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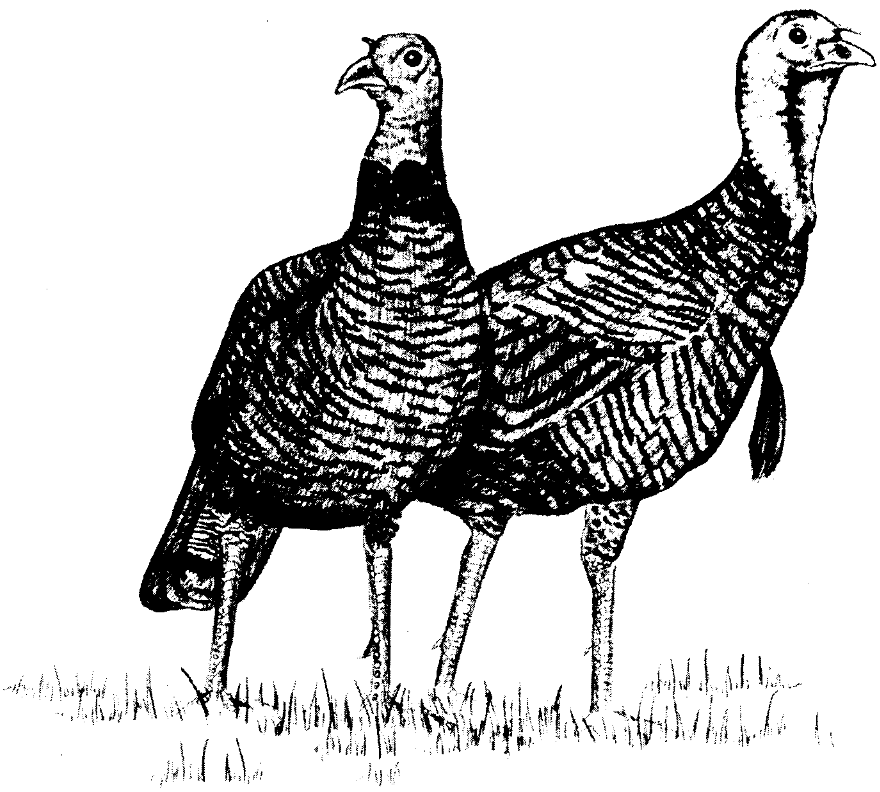
HABITAT SUITABILITY INDEX MODELS: EASTERN WILD TURKEY



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HABITAT SUITABILITY INDEX MODELS: EASTERN WILD TURKEY

by

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PREFACE

This document is part of the Habitat Suitability Index (HSI) Model Series [Biological Report 82(10)] which provides habitat information useful for impact assessment and habitat management. Several types of habitat information are provided. The Habitat Use Information Section is largely constrained to those data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. This information provides the foundation for the HSI model and may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

The HSI Model Section documents the habitat model and includes information pertinent to its application. The model synthesizes the habitat use information into a framework appropriate for field application and is scaled to produce an index value between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). The HSI Model Section includes information about the geographic range and seasonal application of the model, its current verification status, and a list of the model variables with recommended measurement techniques for each variable.

The model is a formalized synthesis of biological and habitat information published in the scientific literature and may include unpublished information reflecting the opinions of identified experts. Habitat information about wildlife species frequently is represented by scattered data sets collected during different seasons and years and from different sites throughout the range of a species. The model presents this broad data base in a formal, logical, and simplified manner. The assumptions necessary for organizing and synthesizing the species-habitat information into the model are discussed. The model should be regarded as a hypothesis of species-habitat relationships and not as a statement of proven cause and effect relationships. The model may have merit in planning wildlife habitat research studies about a species, as well as in providing an estimate of the relative quality of habitat for that species. User feedback concerning model improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to fish and wildlife planning are encouraged. Please send suggestions to:

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EASTERN WILD TURKEY (*Meleagris gallopavo sylvestris*)

HABITAT USE INFORMATION

General

Eastern wild turkeys (*Meleagris gallopavo sylvestris*) occupy a wide range of habitats (Dickson et al. 1978; Bailey et al. 1981), with diversified habitats providing optimum conditions (Bailey and Rinnell 1968; Bailey et al. 1981). Bottomland hardwood forests in association with upland forests, fields, and pastures is the preferred turkey range in the Southeast (G. A. Hurst, Department of Wildlife and Fisheries, Mississippi State University, Mississippi State; letter dated December 3, 1984). Clearings and savannas scattered throughout the forest provide important brood-rearing, feeding, and dusting sites (Bailey et al. 1981). Preferred habitat in forested regions of the agricultural midwest consists of equal amounts of forest and open pastures or cropland, with abundant edge between these habitats (Little 1980; W. F. Porter, College of Environmental Science and Forestry, State University of New York, Newcomb; letter dated December 18, 1984).

Eastern wild turkeys are residents in 34 states, from the southern tip of Maine west to southwestern Minnesota, south through eastern Nebraska to east Texas, and across the southern states, excluding Florida (Bailey 1980).

Food

Eastern wild turkeys are opportunistic omnivores (Bailey and Rinnell 1968) and their diet reflects the types of plant and animal foods that are available (Dalke et al. 1942). The average annual food intake of the turkey consists of 90% plant and 10% animal material (Korschgen 1967). Principal plant food groups in the diet include mast, fruits, seeds, greens, and agricultural crops. Analysis of the contents of 524 turkey stomachs from Virginia revealed over 354 species of plants, representing 80 families (Mosby and Handley 1943). Turkeys also eat a wide variety of animal matter (Korschgen 1967).

Acorns are an important staple food and comprise an average of 17% of the year-round diet by volume, and 32% of the fall and winter diet (Korschgen 1967). Acorns were eaten year round in Missouri, with monthly volumes ranging from a trace in July to 73.3% of the January diet. Acorns comprised one-half to two-thirds of the fall, winter, and spring foods of the eastern wild turkey in Pennsylvania (Kozicky 1942 cited by Korschgen 1967). A variety of oak species (*Quercus* spp.) should be maintained to avoid acorn crop failures, and to help stabilize both food supplies and wildlife populations that use acorns

(Christisen and Korschgen 1955). Mast failures in Georgia and Alabama did not affect turkey survival due to the general availability of alternate food sources (Markley 1967). Turkeys in Louisiana had high population densities in some habitats where oaks were scarce (Dickson et al. 1978). Turkeys in this area obtained green forage from winter crops or from areas that were burned in the winter, as well as mast from species other than oaks.

Grass leaves and seeds are important foods and are consumed most frequently during winter and spring (Korschgen 1967). Turkeys in Missouri used a wide variety of foods; optimum management practices provide for establishing and maintaining diversified habitats within their annual range (Korschgen 1973). Food produced in forest openings and open woodlands was used extensively by turkeys. Flowering dogwood (Cornus florida), black gum (Nyssa sylvatica), wild cherry (Prunus serotina), hackberry (Celtis occidentalis), and similar trees add diversity to the food supply and improve turkey habitat.

Food was not believed to be a limiting factor for turkeys in West Virginia (Bailey and Rinnell 1968) or in the Georgia and Alabama portion of their range (Markley 1967). However, Davis (1976) noted that food can be a limiting factor in areas with large pure stands of pine (Pinus spp.). In an Alabama study area dominated by young pine plantations, food was provided primarily by other forest types (Kennamer et al. 1980). Food also may be lacking during winters in the upper Mississippi Valley portion of the wild turkey's range (Porter et al. 1980). Home range size and habitat use are influenced by the available food resources, with winter food needs exerting the greatest impact (Lewis and Kurzejeski 1984).

The food habits of eastern wild turkeys vary throughout the year (Bailey and Rinnell 1968). Fruits of virtually all plant species are taken in season. Spring foods in Missouri were obtained from the following plant types (percentages are volume measurements): trees (mostly oaks), 53.6%; farm crops, 16.6%; forbs, 13.4%; native grasses, 3.9%; shrubs, 3.7%; sedges (Carex spp.), 3.1%; and vines, 0.8% (Korschgen 1973). Animal foods and plant galls provided the remainder of the spring foods. Green herbaceous growth from wheat (Triticum aestivum), rye (Secale cereale), and alfalfa (Medicago sativa) was an important spring food source in another Missouri study (Ellis and Lewis 1967). In West Virginia, grass is important all year, but especially in early spring when turkeys apparently subsist on it (Bailey and Rinnell 1968). Wheat, rye, and other similar green vegetation provides important turkey forage in late winter and early spring (Hurst, unpubl.).

Insects are important summer foods for young turkey poults (Bailey and Rinnell 1968; Hurst and Stringer 1975). In Mississippi, poults 3 to 7 days old consumed 79% animal food and 21% plant food (Hurst and Stringer 1975). The percentage of animal foods consumed declined steadily as poults got older, and animal foods accounted for only 13% of the diet at 22 to 38 days of age. Insects made up over 80% of the animal foods consumed. Summer foods of juvenile turkeys in Alabama included 61.5% grasses (mostly seeds) and 15.5% grasshoppers (Orthoptera), by volume (Hamrick and Davis 1972). Animal foods were more abundant in forest openings and other areas with abundant herbaceous growth, than in forested habitats (Blackburn et al. 1975; Hurst and Stringer 1975; Martin and McGinnes 1975). Forest clearings in Virginia contained 25 times more insects than were present under the forest canopy, and turkey poults needed less time in clearings than in forests to obtain the same quantity of insects (Martin and McGinnes 1975). Alfalfa fields provided important feeding habitat in Minnesota during the spring and summer (Porter 1978).

