 1953). Black-and-white warblers in Kentucky breed in mature deciduous or broadleaf-evergreen forests (Mengel 1965:386-387). This species uses forest edges and well-advanced old fields in New York (Kendeigh 1945).

Food

Black-and-white warblers forage on large tree trunks in a fashion similar to that of the brown creeper (*Certhia familiaris*) or white-breasted nuthatch (*Sitta carolinensis*; Tyler 1953). They take insects, particularly beetles in bark crevices, but occasionally sally for flying insects (Forbush 1929:200; Tyler 1953; Griscom and Sprunt 1957:45). Caterpillars are the principal food fed to the young.

Breeding and Nesting

Dead branches near tops of exposed trees are used as singing posts by territorial male black-and-white warblers (Kendeigh 1945). Black-and-white warblers build nests on the ground, usually against a tree or shrub and concealed by an accumulation of dead leaves. Birds in New York use deciduous tree material to construct nests (Kendeigh 1945). Rarely, these warblers nest in broken snags or cavities (Tyler 1953). Aboveground nests, constructed of dry leaves, coarse grasses, strips of inner bark, and rootlets, are lined with finer grasses, horsehair, or mosses (Mousley 1916, Tyler 1953).

Important Foods of Black-and-white Warbler

(Listings reflect relative order of importance.)

Wood-boring beetles
Bark beetles
Leaf beetles
Flea beetles
Weevils
Click beetles
Caterpillars
Ants
Moths
Flies
Spiders
Harvestmen
Small wasps
Plant lice
Scale lice

Evaluation Element: BLACK-AND-WHITE WARBLER Habitat Type: UPLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Tree size class and canopy closure		I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1.	1-S; or overmature or dead trees	9-10
2.	1-M	8
3.	2-S	7
4.	2-M	6
5.	3-S	5
6.	3-M	4
7.	1-P	3
8.	2-P; or 3-P	2
9.	1-R; or 2-R; or 3-R	1

II. Shrub and herb canopy		II._____
1. Covers more than 65% of forest floor	8-10	
2. Covers 30-65% of forest floor	4- 7	
3. Covers less than 30% of forest floor	1- 3	

III. Tree canopy height (m)		III._____
1. 12 to 18	5	
2. More than 18	3- 4	
3. 8 to 11	2	
4. Less than 8	1	

IV. Leaf litter depth (cm)		IV._____
1. More than 7, variable depths	5	
2. More than 7, uniform depth	4	
3. 3-7, variable depths	3	
4. 3-7, uniform depth	2	
5. Less than 3	1	

Evaluation Element: BLACK-AND-WHITE WARBLER Habitat Type: UPLAND HARDWOOD

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

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(1) Maximum possible score for form ..... (1) 30

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

NORTHERN PARULA

(*Parula americana*)

Life Requirements

General Habitat

The northern parula is a fairly common summer resident in Missouri (Widmann 1907:220; Bennitt 1932:53). Throughout most of its range it is associated with watercourses, swampy areas, or shores of impoundments (Bent 1953:136). In Arkansas, mature bottomland forest, regardless of density of understory, provides the best habitat (Shugart and James 1973). The northern parula inhabits alluvial lowlands, swamp forests, moist ravines, and disturbed growth along streams in Kentucky (Mengel 1965:399).

Food

This warbler is insectivorous, preying on leaf beetles, moths, flies, and caterpillars (Wetmore 1916:107; Griscom and Sprunt 1957:98). The young are fed mainly lepidopteran larvae and mayflies (Graber and Graber 1951). The northern parula forages in the forest canopy above 15 m by gleaning foliage at the tips of small limbs (Morse 1967).

Breeding and Nesting

Territorial male northern parulas sing from perches in a forest canopy above 15 m (Morse 1967), and with more than 50% canopy closure (Missouri Cooperative Wildlife Research Unit, unpubl. data). The nest is built in tangled tufts of flood drift lodged in bushes, small trees, or bunches of leaves (Peterson 1946; Mengel 1965:400). Nests range from 3 to 9 m above the ground and are constructed of fine grasses, bark strips, plant down, and mosses. They are lined with fine rootlets or feathers (Bent 1953:140; Griscom and Sprunt 1957:98). In other portions of the range, Spanish moss or beard lichen are used for nest construction.

Important Foods of Northern Parula

(Listings reflect relative order of importance.)

Spiders
Lantern flies
Caterpillars
Leafhoppers
True bugs
Small wasps
Ants
Weevils
Leaf beetles
Long-horned beetles
Ladybird beetles
Darkling beetles
Moths
Flies
Mayflies

Evaluation Element: NORTHERN PARULA | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE

I. Tree size class and canopy closure — I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1.	1-S; or overmature trees	10
2.	1-M	9
3.	2-S	8
4.	2-M	7
5.	3-S	6
6.	3-M	5
7.	1-P	4
8.	2-P	3
9.	3-P	2
10.	1-R; or 2-R; or 3-R	1

II. Canopy height (m) — II._____

1.	More than 20	9-10
2.	15-20	5- 8
3.	10-14	2- 4
4.	Less than 10	1

III. Availability of flood drift (nesting sites) — III._____

1.	Tangles of leaves present in undergrowth	3- 5
2.	Tangles of leaves absent from undergrowth	1- 2

To Be Evaluated from Aerial Photographs

IV. Distance to water (km) — IV._____

1.	Less than 0.25	8-10
2.	0.25-0.50	5- 7
3.	More than 0.50	1- 4

Evaluation Element: NORTHERN PARULA Habitat Type: BOTTOMLAND HARDWOOD

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1)	Maximum possible score for form	(1)	35
(2)	Total maximum possible score(s) for characteristic(s) tallied as NA	(2)	
(3)	Corrected maximum possible score: (1) - (2)	(3)	
(4)	Total actual scores	(4)	
(5)	(4) ÷ (3) x 10	(5)	HABITAT UNIT VALUE

KENTUCKY WARBLER

(*Oporornis formosus*)

Life Requirements

General Habitat

The Kentucky warbler is a common summer resident of forests in Missouri, especially dark, dense stands in alluvial areas (Widmann 1907:235; Bennitt 1932:55). Moist, mature forests with abundant undergrowth are preferred habitat in Kentucky (Barbour et al. 1973:183). Birds also occupy overgrown clearings, swampy thickets, and woodland borders with rank undergrowth (Chapman 1907: 237).

Cover

The Kentucky warbler, a ground-dwelling bird, requires dense undergrowth and a dense canopy or subcanopy (Griscom and Sprunt 1957: 201). In Missouri, optimum stem densities of tall shrubs and tree reproduction surrounding song perches ranged from 5-13 stems per 25 m^2 (Missouri Cooperative Wildlife Research Unit, unpubl. data). Tangles of cane along streams in damp, heavily shaded woods or thickets provide excellent cover in Arkansas (Shugart and James 1973).

Food and Water

Ground-dwelling insects are the primary diet of this warbler, including moths, plant lice, ants, true bugs, beetles, and grubs (Howell 1924:316; Forbush 1929:289). This warbler usually forages on the ground, occasionally leaping about 1 m in pursuing an insect. Kentucky warblers have been observed eating berries in Massachusetts during summer (Forbush 1929:289).

Most territories of Kentucky warblers are located near a water source (Bent 1953:504; Griscom and Sprunt 1957:201).

Breeding and Nesting

Males use singing perches between 1 and 10 m high in Missouri (Missouri Cooperative Wildlife Research Unit, unpubl. data). Nests are on or near the ground sheltered by overhanging vegetation, patches of annual herbaceous plants, or at the base of a tree (Bent 1953:505; Barbour et al. 1973:183). Nests are constructed with dead leaves, grass stems, or grape bark and lined with dead leaves, fine rootlets, or some other fibrous materials (Chapman 1907:240).