Important fall foods of the wild turkey include crabgrass (Digitaria sanguinalis), acorns, grass and sedge leaves, tick-trefoil (Desmodium spp.), and beechnuts (Fagus grandifolia) (Korschgen 1967). Turkeys in Alabama fed in more open fields and pastures in the fall, and shifted to forested habitats that supplied acorns and other mast as food became less plentiful towards winter (Barwick and Speake 1973). Fall range in the mountains of the Southeast consisted of mast producing hardwood forests (Healy 1981). The value of the range increased as both the proportion of hardwood forest and the percent in mast production increased. Trees that may provide fall and winter foods for the eastern wild turkey include oaks, dogwoods, beech, gums, ash (Fraxinus spp.), pecans and hickories (Carya spp.), pines, cherries, sumacs (Rhus spp.), and hawthorn (Crataegus spp.) (Korschgen 1967).

Early winter foods in Virginia included grapes (Vitis spp.), acorns, corn (Zea mays), dogwood fruits, grass blades, and ash seeds (Martin et al. 1939). Fruiting shrubs provided over 10% of the winter diet of the eastern wild turkey (Korschgen 1967). Waste grain was an important winter food in Missouri (Ellis and Lewis 1967). Turkeys in the Upper Missouri Valley made extensive use of corn fields located adjacent to hardwood stands (Porter et al. 1980). Areas lacking corn experienced a 60% loss of turkeys during severe winters, whereas those with available corn had losses of less than 15%. Corn, oats (Avena sativa), and wheat are the primary cultivated grains consumed by turkeys (Korschgen 1967). Corn is highly digestible, whereas oats are less digestible by wild turkeys (Glover and Bailey 1949). Soybeans (Glycine max) are a highly preferred food in Missouri (J. B. Lewis, Missouri Department of Conservation, Columbia; letter dated November 8, 1984).

Croplands played a major role in maintaining turkey populations in northern Missouri (Lewis and Kurzejeski 1984). Cropfields without adjacent stands of mature timber were seldom used. Furthermore, regardless of the amount of adjacent mature timber, croplands were used much less when acorns were abundant. This suggests that crops may be a secondary food source. Wintering turkeys in Minnesota fed on either acorns in hardwood forests or corn depending on the abundance of these two major food resources (Porter 1978). Hardwood habitats were important, but agricultural areas provided the reliable and abundant food supplies needed to maintain turkey populations.

Turkeys also eat tubers, bulbs, rhizomes, earthworms, millipedes, spiders, snails, and salamanders hidden within and below the layer of leaves and organic matter on the ground (Bailey and Rinnell 1968). These food items are available year round, except during periods of deep snow or frozen ground.

Water

Water is an essential factor in good turkey range. Turkeys in the eastern United States can easily obtain water year-round from streams, ponds, seeps, or depressions in the ground (Korschgen 1967). Water was apparently not required in early brood ranges in the mountains of the Southeast, because hens and broods could obtain adequate amounts of water from their food (Healy 1981). The presence of a free water source also was not an important factor in brood habitat selection in Minnesota (Porter 1980).

Cover

Wild turkeys use forested habitats for cover throughout the year, and spend a large amount of time loafing and feeding in open areas (Porter, unpubl.). A mixture of forests and open lands may provide habitat that is equal or superior to extensive forested areas (Little 1980; Hecklau et al. 1982). Turkeys appear to prefer woodlands that are open and mature (Lindzey 1967; Markley 1967), possibly because such habitats allow the turkey to use its keen eyesight to detect predators and increase its chances for escape and survival (Lindzey 1967). Dense, brushy areas are used for escape cover, but such areas are not preferred for normal activities. Favored travel areas in a Georgia study had scant ground cover and good eye-level visibility (Eichholz and Marchinton 1976). Areas with dense briars or saplings were not used for travel. Forested stands composed of one or only a few tree species (especially conifers) provide poor turkey habitat (Bailey and Rinnell 1968). Preferred foraging cover for hens with young consists of fields or open forests where the herbaceous vegetation is high enough to provide concealment and sparse enough to allow easy movement.

Ideal turkey range in Alabama was described as follows by Davis (1976:22):

> "It is generally agreed that ideal wild turkey range in Alabama consists of a minimum of 5,000 acres of a multi-aged, mixed, pine-hardwood forest, interspersed with ample meadow or grassy openings. Ideal range should also have a relatively open understory, consisting of shrubs, vines, saplings and small trees, a high percentage of which are dogwood and other food-producing types such as plums, mayhaws, and muscadines. Openings may account for as much as 25-30 percent of the total acreage, provided these are several in number and are well distributed throughout the forested habitat. Ideal range is well watered with springs, small streams, ponds, or rivers and consists of the usual mixture of hardwood forest tree species, including a number of different kinds of oaks."

Habitats providing poor turkey range include large acreages of even-aged, short rotation pine plantations, intensive agricultural areas (particularly row crops), and areas with either dense human populations or high levels of human activity (Davis 1976).

Winter was a time of stress for wild turkeys in Vermont, and some flocks that normally wintered in northern hardwoods sought dense conifers during periods of extreme cold (Bortner and Bennett 1980). Winter roost sites in Pennsylvania were not different from adjacent forest stands, and forests with a balance of age classes that provide adequate food would likely provide adequate winter roost sites (Tzilkowski 1971).

Turkeys in southeastern Minnesota had difficulty moving in snow that exceeded 25.0 cm in depth (Porter 1977), and prolonged periods of deep snow in this region can be a limiting factor for turkeys (Porter et al. 1980). Severe winter weather with deep snows and a poor food supply caused high winter mortality of turkeys in West Virginia (Glover 1948). Although snow may cause some mortality, the highest turkey populations and largest broods in West Virginia often occurred in areas that received the greatest snowfall (Bailey and Rinnell 1968). Turkeys in another West Virginia study area tended to seek areas with the least amount of snow, for ease of feeding (Healy 1977). Feeding sites in cherry (Prunus spp.)-maple (Acer spp.) forests were characterized by seeps, southern exposures, and sawtimber stands with a high proportion of wild cherry.

Turkeys in the Upper Mississippi Valley were frequently restricted by snow in winter to less than 10% of their normal range (Porter et al. 1980). Spring seeps, important winter food source areas in the eastern United States, are uncommon in the Upper Mississippi Valley and mast production is often poor. Areas with corn available through winter tended to provide enough high quality food to mitigate the effects of severe winters.

Turkey dusting sites are frequently in the dry residue of rotted logs, ant hills, newly tilled soils, or other bare soil areas (Bailey and Rinnell 1968).

Reproduction

Turkeys nest on the ground in areas concealed by fairly dense brush, vines, deep grass, or fallen tree tops (Williams 1981). Hay fields, fence rows, and utility rights-of-way provide important nest sites in densely forested areas. Nests in the Southeast were found mostly in or near openings (Hillestad 1973; Speake et al. 1975), and large forested areas lacking openings provided poor nesting habitats (Davis 1976).

Thirty-seven percent of the nests in an Alabama study were on power line rights-of-way, although this cover type comprised only 0.6% of the study area (Everett 1982). Turkeys avoided nesting in the rights-of-way when the average vegetation height was less than 25.0 cm during the first year these areas were mowed. Nests were placed in the rights-of-way in the second and third years after mowing, when the vegetation consisted of mixed herbaceous growth and low shrubs with heights from 1 to 2 m. Such vegetation conditions were preferred nest sites wherever they occurred, and provided 73% of all nest sites located in the study area.

Vegetation around nests in the mountains of the Southeast usually provided hens with a wide view of the surroundings, yet still provided concealing cover (Healy 1981). Ground cover less than 25.0 cm tall was usually sparse, while cover 25.0 to 50.0 cm tall was provided by brush, vines, slash or fallen logs. Woody understory greater than 50.0 cm tall and less than 2.5 cm dbh was frequently moderately dense. Preferred foraging cover for hens with young appears to be that which is tall enough to conceal the young for the six weeks after hatching, but short enough to allow females enough visibility to detect distant predators (Porter, unpubl.). Healy (1981) concluded that all common forest types in the Southeast could provide suitable nesting habitat.

Striped skunks (Mephitis mephitis), raccoons (Procyon lotor), and opossums (Didelphis marsupialis) accounted for approximately two-thirds of nest predation in Alabama (Davis 1976). Logging, mowing, or haying may cause nest abandonment, or may cripple or kill the hen. In another Alabama study, raccoons, feral dogs, and opossums were the three most significant nest predators (Speake 1980).

The essential feature of turkey brood habitat is adequate herbaceous vegetation (Healy and Nenno 1983), and the lack of high quality brood rearing habitat may be a limiting factor for turkeys in some areas (Hillestad and Speake 1970). The presence of high quality brood rearing habitat increases the rate of turkey poult survival (Davis 1976). In an Alabama study area, only 2% of the forest habitat contained openings, and it appeared that this absence of adequate brood range was a limiting factor for this turkey population (Everett 1982).

Broods in West Virginia preferred forest understories with abundant herbaceous growth and avoided stands with a dense woody understory (Pybus 1977). Broods preferred forests with basal areas between 9 and 18 m^2/ha and avoided forests with basal areas exceeding 23 m^2/ha (Pack et al. 1980). Coniferous forest types received little or no brood use.

Early brood range in the mountainous regions of the Southeast is characterized by abundant, low growing herbaceous cover, with few overstory trees (Healy 1981). The biomass of herbaceous vegetation is more important than the species composition. Sparse herbaceous understories, 9.0 to 23.0 cm tall and 100 to 460 kg/ha dry weight, typical of many oak forests, did not provide enough seeds or insects for poult feeding. Lush orchardgrass (Dactylis glomerata) stands, 78.0 cm tall and 3,380 kg/ha dry weight, provided an abundance of insects, but were too dense for foraging poults to move through.

Healy (1978) estimated that the best habitat for young broods in the Southeast consisted of a complete cover of forbs and grasses, 40.0 to 70.0 cm tall, with a biomass of 600 to 3,000 kg/ha dry weight. This vegetation structure provides food for both hens and poults, cover for poults, and allows hens to see over the top of the vegetation while remaining concealed. This type of vegetation is abundant in fields, and also occurs in mesic forests. Interspersion of trees and openings allows broods to escape predators and to select a suitable microclimate within a short distance. As an alternative to biomass measurements, Healy (W. M. Healy, U.S. Forest Service, Holdworth Hall, University of Massachusetts, Amherst; pers. comm.) recommended the following to describe ideal early brood range: (1) 60 to 100% total vegetative cover (woody and herbaceous) in the understory; (2) vegetation heights from 20.0 to 60.0 cm; and (3) at least one-half the vegetation comprised of herbaceous growth.

Forest clearings should be managed for young poults (less than one month old) due to the poults' high mortality rates, small home ranges, specialized food habits, and narrow habitat requirements compared to older poults and adults (Healy and Nenno 1983). Brood range for older poults can be provided by a larger variety of habitat types. Older poults can utilize most forest openings, including those that were too dense for young poults (Healy 1981).

Good brood habitat in Mississippi was thought to consist of poorly managed (unimproved) pastures (Owen 1976 cited by Hurst 1978) which provided an abundance of insect and plant food, and cover in the form of clumps of woody vegetation (Hurst 1978). Savannah-like old fields appear to provide better habitat for turkey poults than intensively managed agricultural clearings (Nenno and Lindzey 1979). The benefits of the savannah-like fields include: (1) an increased variety of invertebrate foods; (2) a greater variety and abundance of plant foods; (3) a vegetation structure that allows easier poult movements; (4) favorable microclimates; (5) increased edge; and (6) protection provided by the partial canopy cover. Tree canopy cover ranging from 30 to 60% allows for adequate herbaceous growth, and is a preferred brood habitat.

Females with broods in Minnesota spent as much as half of their daytime hours in crop and hay fields (Porter 1978). Corn fields provided loafing and escape cover for hens, whereas broods spent most of their time in alfalfa fields.

Reclaimed surface mines in Pennsylvania can provide useful brood habitat, depending on vegetation density and corresponding insect abundance (Anderson and Samuel 1980). Grain drill planting of cover crops in such areas provided greater mobility for poults than hydroseeding which resulted in matted vegetation. Poults used the row spaces in grain drilled areas for stalking invertebrates. The poults also had less contact with morning dew in these areas, which reduced the amount of required brood time with the hen.

Interspersion and Composition

An interspersion of grassy, permanent forest openings, along with the edges they create, enhances brood production of turkeys (Blackburn et al. 1975). Different authors have reported varying requirements for the percentage of openings needed for good wild turkey range. Latham (1958) stated that at least 10% of the total range should be in openings for satisfactory populations, and that clearings should be spaced so a hen need not travel more than 1.6 to 3.2 km to find one. Speake et al. (1975) recommended that spring and summer turkey habitat in the Southeast should include 12 to 25% of the area in well-dispersed openings. Poults in a Minnesota study area used about 29.0 ha for a weekly brood range (Porter 1980). Four or five such blocks of optimal brood habitat per 10.0 km^2, or 1.8 km radius, appeared to satisfy summer habitat needs of broods. This corresponds to a habitat with 11.6 to 14.5% of the area meeting brood needs.

The interspersion of hardwood forests and agricultural lands is an important feature in providing favorable turkey habitat in the Upper Midwest (Porter 1978). Thriving turkey populations exist in Missouri in areas of 50% forest cover, with well-interspersed open land and alternate winter foods for times of low mast production (Ellis and Lewis 1967). Lewis and Kurzejeski (1984) suggested that optimal habitat in Missouri is approached in areas with a 50:50 mix of mast-producing forests and open lands. Of the 50% open lands, they suggested that at least 20% should be row crops, 45% pasture, and 25% old fields. Recent studies of turkeys in Iowa also have suggested that a 50:50 ratio of forests to open lands is better than extensive forests (Little 1980).

Iowa has reintroduced turkeys into such areas and subsequent population densities are among the highest reported for the eastern wild turkey. Few forest stands in these areas exceed 400 ha in size, and most are smaller and scattered. The area has abundant edge between forest lands and crop and pasturelands, which provides access to insects for broods and waste grain for winter food. Turkeys also occur on dairy lands in New York where most woodlots are less than 101 ha in size (Bailey and Rinnell 1968). Turkeys in a Minnesota study survived and reproduced in areas with as little as 12% forest cover (Hecklau et al. 1982).

Turkeys did not readily use the centers of 12.2 to 24.3 ha fields in Tennessee and Michigan, unless a peninsula of trees penetrated the field to provide travel cover (Lewis 1964). Turkeys in Virginia were not observed in the interior of a 24.3 ha clearcut, although they did use the edges (Raybourne 1968). Turkeys crossed clearcuts less than 137 to 183 m in width, but only traveled 46 to 69 m into clearcuts greater than 274 m in width. Clearcuts greater than 183 m in width may restrict turkey movements to the edge of the area.

The annual and seasonal range sizes of wild turkeys are related to habitat quality (Everett 1982). Turkeys on poor ranges must move greater distances to meet their needs than turkeys on better quality habitat. Turkey range sizes and movements are dictated by the food supply (Korschgen 1967). The annual ranges of males and females in Missouri were 448 ha and 553 ha, respectively (Ellis and Lewis 1967). In Alabama, male turkeys had an annual range of 1,631 ha, and females had an annual range of 1,439 ha (Everett 1982). Average seasonal range sizes in the Southeast were smallest for hens with broods (111 ha) and largest for hens in the fall and winter (430 ha) (Speake et al. 1975). Winter ranges of most turkeys in a Minnesota study were less than 25 ha due to the restrictions caused by snow cover (Porter 1977). Speake et al. (1969) estimated that the requirements of a self-sustaining population of turkeys could probably be met in an area of 3,240 to 4,050 ha. Lewis and Kurzejeski (1984) suggested that a minimum of 750 ha of habitat is required in Missouri to insure high turkey population densities. Turkeys were introduced into Presque Isle State Park in Pennsylvania, which has a high level of human use (Wunz 1971). Turkeys restricted their movements to 81 ha of very dense understory. Wunz (1971) concluded that as little as 203 ha may be adequate for establishing turkeys in forested areas with dense human populations.

In New York, hens (older than 1 year) moved an average of 5.5 km from winter range to nest sites, and an average of 1.9 km from nest sites to brood-rearing areas (Eaton et al. 1976). Large improved pastures, roads, and large cropland clearings acted as barriers to turkey movements in Georgia (Eichholz and Marchinton 1976).

Special Considerations

Wild turkeys have a low tolerance of continuous and varied human activities (Davis 1976). Turkey populations may decline due to habitat losses associated with urbanization, highway and reservoir construction, expanded row crop farming, and conversion of large areas to short rotation, even-aged, pure pine plantations. Turkey abundance usually is inversely correlated with human abundance (Bailey and Rinnell 1968). However, there is a wide variation in wariness of humans among different turkey populations, depending on hunting pressure and other disturbance levels (Wright and Speake 1975). Humans are less of a disturbance factor where turkey hunting does not occur (Bailey and Rinnell 1968). Turkey populations in Louisiana were significantly lower in areas where it was believed that poaching was a problem (Dickson et al. 1978). Human densities in Minnesota as high as 15 people/km² did not appear to affect survival and reproduction of transplanted turkeys during their first year (Hecklau et al. 1982).

Turkeys in a Kentucky study avoided a large area that was used by off-road vehicles (Wright and Speake 1975). Turkeys also avoided areas within 1,000 m of a new foot trail which was used by about 125 people/week, whereas similar adjacent habitats without trails were consistently used by turkeys. Areas within 1,000 m of a campground also were avoided by foraging turkeys. Turkeys tolerated routine agricultural operations and were seen feeding in a large field where a tractor was working at a distance of 500 m.

Forestry practices exert a strong influence on turkey numbers (Markley 1967). Extensive clear-cutting may make areas unsuitable for turkeys. Hardwood removal and conversion to short rotation pine plantations also have a negative effect on turkeys.

Controlled burning of forests in the Southeast may be used to produce a greater abundance and diversity of accessible food items (Davis 1976). Burned tracts of loblolly pine (*P. taeda*) - shortleaf pine (*P. echinata*) forest provided either more insects or more available insects than areas that were not burned for 4 years (Hurst 1978). Burned areas were more open and allowed ease of movement for poults. Unburned areas (≤ 3 years since burning) provided nest habitat, escape, and brood cover, and an abundance of dewberries (*Rubus trivialis*). However, both burned and unburned tracts in this forest type were not as good for brood habitat as pastures and fields.