Important Foods of Kentucky Warbler

(Listings reflect relative order of importance.)

Spiders
True bugs
Ground beetles
Caterpillars
Ants
Moths
Plant lice
Grubs
Berries

Evaluation Element: KENTUCKY WARBLER | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
I. Tree size class and canopy closure		I._____

Code

Canopy Closure	Size Class (dbh) of Trees Composing Predominant Foliage Layer (Overstory)
1=70-100%	S=sawtimber (more than 23 cm)
2=40- 69%	P=poles/small trees (5-23 cm)
3=10- 39%	R=reproduction (less than 5 cm)

No Size Class Predominant in Overstory

M=mixed (must include sawtimber component)

1.	1-M	10
2.	1-S	9
3.	1-P	8
4.	2-M	7
5.	2-S, 1-R	6
6.	2-P	5
7.	3-M	4
8.	3-S	3
9.	3-P	2
10.	2-R, or 3-R	1

II. Canopy of shrubs and herbs less than 1 m tall		II._____
1. Covers more than 80% of forest floor	8-10	
2. Covers 60-80% of forest floor	5- 7	
3. Covers 40-59% of forest floor	3- 4	
4. Covers less than 40% of forest floor	1- 2	
III. Leaf litter		III._____
A. Depth of leaf litter (cm)		A._____
1. More than 7	5	
2. 3-7	2- 4	
3. Less than 3	1	
B. Distribution of litter (> 5 cm deep)		B._____
1. Covers 50% or more of site	4- 5	
2. Covers less than 50% of site	1- 3	

(NOTE: Add A and B to obtain value for characteristic III.)

Evaluation Element: KENTUCKY WARBLER | Habitat Type: BOTTOMLAND HARDWOOD

CHARACTERISTIC	POSSIBLE SCORE	ACTUAL SCORE
IV. Average density of shrubs and tree reproduction more than 1 m tall (stems/m^2)		IV._____
1. More than 2	5	
2. 0.5-2	3- 4	
3. Less than 0.5	1- 2	
V. Frequency, time, and duration of flooding		V._____
1. No flooding or occasional short-term flooding during late winter and early spring	5	
2. Occasional long-term flooding during late winter and early spring	3- 4	
3. Frequent long-term flooding during growing season	1- 2	
To Be Evaluated from Aerial Photographs		
VI. Distance to water (km)		VI._____
1. 0.25 or less	3- 5	
2. More than 0.25	1- 2	

NOTES: (A) IF CHARACTERISTIC NOT APPLICABLE, ENTER NA AND DO NOT COUNT IT AS A CHARACTERISTIC USED.

(B) IF ALL CHARACTERISTICS ARE SCORED AS 1, DISREGARD COMPUTATIONS BELOW, AND ENTER 1 ON LINE (5) AS HABITAT UNIT VALUE.

---

(1) Maximum possible score for form ..... (1) 45

(2) Total maximum possible score(s) for characteristic(s) tallied as NA ..... (2) _____

(3) Corrected maximum possible score: (1) - (2) ..... (3) _____

(4) Total actual scores ..... (4) _____

(5) (4) ÷ (3) x 10 ..... (5) _____ HABITAT UNIT VALUE

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CONCLUSION

The Blue Handbook, predecessor of this publication, was tested repeatedly during its development. Sampling problems and changes in the field sheets affected the comparability of consecutive test results (Flood et al. 1977; Sparrowe and Sparrowe 1978). Nevertheless, the tests established that participants scoring in groups assigned less variable scores than did participants scoring individually. Seasonal differences in scoring performance were reported. Tests also indicated that habitat scores assigned by individual participants varied less when the Handbook was used than when it was not (Flood et al. 1977:68, 70).

After the Blue Handbook was published, it was used as one of four methods of habitat evaluation in extensive field tests (Ellis et al. 1978, 1979). Ninety-seven biologists from 13 State, Federal, and private agencies and universities participated. Used as a separate evaluation method, the Blue Handbook proved superior in several respects to the totally subjective HEP Form 3-1101 (U. S. Fish and Wildlife Service 1976); more consistent scores were assigned during different seasons, and scores were less affected by observers' experience in official (agencies') habitat scoring practices. Field time costs were slightly lower for the Blue Handbook than for the other methods. In some ways, it was inferior to the highly objective Matrix method (see Ellis et al. 1978). Value of the Blue Handbook as a complement to the other systems was not tested.

Field Testing the Yellow Handbook

All scoring sheets of the Yellow Handbook have been tested in the field by project staff members and others. Revisions and further limited tests were then made to reduce inaccuracies and ambiguities.

The final version of the Yellow Handbook has not been tested as exhaustively as was the Blue Handbook; however, it has the same approach and organizational scheme. It has fewer subjective criteria, and has been constructed to avoid other Blue Handbook problems found during field testing described by Ellis et al. (1978, 1979). In general, then, it can be expected to share many of the attributes of the Blue Handbook, but should lead to more accurate and consistent scoring.

This expectation was realized in results of field tests conducted in May 1979 after final revision of field sheets for the Yellow Handbook. Scoring individually, 10 biologists used each of 16 field sheets. Coefficients of variation (CV's) for only 3 of the 16 sets of scores exceeded 15% and half were 10% or less (Table 2).

Scoring was more consistent for some species than others. In some instances (turkey vs. deer, for example) the reasons are not clear. In others, variation probably reflects intrinsic difficulties in assessing quality of essential habitat characteristics or interactions among them. For example, presence of large trees is a key factor in pileated woodpecker habitat, and the field sheets emphasize this simple fact. For the blue-winged warbler, habitat quality depends on several complex vegetative characteristics of old fields, and is not so amenable to simple evaluation. Reflecting these differences, CV's for the pileated woodpecker were lower than those for the blue-winged warbler (Table 2).

Because several species were combined as evaluation elements in the Blue Handbook, results from the Blue and Yellow Handbooks cannot be compared directly. However, forest game scores from Blue Handbook tests conducted in July 1977 compared with Yellow Handbook scores for white-tailed deer and for turkey from May 1979 tests indicate that Yellow Handbook scores were indeed less variable than those from the Blue Handbook (Table 3). With one exception (Deer: Old Field Site 2), Yellow Handbook scores had CV's equal to or considerably lower than those for the Blue Handbook.

Table 2. Results of May 1979 field tests of Yellow Handbook by 10 participants, Ashland Wildlife Area, Boone County, Missouri.

Test site and evaluation element	Range	Mean ± 1/2 confidence interval (95%)	Coeff. of variation
Forest Site 1			
White-tailed deer	5.4-7.7	6.23 ± 0.55	0.12
Turkey	6.2-7.7	6.74 ± 0.37	0.08
Pileated woodpecker	8.0-9.7	8.65 ± 0.45	0.07
White-footed mouse	3.6-5.6	4.62 ± 0.51	0.15
Forest Site 2			
White-tailed deer	5.6-7.6	6.47 ± 0.41	0.09
Turkey	6.2-7.3	6.86 ± 0.24	0.05
Pileated woodpecker	5.5-7.2	6.31 ± 0.38	0.08
White-footed mouse	3.4-5.0	4.01 ± 0.32	0.11
Old Field 2			
White-tailed deer	3.9-9.5	6.67 ± 1.16	0.24
Turkey	6.6-8.8	7.88 ± 0.52	0.09
Prairie vole	3.9-7.0	5.80 ± 0.62	0.15
Blue-winged warbler	4.2-9.1	7.53 ± 0.92	0.17
Old Field 4			
White-tailed deer	6.3-9.3	8.03 ± 0.69	0.12
Turkey	7.4-8.9	8.19 ± 0.38	0.07
Prairie vole	5.4-7.6	6.20 ± 0.46	0.10
Blue-winged warbler	3.6-8.8	7.39 ± 1.10	0.21

Table 3. Comparison of forest game scores, Blue Handbook, July 1977, with deer and turkey scores, Yellow Handbook, May 1979. Tests were conducted at Ashland Wildlife Area, Boone County, Missouri.