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model was developed for application within the entire range of the eastern wild turkey. Current range maps for the eastern wild turkey were not found in the literature. Users near the periphery of the range of the eastern wild turkey should consult local authorities to confirm the appropriateness of applying this model.

Season. This model was developed to evaluate the year round habitat needs of the eastern wild turkey.

Cover types. This model was developed to evaluate habitat quality in Deciduous Forested Wetland (DFW), Evergreen Forest (EF), Deciduous Forest (DF), Evergreen Tree Savanna (ETS), Deciduous Tree Savanna (DTS), Evergreen Shrubland (ES), Deciduous Shrubland (DS), Evergreen Shrub Savanna (ESS), Deciduous Shrub Savanna (DSS), Grassland (G), Forbland (F), Pasture and Hayland (P/H), and Cropland (C) areas (terminology follows that of U.S. Fish and Wildlife Service 1981).

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before a species will occupy an area. Based on annual range sizes reported in the literature, it is assumed that a minimum of 900 ha of habitat must exist or the HSI for eastern wild turkeys will equal zero.

Verification level. This model represents several hypotheses of species-habitat relationships and does not reflect proven cause and effect relationships. Previous drafts of this model were reviewed by William M. Healy, U.S. Forest Service, Northeastern Forest Experiment Station, Amherst, MA; George A. Hurst, Dept. of Wildlife and Fisheries, Mississippi State University, Mississippi State; John B. Lewis, Missouri Dept. of Conservation, Columbia; Terry W. Little, Iowa Conservation Commission, Des Moines; William E. Porter, State University of New York, Newcomb Campus, Newcomb; and Dan W. Speake, Alabama Cooperative Wildlife Research Unit, Auburn. Improvements and modifications suggested by these reviewers have been incorporated into this model, and are cited as personal communications, where appropriate.

Model Description

Overview. The year-round habitat needs of eastern wild turkeys can be provided by a variety of different cover types. The summer food and brood habitat requirements are provided in areas containing herbaceous vegetation of the proper height and density, in proximity to protective woody cover. Such areas provide abundant insect and plant foods for poults and adequate cover for hens with poults. Coniferous cover types are generally avoided during the summer.

Habitats with a variety of food sources provide potentially optimum food values during fall, winter, and spring. Eastern wild turkeys prefer areas with a diversity of food-producing trees and shrubs. Agricultural crops, especially corn and soybeans, also provide an important winter food source.

The cover needs of the adult turkey are provided in mature hardwood forests with relatively open understories. It is assumed that nest sites will be present if food and cover are adequate, and that water will not be a limiting factor due to its widespread availability throughout the range of the eastern wild turkey. The following sections provide written documentation of the logic and assumptions used to interpret the habitat information for the eastern wild turkey in order to explain the variables that are used in the HSI model. Specifically, these sections identify important habitat variables, describe suitability levels of the variables, and describe the relationships between variables.

Summer food/brood habitat component. The major summer food and brood needs are insect food and cover for young poults. It is assumed that summer food and brood habitat needs may be provided in all cover types except evergreen forests, evergreen shrublands, and croplands. A measurement of the structure of herbaceous vegetation is assumed to be an adequate indicator of the quality of insect food and cover resources. The amount of biomass of herbaceous vegetation is more important than the species composition (Healy 1981). The optimum structure of herbaceous vegetation is assumed to occur when plant height and density provide the maximum amount of vegetative biomass (i.e., potential insects) without restricting the movements of young poults. This level is assumed to occur when the herbaceous canopy cover is between 60 and 80%. Suitability is assumed to decrease to a moderate level in areas with 100% herbaceous cover due to the restrictions in poult movement caused by the extremely dense cover. It is assumed that areas with less than 20% herbaceous canopy cover will be too sparse to provide adequate food or cover for poults. The relationship between herbaceous canopy cover and a suitability index (SIV1) for the eastern wild turkey is presented in Figure 1a.

Optimum herbaceous canopy height occurs where the vegetation is high enough to provide concealment for the hen, but low enough to permit the hen to see the surrounding habitat. It is assumed that optimum herbaceous height occurs between 20.0 and 60.0 cm. Suitability is assumed to decrease to zero as heights increase to 100.0 cm, due to the inability of hens to view their surroundings in such areas. Vegetation less than 5 cm is assumed to be too short to provide cover. The relationship between herbaceous canopy height and a suitability index (SIV2) for the eastern wild turkey is presented in Figure 1b.

An index for summer food/brood habitat suitability (FBSI1) is computed by combining the indices for density and height of herbaceous vegetation (SIV1 and SIV2, respectively). A habitat with very low herbaceous heights and a very sparse canopy cover of herbaceous vegetation would provide more food and cover for turkeys if either the height or density of herbaceous vegetation was increased to a higher suitability level; i.e., there is a compensatory relationship between the variables. It is further assumed that when herbaceous height and density are present at the same levels of suitability, the habitat value for the summer food/brood habitat component will be equal to that level of suitability. This relationship applies to specific forest and tree savanna cover types (DFW, DF, ETS, and DTS) and can be expressed mathematically as shown in Equation 1.

$$FBSI1 = (SIV1 \times SIV2)^{1/2} \qquad (1)$$

Fig. 1a

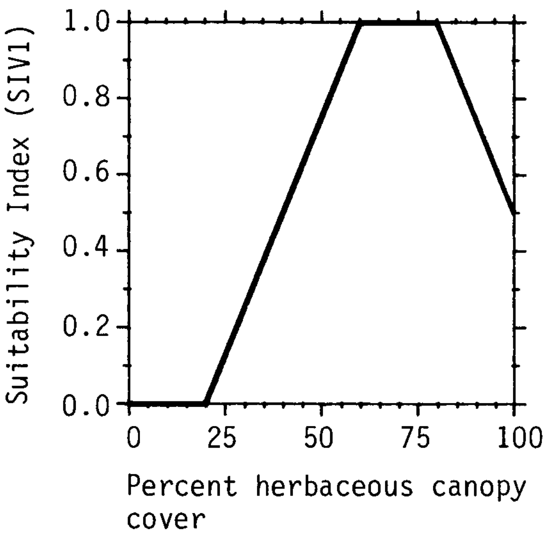


Fig. 1b

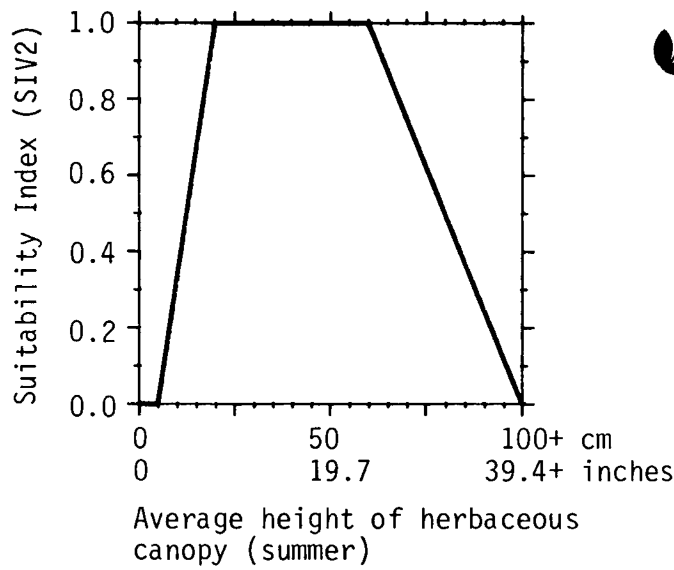


Fig. 1c

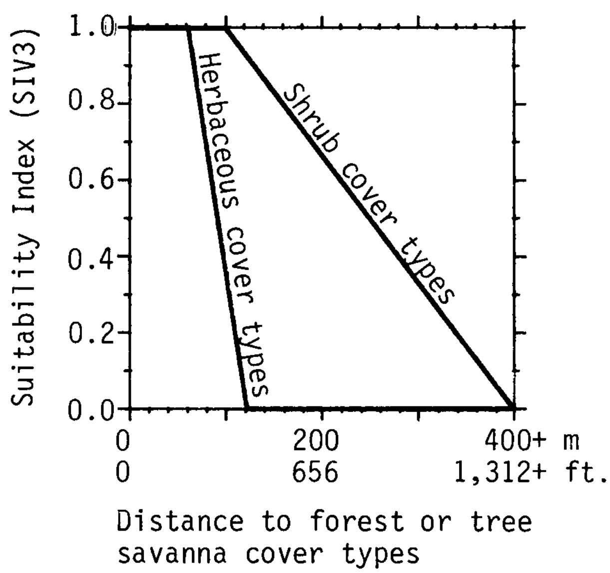


Figure 1. The relationships between habitat variables used to evaluate summer food and brood habitat and the suitability indices for the variables.

The suitability of herbaceous vegetation for hens and broods is affected by the proximity of forest cover that can be used for escape and protection. It is assumed that escape cover will not be a limiting factor in forested or tree savanna cover types. In herbaceous dominated cover types (e.g., grassland, forbland, and pasture and hayland), it is assumed that optimum suitabilities will exist when a tree dominated cover type is within 61 m. It also is assumed that herbaceous areas more than 122 m from forest cover will not be used by turkeys. These estimates are based on data from Lewis (1964) and Raybourne (1968) on turkey use of openings. Turkeys will move greater distances away from forest cover in cover types that provide overhead cover (Porter, unpubl.). It is assumed that in shrub dominated cover types (shrublands and shrub savannas) optimum suitabilities will exist when a tree dominated cover type is within 100 m, and that shrub dominated areas farther than 400 m from forest cover will be unsuitable. The relationships between the distances from herbaceous or shrub cover types and a suitability index are presented in Figure 1c.

The value of the summer food/brood habitat component (FBSI2) in specific shrub and herbaceous dominated cover types is equal to the value determined for herbaceous height and density, directly modified by the value related to the proximity of forest cover. The suitability of the herbaceous growth in such areas will be directly lowered as the distance to forest cover increases. This relationship applies to specific shrub and herbaceous cover types (DS, ESS, DSS, G, F, and P/H) and can be expressed mathematically as shown in Equation 2.

$$FBSI2 = (SIV1 \times SIV2)^{1/2} \times SIV3 \qquad (2)$$

<u>Fall/winter/spring food component</u>. Eastern wild turkeys are omnivorous opportunists (Bailey and Rinnell 1968) and the best management would provide a diversity of habitats within their annual range (Korschgen 1973). Fall, winter, and spring foods are provided in forests, shrublands, and croplands and include hard mast, seeds, and soft mast produced by trees and shrubs, as well as agricultural crops, especially corn or soybeans. Acorns are an important food source in many areas, but are not essential, because other trees may provide alternate foods. The specific trees used as food sources will vary across the range of the eastern wild turkey. Food producing species include, but are not limited to, oaks, dogwoods, beech, gums, ash, pecans, hickories, pines, wild cherry, hackberry, sumac, and hawthorn.

For purposes of this model, hard mast trees are assumed to include species such as oaks, hickories, pecan, beech, and pine. Soft mast trees include species such as gums, ash, wild cherry, hackberry, sumac, and hawthorn. For specific applications of this model, it is suggested that users define a list of both hard and soft mast producing trees for the particular geographic region of the application.

The amount of acorn mast produced in a forest varies from year to year, from species to species, and from tree to tree of the same species (Shaw 1971). The number of acorns produced per tree increases in a linear relationship with increased tree diameter (Goodrum et al. 1971; Shaw 1971). Although acorn production is positively correlated with individual tree diameters, overall acorn production in forest stands is influenced by canopy conditions and shading. Shaded trees produce less mast than trees grown in open stands. The exact structural forest conditions that must exist to maximize hard mast production have not been reported in the literature.

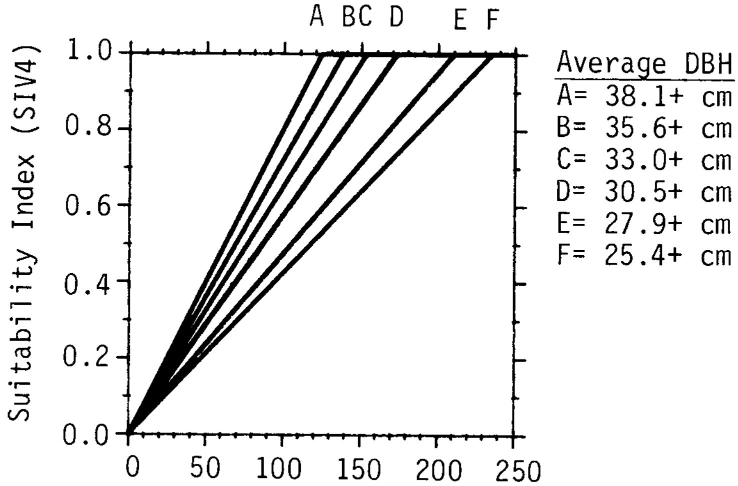
McQuilkin and Musbach (1977) conducted a 14-year study of pin oak (Q. palustris) acorn production on both flooded and unflooded sites in Missouri. Their data indicated that mast production on plots with trees mostly 27.9 cm dbh or larger was 85% higher than on plots with most trees less than 25.4 cm dbh. On nonflooded plots, which would be most representative of typical turkey habitat, there were no statistically significant differences in acorn production on plots with low, medium, or high stocking rates. Low stocking rate plots had basal areas of 9.2 m^2/ha, medium plots had basal areas of 13.8 m^2/ha, and high plots had basal areas of 17.2 to 20.7 m^2/ha.

The low stocking rate in McQuilkin and Musbach's (1977) study is about equal to the lower limits of upland hardwood stands that are termed understocked by the U.S. Forest Service (Gingrich 1971). The stocking chart from Gingrich (1971:66) was used to estimate the minimum numbers of trees of specific size classes that are required to reach the lower limit of understocked stands. It is assumed that forests with tree densities below this level will show reduced hard mast production. Using the stocking chart, it can be determined that, for 25.4 cm diameter trees, 235 or more trees per ha are needed to be at the lower limit of understocked stands. For trees 38.1 cm in diameter, 124 or more are needed per ha to reach the minimum stocking level. The relationships between the number of trees of various diameter classes and suitability indices (SIV4) for the eastern wild turkey are shown in Figure 2a. It should be noted that SIV4 is comprised of two measured habitat variables: average dbh of hard mast trees that are greater than 25.4 cm dbh; and number of hard mast trees/ha that are greater than 25.4 cm dbh.

It is assumed that total forest hard mast production will not increase at tree densities above those shown as maximum in Figure 2a. This is based on the assumption that although there will be more trees in such stands, the amount of mast produced per tree will be lower due to shading and, thus, overall mast production will be the same. This assumption is supported by the study of McQuilken and Musbach (1977), which showed no difference in acorn production at low, medium, and high stocking conditions. Although the preceding mast relationships were developed using data from oaks, it is assumed that the basic relationships will apply to all trees that produce hard mast.

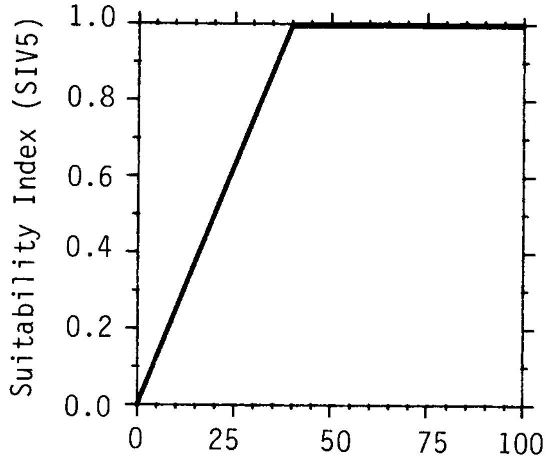
In general, soft mast producing trees begin to produce mast at smaller tree diameters than hard mast trees. Therefore, it is assumed that a measure of dbh is not needed for soft mast trees. A measurement of tree canopy closure of soft mast trees is assumed to provide an indirect measure of food abundance.

Fig. 2a



Number of hard mast producing trees/ha that are >25.4 cm dbh (average dbh values should only consider hard mast trees that are >25.4 cm dbh)

Fig. 2b



Percent canopy closure of soft mast producing trees

Figure 2. The relationship between habitat variables used to assess the fall, winter, and spring food value of trees and suitability indices for the eastern wild turkey.

Optimum forested habitats are assumed to contain 40% or greater tree canopy closure of soft mast producing trees. It is further assumed that overall soft mast production will not increase as canopy closures exceed 40%, due to the increase in shading and lower production per tree in such areas. The relationship between the percent tree canopy closure of soft mast producing trees and a suitability index (SIV5) for the eastern wild turkey is presented in Figure 2b. It is assumed that either soft or hard mast, or a combination of the two, may provide optimum overall mast conditions for the eastern wild turkey.

Shrubs also may contribute to the fall, winter, and spring food value. A dense layer of shrubs would provide abundant wild turkey food; however, turkey access and movements would be restricted in such areas due to the poor visibility and vulnerability of turkeys to predation. It is assumed that optimum shrub densities for food production occur at shrub crown covers of 20% or more. Areas with no shrubs will contribute nothing to shrub food production. The relationship between shrub cover for food production and a suitability index (SIV6) is presented in Figure 3a. It is further assumed that shrub densities of less than 40% crown cover will not restrict wild turkey use of an area. As shrub cover exceeds 40%, it is assumed wild turkeys will show decreased use of the area, regardless of the amount of food production from trees and/or shrubs, due to a behavioral response to the dense shrub cover.