Handbook tested, evaluation element, and test site		N	Mean ± 1/2 confidence interval (95%)	Range	Coeff. of variation
Blue Handbook-Forest Game (Deer and Turkey)					
Forest Site	1	18	5.07 ± 0.61	3.0-6.7	0.24
	2	19	5.57 ± 0.39	3.7-7.0	0.15
Old Field Site	1	19	5.92 ± 0.51	4.2-7.8	0.18
	2	18	6.75 ± 0.38	5.5-7.9	0.11
Yellow Handbook-Deer					
Forest Site	1	10	6.23 ± 0.55	5.4-7.7	0.12
	2	10	6.47 ± 0.41	5.6-7.6	0.09
Old Field Site	2	10	6.67 ± 1.16	3.9-9.5	0.24
	4	10	8.03 ± 0.69	6.3-9.3	0.12
Yellow Handbook-Turkey					
Forest Site	1	10	6.74 ± 0.37	6.2-7.7	0.08
	2	10	6.86 ± 0.24	6.2-7.3	0.05
Old Field Site	2	10	7.88 ± 0.52	6.6-8.8	0.09
	4	10	8.19 ± 0.38	7.4-8.9	0.07

Uses of the Handbook

Even though the Yellow Handbook was written specifically for central Missouri habitats, we believe that it can be used in most of the Oak-Hickory Forest Section of the Eastern Deciduous Forest delineated by Bailey (1976). The kinds of criteria presented here should prove useful in developing criteria for other regions, and only slight modifications would be needed to adapt the criteria and weighting schemes to similar ecoregions. Much of the information about life requirements of the species used as evaluation elements was drawn from the best sources, no matter where the studies were made. This information should be useful outside central Missouri.

We hope that this Handbook will have value as a training supplement to official habitat evaluation procedures for Federal projects in which the HEP manual (U. S. Fish and Wildlife Service 1976) is used.

We believe it may be particularly useful to orient persons not familiar with procedures in habitat evaluation. It may be helpful for evaluators who are not thoroughly acquainted with the Oak-Hickory Forest Section (Bailey 1976) or the wildlife species associated with it, by elucidating life requirements and critical habitat characteristics for these species.

We believe this Handbook or derivatives of it can serve as principal evaluation instruments in studies not requiring official HEP activities. Examples may be evaluations for power line siting, State or city park management plans, and circumscribed areas in which wildlife research is to be conducted.

For all of these uses, we suggest trial runs, after which all participants confer about their scores and the reasons they assigned them. We believe that this practice will produce better relative scores for different habitats, even when group rather than individual scores ultimately will be used.

Finally, the real test of a handbook of this sort is whether the scores reflect animal abundance or wildlife usage of the habitat. In a few instances (e.g., grasshopper sparrow and Henslow's sparrow) we have "tuned" the field sheets to reflect known abundance of the animals. In most instances, however, the criteria on the field sheets represent our best estimates of habitat needs, without supporting data on animal numbers.

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APPENDIX I

COMMON AND SCIENTIFIC NAMES OF PLANTS MENTIONED IN TEXT

ACANTHACEAE

Water willow (*Justicia americana*)

ACERACEAE

Maples (*Acer* spp.)
Red maple (*Acer rubrum*)
Silver maple (*Acer saccharinum*)
Sugar maple (*Acer saccharum*)

ALISMACEAE

Arrowheads (*Sagittaria* spp.)