Fig. 3a

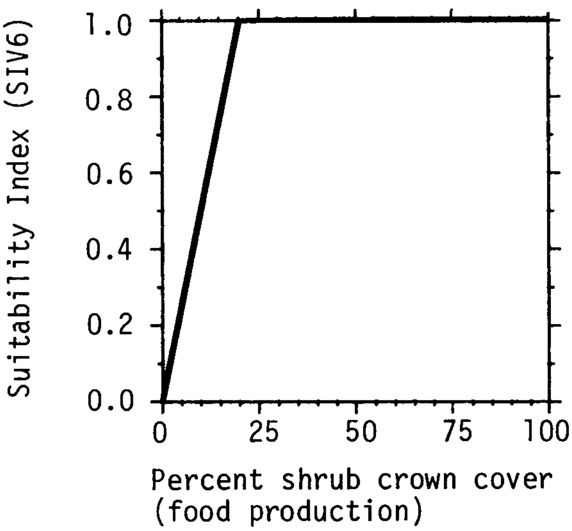


Fig. 3b

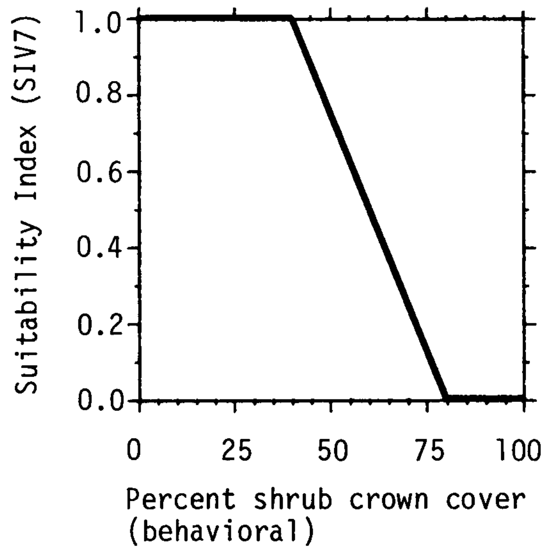


Fig. 3c

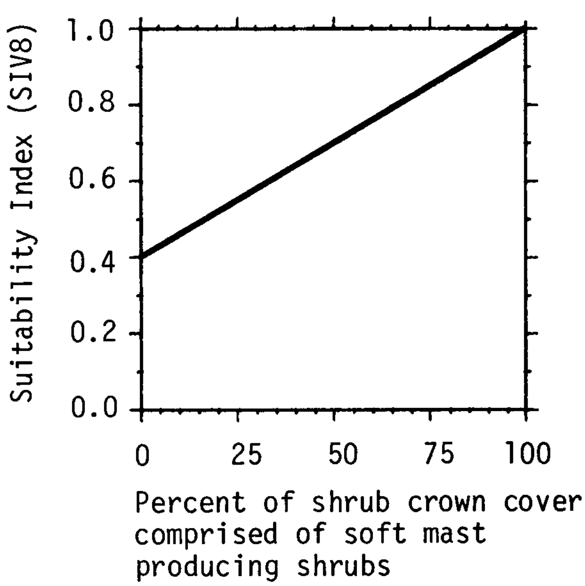


Figure 3. The relationship between habitat variables used to assess the fall, winter, and spring food value of shrubs and suitability indices for the eastern wild turkey.

Areas with shrub coverage of 80% or greater are assumed to be totally unsuitable for turkeys. The relationship between shrub cover related to the turkey's behavioral response and a suitability index (SIV7) is presented in Figure 3b. It is assumed that the best shrub conditions exist when 100% of the shrubs produce soft mast, and that low suitabilities will still be provided in areas with a lack of soft fruit producing shrubs, due to the turkey's use of other shrub plant parts for food. The relationship between the amount of soft fruit producing shrubs and a suitability index (SIV8) is presented in Figure 3c.

The fall, winter, spring food value (FWSSI1) in forest and tree savanna cover types is equal to the combined values of tree and shrub mast, modified by overall shrub density. Tree mast may be provided by either soft or hard mast species, and it is assumed that tree mast and shrub mast are equal in value. Excessive shrub densities will detract from the value of all mast resources. These relationships can be expressed mathematically, as shown in Equation 3, for DFW, EF, DF, ETS, and DTS.

$$\text{FWSSI1} = \frac{(\text{SIV4} + \text{SIV5}) + (\text{SIV6} \times \text{SIV8})}{2} \times \text{SIV7} \quad (3)$$

Note: When the sum of SIV4 + SIV5 exceeds 1.0, it should be reduced to 1.0 before computing FWSSI1.

The fall, winter, spring food value (FWSSI2) in shrub cover types is equal to the amount of food producing shrubs, modified by overall shrub density and the distance to forest cover. Shrubs alone are assumed to be able to provide up to one-half of the total fall, winter, and spring food value. This relationship can be expressed mathematically, as shown in Equation 4, for ES, DS, ESS, and DSS.

$$\text{FWSSI2} = \frac{(\text{SIV6} \times \text{SIV8})}{2} \times \text{SIV7} \times \text{SIV3} \quad (4)$$

Croplands may provide high quality fall, winter, and spring food for the eastern wild turkey, especially in the western and northern portions of the turkey's range. Corn and soybeans are highly preferred, while other grains are somewhat less valuable food sources. Crops other than corn, soybeans, and other grains are assumed to provide no food value. The relationship of the type of crop to a suitability index (SIV9) is presented in Figure 4a. The overwinter management of croplands will have a significant effect on the amount of crop food potentially available to turkeys. A direct measure of waste crop availability requires considerable field time and there is a large amount of variability in such measurements (Frederick et al. 1984). Therefore, a general approach is taken in this model to assess overwinter crop availability. Optimum conditions are assumed to exist in areas where more than 5% of the crop remains unharvested through the winter. Areas with the crop harvested in the fall, but plowed in the spring, will have moderate suitability. Croplands with a fall harvest and fall plowing will have no suitability, due to the lack of waste crops. The relationship between the overwinter management of croplands and a suitability index (SIV10) is presented in Figure 4b. The objective in assessing croplands is to determine the actual amount of waste grain available. Users with specific information on waste grain abundance may wish to revise these variables to fit their local data. An additional factor affecting the useability of croplands is the proximity to forest cover. This relationship in croplands is assumed to be the same as that described for herbaceous cover types in Figure 1c for summer food/brood habitat. The overall fall, winter, spring food value (FWSSI3) in croplands is equal to the value for the type of crop, directly modified by the type of overwinter management and distance to forest cover. This relationship can be expressed mathematically, as shown in Equation 5, for croplands.

$$FWSSI3 = SIV9 \times SIV10 \times SIV3 \qquad (5)$$

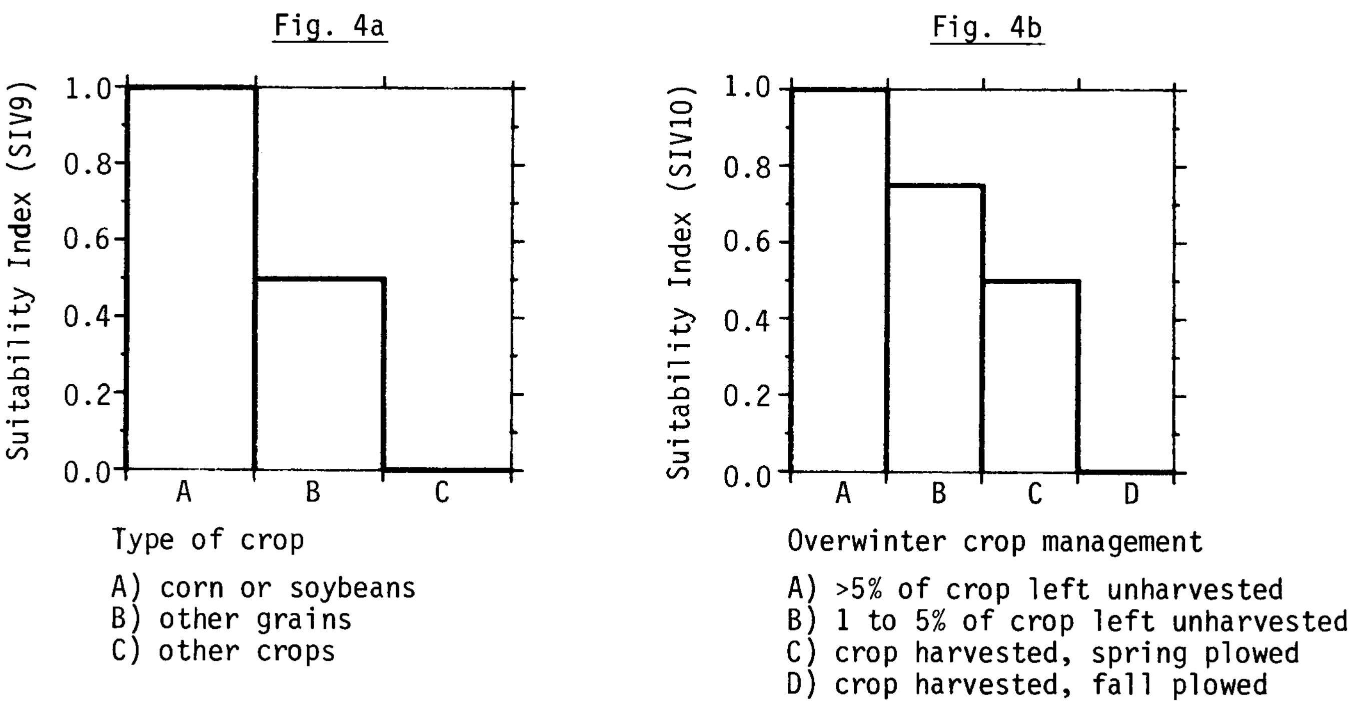


Figure 4. The relationships between habitat variables used to assess the fall, winter, and spring food value of crops and suitability indices for the eastern wild turkey.

Cover component. The cover needs of the eastern wild turkey are provided by mature deciduous, and mature mixed evergreen and deciduous, forests. Turkeys prefer forests with mostly open understories, and understory density is considered in this model by the shrub cover variables in the fall, winter, spring food component. It is assumed that roost sites will be adequate in areas that provide cover, as described in the following paragraphs.

This model assumes that optimum cover conditions for the eastern wild turkey exist in areas with ≥ 50% tree canopy cover. Habitats with less than 10% tree canopy cover are assumed to be unsuitable for turkeys because of the small amount of cover they will provide. The relationship between tree canopy cover and a suitability index (SIV11) for the eastern wild turkey is presented in Figure 5a. It should be noted that the distribution and interspersion of forest cover is assessed by the variable presented in Figure 1c.

Eastern wild turkeys prefer mature or old growth forests due to both the structural characteristics and food production in such habitats. Sapling forests provide poor overhead cover and are frequently too dense at ground level for turkeys. The diameter of overstory trees provides an indirect assessment of forest maturity, and it is assumed that optimal habitats contain overstory trees that average 30.5 cm dbh (Lewis, unpubl.). All trees are assumed to have some value for eastern wild turkeys; however, suitability is assumed to decrease to a very low level as the average size of overstory trees decreases to 12.7 cm dbh or less (Lewis, unpubl.). The relationship between overstory tree diameter and a suitability index (SIV12) for the eastern wild turkey is presented in Figure 5b.

Turkeys utilize both deciduous and evergreen forests, but deciduous forest types are preferred. It is assumed that habitats with less than 30% of the canopy comprised of evergreens will be optimal. Forests that are entirely evergreen will have low suitability for eastern wild turkeys. The relationship between the amount of evergreens in the tree canopy and a suitability index (SIV13) for the eastern wild turkey is presented in Figure 5c. A total lack of evergreen trees in the northern portions of the range of the eastern wild turkey may indicate less than optimum suitabilities, especially during severe winters when conifers are used for cover. Users in these geographic areas should consider this possibility prior to applying this model.

The overall cover value (CSI) for eastern wild turkeys in forested cover types is a function of tree canopy closure, the percent evergreen trees, and forest maturity (i.e., dbh). The cover value is assumed to be optimal only when suitability values for all three variables are optimal. The cover value is assumed to be lowered in direct proportion to low values for any of the variables. This relationship can be expressed mathematically, as shown in Equation 6, for DFW, DF, EF, DTS, and ETS.

$$CSI = SIV11 \times SIV12 \times SIV13 \qquad (6)$$

Fig. 5a

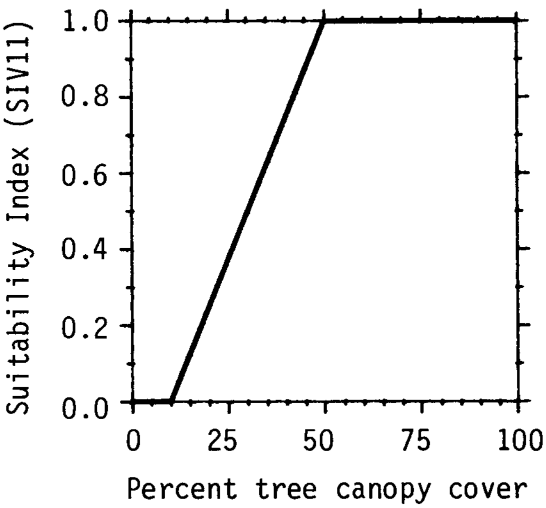


Fig. 5b

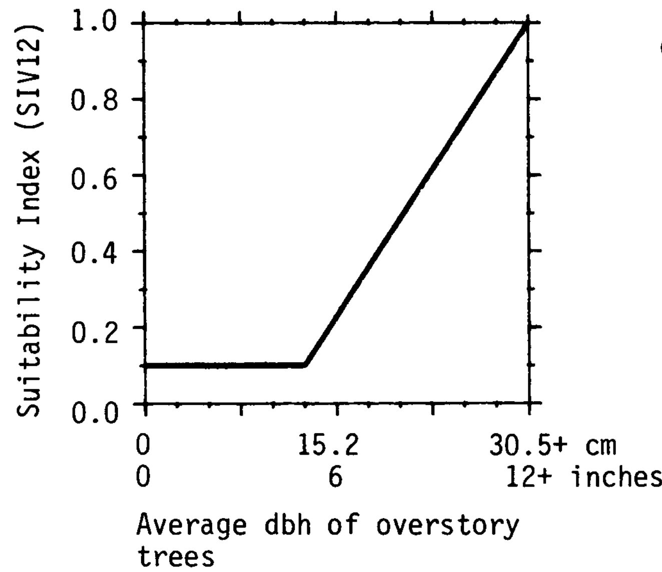


Fig. 5c

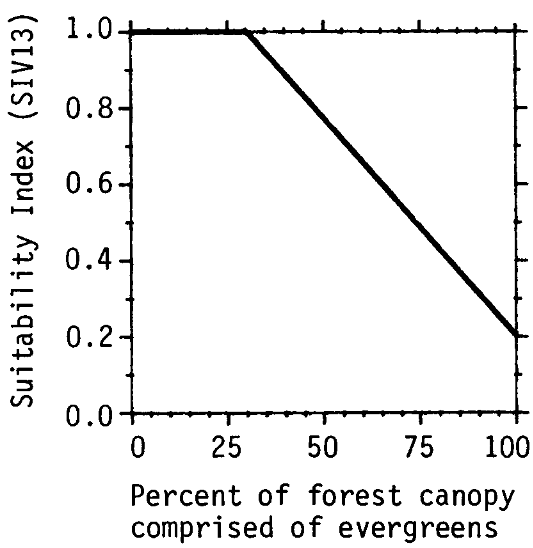


Figure 5. The relationships between habitat variables used to assess the cover value of trees and suitability indices for the eastern wild turkey.

Composition component. Optimal habitats for the eastern wild turkey must provide the proper mix of life requisites. A relatively small area is required to meet the summer food/brood needs of the turkey. Several authors have estimated the amount of area needed in openings to support turkey broods. Latham (1958) recommended 10% openings, Speake et al. (1975) suggest a need for 12 to 25% openings, and Porter's (1980) data correspond to a need for about 14.5% openings. Based on the average of these percentages, it is assumed that optimal turkey habitats should contain at least 15% of the area in summer food/brood habitat. It is assumed that, in optimal habitats, the balance of the area, or 85%, should provide fall, winter, and spring food. Turkeys are primarily forest birds, but several recent studies have shown that they may attain dense populations in areas with an even mix of forest cover and open lands. Turkeys in Minnesota survived in areas with only 12% forest cover (Hecklau et al. 1982). This model assumes that in ideal habitats, 50% or more of the area should provide optimal levels of cover. Habitats with less than 10% of the area providing cover are assumed to be unsuitable. The relationships between the variables used to assess habitat composition and suitability indices (SIV14, SIV15, and SIV16) for the eastern wild turkey are presented in Figure 6.

This habitat model is structured in a flexible manner, such that various combinations of cover type conditions may exist to provide the optimal mix of life requisites. For example, assuming that the appropriate habitat variables (V1 through V13) are optimum, the model would rate either of the following cover type mixes as optimum:

1. 85% forest cover, 15% pasture

2. 50% forest cover, 35% cropland, 15% pasture

HSI determination. The overall value of a habitat for eastern wild turkeys is a function of the quality, quantity, and interspersion of life requisites. Interspersion is considered by the habitat variable (V3) that measures the distance from open areas to forest cover. Several steps must be followed to determine the quality and quantity of life requisites for the turkey, as follows:

1. Determine suitability index (SI) values for each variable in the appropriate cover type by entering the field data into the appropriate SI graphs.

2. Calculate life requisite values in each cover type by using the SI values in the appropriate equations.

3. Determine the relative area (%) of each cover type used by turkeys within the study area, as follows:

$$\text{Relative area (\%) for cover type A} = \frac{\text{Area of cover type A}}{\text{Total area of all cover types used by the turkey}} \times 100$$