ANACARDIACEAE

Dwarf sumac (*Rhus copallina*)
Fragrant sumac (*Rhus aromatica*)
Poison ivy (*Rhus radicans*)
Smooth sumac (*Rhus glabra*)

BALSAMINACEAE

Spotted touch-me-not (*Impatiens capensis*)

BETULACEAE (CORYLACEAE)

Hop hornbeam (*Ostrya virginiana*)
River birch (*Betula nigra*)

BROMELIACEAE

Spanish moss (*Tillandsia usneoides*)

CAPRIFOLIACEAE

Black haw (*Viburnum prunifolium*)
Common elderberry (*Sambucus canadensis*)
Coral berry (*Symphoricarpos orbiculatus*)
Viburnums (*Viburnum* spp.)

CHENOPODIACEAE

Pigweed (*Chenopodium album*)

COMPOSITAE

Asters (Aster spp.)
Beggar ticks (Bidens spp.)
Common ragweed (Ambrosia artemisiifolia)
Daisy fleabane (Erigeron strigosus)
Dandelion (Taraxacum officinale)
Fleabanes (Erigeron spp.)
Giant ragweed (Ambrosia trifida)
Goldenrods (Solidago spp.)
Lance-leaf ragweed (Ambrosia bidentata)
Lettuces (Lactuca spp.)
Pussy's toes (Antennaria plantaginifolia)
Ragweeds (Ambrosia spp.)
Sunflowers (Helianthus spp.)
Tall thistle (Cirsium altissimum)
White heath aster (Aster pilosus)
Whitetop fleabane (Erigeron annuus)

CORNACEAE

Black gum (Nyssa sylvatica)
Dogwoods (Cornus spp.)
Flowering dogwood (Cornus florida)

CRUCIFERAE

Water cress (Nasturtium officinale)

CUPRESSACEAE

Red cedar (Juniperus virginiana)

CYPERACEAE

Sedges (Carex spp.)
Spike rushes (Eleocharis spp.)
Yellow nut grass (Cyperus esculentus)

EBENACEAE

Persimmon (Diospyros virginiana)

EQUISETACEAE

Horsetails (Equisetum spp.)

EUPHORBACEAE

Crotons (Croton spp.)
Milk purslane (Euphorbia supina)
Nodding spurge (Euphorbia maculata)
Three-seeded mercuries (Acalypha spp.)
Three-seeded mercury (Acalypha virginica)

FAGACEAE

Acorns (Quercus spp.)
Black oak (Quercus velutina)
Black jack oak (Quercus marilandica)
Bur oak (Quercus macrocarpa)
Chinquapin oak (Quercus prinoides)
Pin oak (Quercus palustris)
Post oak (Quercus stellata)
Red oak (Quercus rubra)
Shingle oak (Quercus imbricaria)
Shumard oak (Quercus Shumardii)
Swamp white oak (Quercus bicolor)
White oak (Quercus alba)
Willow oak (Quercus Phellos)

GERANIACEAE

Wild geranium (Geranium maculatum)

GRAMINEAE

Barnyard grass (Echinochloa crusgalli)
Big bluestem (Andropogon Gerardi)
Blue grasses (Poa spp.)
Brome grasses (Bromus spp.)
Broom sedge (Andropogon virginicus)
Cane (Arundinaria gigantea)
Chess (Bromus secalinus)
Common crab grass (Digitaria sanguinalis)
Common millet (Setaria italica)
Cord grass (Spartina pectinata)
Corn (Zea Mays)
Crab grasses (Digitaria spp.)
Downy chess (Bromus tectorum)
Dropseeds (Sporobolus spp.)
Fall panic grass (Panicum dichotomiflorum)
Fescue (Festuca elatior)
Fescues (Festuca spp.)
Foxtails (Setaria spp.)
Goose grass (Eleusine indica)
Green foxtail (Setaria viridis)
Hairy chess (Bromus racemosus)
Indian grass (Sorghastrum nutans)
Japanese chess (Bromus japonicus)
Johnson grass (Sorghum halepense)
Kentucky blue grass (Poa pratensis)
Little bluestem (Andropogon scoparius)
Love grasses (Eragrostis spp.)
Muhly grasses (Muhlenbergia spp.)
Nodding foxtail (Setaria Faberii)
Oats (Avena sativa)
Orchard grass (Dactylis glomerata)
Panic grasses (Panicum spp.)
Paspalums (Paspalum spp.)
Prairie dropseed (Sporobolus heterolepis)
Purpletop (Tridens flavus)
Quack grass (Agropyron repens)
Reed canary grass (Phalaris arundinacea)
Sideoats grama (Bouteloua curtipendula)
Small crab grass (Digitaria Ischaemum)

GRAMINEAE (continued)

Smooth brome (Bromus inermis)
Sorghums (Sorghum spp.)
Switch grass (Panicum virgatum)
Timothy (Phleum pratense)
Wheat (Triticum aestivum)
Wild oat grass (Danthonia spicata)
Wild ryes (Elymus spp.)
Yellow foxtail (Setaria glauca)

HAMAMELIDACEAE

Sweet gum (Liquidambar Stryraciflua)

HYDROCHARITACEAE

Eelgrass (Vallisneria americana)
Waterweed (Anacharis Nuttallii)

JUGLANDACEAE

Big shellbark hickory (Carya laciniosa)
Bitternut hickory (Carya cordiformis)
Walnut (Juglans nigra)
Hickories (Carya spp.)
Pecan (Carya illinoensis)
Pignut hickory (Carya glabra)
Shagbark hickory (Carya ovata)

JUNCACEAE

Soft rush (Juncus effusus)

LAURACEAE

Sassafras (Sassafras albidum)

LEGUMINOSAE

Alfalfa (Medicago sativa)
Clovers (Trifolium spp.)
Eastern redbud (Cercis canadensis)
Honey locust (Gleditsia triacanthos)
Korean lespedeza (Lespedeza stipulacea)
Lespedezas (Lespedeza spp.)
Large hop clover (Trifolium campestre)
Red clover (Trifolium pratense)
Soy beans (Glycine Max)
Sweet clovers (Melilotus spp.)
Tick trefoils (Desmodium spp.)
White clover (Trifolium repens)
Wild beans (Strophostyles spp.)

LEMNACEAE

Duckweeds (Lemna spp.)

LILIACEAE

Bristly greenbriar (Smilax tamnoides)
Greenbriars (Smilax spp.)
Onion (Allium Cepa)
White dog-tooth violet (Erythronium albidum)

MALVACEAE

Prickly mallow (Sida spinosa)

MORACEAE

Mulberries (Morus spp.)
Osage orange (Maclura pomifera)
Red mulberry (Morus rubra)

NAJADACEAE

Fennel-leaved pondweed (Potamogeton pectinatus)
Pondweeds (Potamogeton spp.)

NYMPHAEACEAE

American lotus (Nelumbo lutea)
Fragrant water lily (Nymphaea odorata)
Water-shield (Brasenia Schreberi)
Yellow pond lily (Nuphar luteum)

OLEACEAE

Ashes (Fraxinus spp.)
Green ash (Fraxinus pennsylvanica)
White ash (Fraxinus americana)

OXALIDACEAE

Violet wood sorrel (Oxalis violacea)
Wood sorrels (Oxalis spp.)
Yellow wood sorrel (Oxalis stricta)

PHYTOLACCACEAE

Pokeweed (Phytolacca americana)

PLANTAGINACEAE

English plantain (Plantago lanceolata)
Plantains (Plantago spp.)
Rugel plantain (Plantago Rugelii)

PLATANACEAE

Sycamore (Platanus occidentalis)

POLYGONACEAE

Buckwheat (Fagopyrum sagittatum)
False buckwheat (Polygonum scandens)
Knotweed (Polygonum aviculare)
Sheep sorrel (Rumex Acetosella)
Smartweeds (Polygonum spp.)
Sour dock (Rumex crispus)
Wild water pepper (Polygonum hydropiperoides)

POLYPODIACEAE

Ferns (multiple genera)

PORTULACACEAE

Purslane (Portulaca oleracea)

RANUNCULACEAE

Buttercups (Ranunculus spp.)
Small-flowered crowfoot (Ranunculus abortivus)

RHAMNACEAE

New Jersey Tea (Ceanothus americanus)

ROSACEAE

Apples (Pyrus spp.)
Blackberries (Rubus spp.)
Black cherry (Prunus serotina)
Cherries (Prunus spp.)
Cinquefoil (Potentilla simplex)
Dewberry (Rubus flagellaris)
Hawthorns (Crataegus spp.)
Multiflora rose (Rosa multiflora)
Pasture rose (Rosa carolina)
Plums (Prunus spp.)
Raspberries (Rubus spp.)
Roses (Rosa spp.)
Shadbush (Amelanchier arborea)
Strawberries (Fragaria spp.)
Wild Plum (Prunus americana)

RUBIACEAE

Bedstraws (Galium spp.)
Buttonbush (Cephalanthus occidentalis)

SALICACEAE

Black willow (Salix nigra)
Cottonwood (Populus deltoides)
Willows (Salix spp.)

SOLANACEAE

Horse nettle (Solanum carolinense)

SPARGANIACEAE

Bur-reeds (*Sparganium* spp.)

TILIACEAE

Basswood (*Tilia americana*)

TYPHACEAE

Cat-tails (*Typha* spp.)

ULMACEAE

American elm (*Ulmus americana*)
Elms (*Ulmus* spp.)
Hackberry (*Celtis occidentalis*)
Red elm (*Ulmus serotina*)
Slippery elm (*Ulmus rubra*)

VITACEAE

Grapes (*Vitis* spp.)
Raccoon grape (*Ampelopsis cordata*)
River-bank grape (*Vitis riparia*)
Virginia creeper (*Parthenocissus quinquefolia*)

APPENDIX II

ANIMAL FOODS LIST

ARTHROPODA

- Arachnida
  - Harvestmen
  - Spiders
- Chilopoda
  - Centipedes
- Crustacea
  - Crayfish
  - Isopods
- Diplopoda
  - Millipedes
- Insecta
  - Coleoptera
    - Bark beetles
    - Click beetles
    - Darkling beetles
    - Diving beetles
    - Dung beetles
    - Flea beetles
    - Ground beetles
    - Grubs
    - Horned beetles
    - Japanese beetles
    - June beetles
    - Ladybird beetles
    - Leaf beetles
    - Long-horned beetles
    - Scavenger beetles
    - Weevils
    - Wood-boring beetles
  - Diptera
    - Adult midges
    - Crane flies
    - Flies
    - Horse flies
    - Mosquitos
  - Ephemeroptera
    - Mayflies

ARTHROPODA, Insecta (continued)

Hemiptera

Soldier bugs
Stink bugs
True bugs
Water striders

Homoptera

Aphids
Lantern flies
Leaf hoppers
Plant gall insects
Plant lice
Scale lice

Hymenoptera

Ants
Carpenter ants
Ichneumon flies
Saw flies
Wasps

Isoptera

Termites

Lepidoptera

Caterpillars
Moths

Neuroptera

Lacewings

Odonata

Damsel flies
Dragonfly naiads

Orthoptera

Crickets
Katydids
Long-horned grasshoppers
Short-horned grasshoppers
Walking stick
Wood cockroach

MOLLUSCA

Gastropoda

Slugs
Snails

Pelecypoda

Clams

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