Fig. 6a

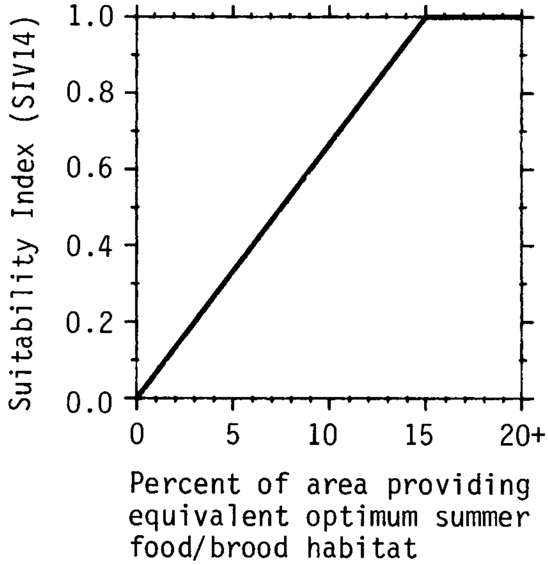


Fig. 6b

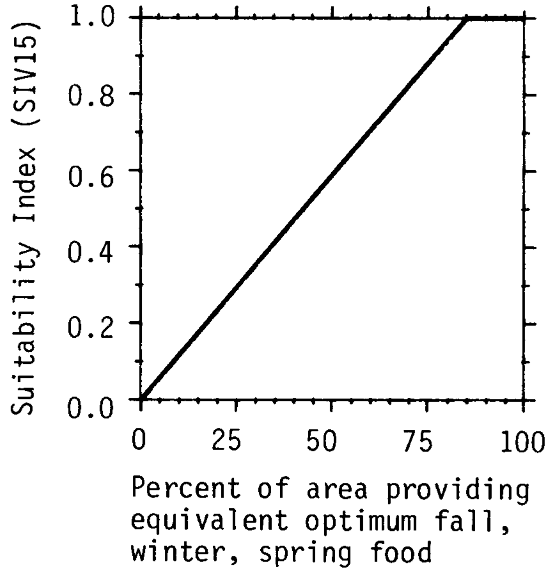


Fig. 6c

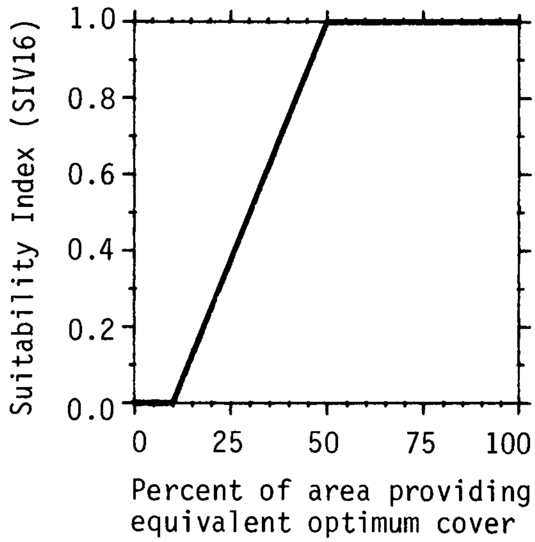


Figure 6. The relationships between the variables used to assess habitat composition and suitability indices for the eastern wild turkey.

4. Multiply the life requisite values for each cover type by the relative area (%) of that cover type, and sum these products for each life requisite.

5. To determine the overall life requisite values, enter the value from step 4 for each life requisite into the appropriate SI graph (Fig. 6a-c). The resulting index values are the overall life requisite values.

6. The HSI for the entire study area is equal to the lowest of the overall life requisite values.

Application of the Model

Summary of model variables. Fourteen habitat variables and three composition variables are used in this model to determine life requisite values for the eastern wild turkey. The relationship between habitat variables, life requisites, cover types, and the HSI for the turkey are illustrated in Figure 7. The specific trees that provide food for the eastern wild turkey vary across the geographic range of the turkey. It is suggested that users develop a specific list of both hard and soft mast producing trees for use in Figure 2a and 2b.

Definitions of variables and suggested measurements techniques (Hays et al. 1981) are provided in Figure 8.

Model assumptions. Despite the abundance of information and research that has been gathered concerning the eastern wild turkey, their specific habitat requirements are not well understood (Bailey and Rinnel 1968; Kennamer et al. 1980; Little 1980; Hurst 1981). Numerous assumptions were made in the transformation of the published habitat information on eastern wild turkeys to the suitability index relationships and formulas used in this model. The major assumptions in the model are listed below.

1. The habitat variables and life requisite relationships apply to the entire geographic range of the eastern wild turkey.

2. Water is not a limiting factor.

3. Nest sites will be present if fall, winter, and spring food, cover, and summer food/ brood needs are met.

4. Optimal fall, winter, and spring food values may be provided by crops alone, by the combined value of crops and mast from trees and shrubs, or by the combined value of mast from trees and shrubs.

5. The relationships for hard mast were developed using data from oaks. It is assumed that these relationships apply to all hard mast producing trees.

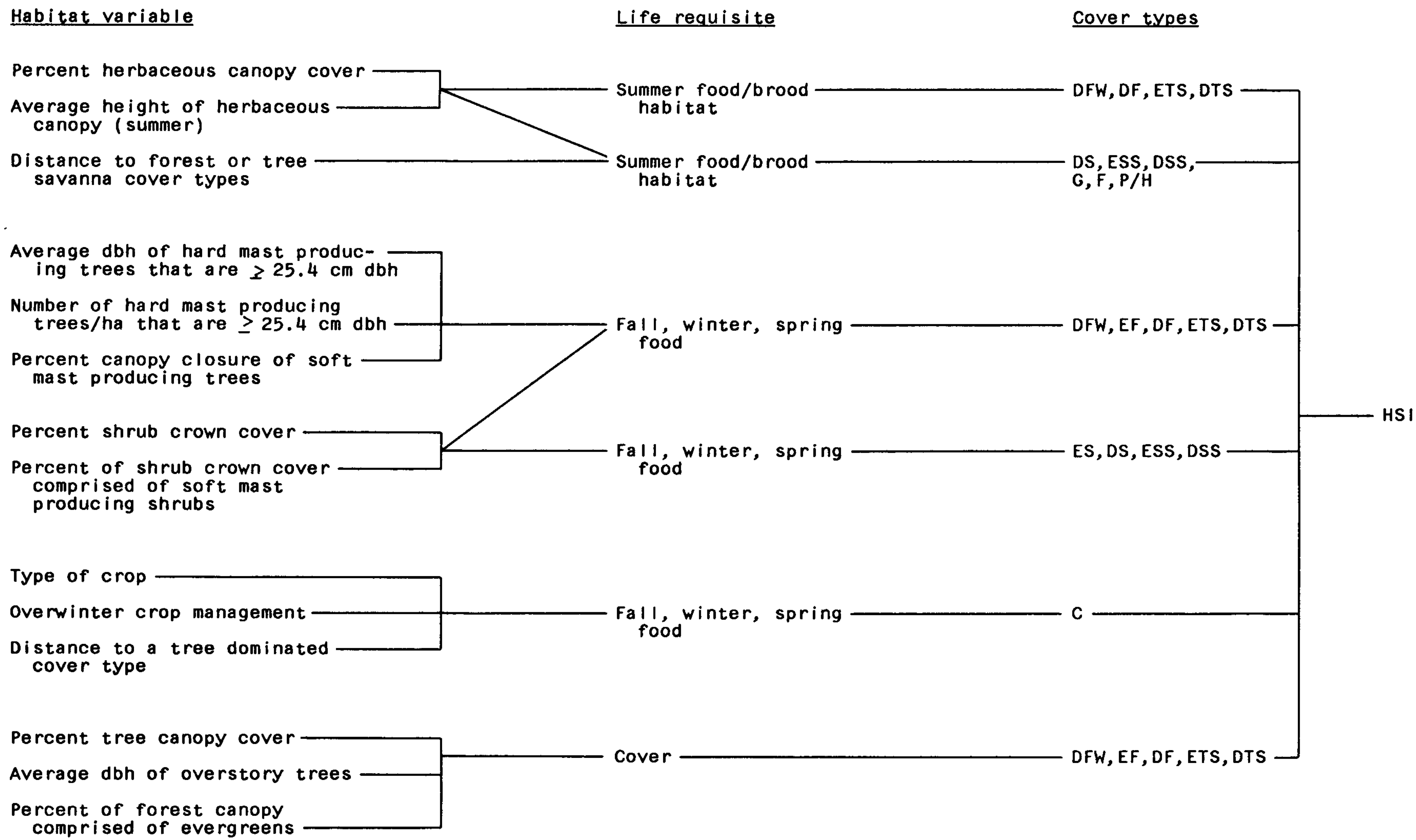


Figure 7. Relationships between habitat variables, life requisites, cover types, and the HSI for the eastern wild turkey.

Variable (definition)	Cover types	Suggested technique
Percent herbaceous canopy cover (the percent of the ground surface that is shaded by a vertical projection of all non-woody vegetation).	DFW,DF,ETS,DTS, DS,ESS,DSS,G,F, P/H	Line intercept, quadrat
Average height of herbaceous canopy (summer) (the average vertical distance from the ground surface to the dominant height stratum of the herbaceous vegetative canopy).	DFW,DF,ETS,DTS, DS,ESS,DSS,G,F, P/H	Line intercept, graduated rod
Distance to forest or tree savanna cover types (the distance from random points to the nearest edge of a forest or tree savanna cover type).	DS,ESS,DSS, G,F,P/H,C	Remote sensing
Average dbh of hard mast producing trees that are ≥ 25.4 cm (10 inches) dbh [the average diameter of all hard mast producing trees that exceed 25.4 cm (10 inches) diameter at 1.4 m (4.5 ft) above ground].	DFW,EF,DF,ETS, DTS	Quadrat; Biltmore stick or diameter tape
Number of hard mast producing trees/ha that are ≥ 25.4 cm (10 inches) dbh [actual or estimated number of hard mast producing trees per ha that are ≥ 25.4 cm (10 inches) diameter at 1.4 m (4.5 ft) above ground].	DFW,EF,DF,ETS, DTS	Quadrat

Figure 8. Definitions of variables and suggested measurement techniques.

Variable (definition)	Cover types	Suggested technique
Percent canopy closure of soft mast producing trees [the percent of the ground surface that is shaded by the vertical projection of the canopies of trees that produce seeds encased in a pulpy mass (e.g., cherry, hawthorn, etc.)].	DFW,EF,DF,ETS, DTS	Line intercept
Percent shrub crown cover [the percent of the ground surface that is shaded by a vertical projection of the canopies of woody vegetation ≤ 5.0 m (16.4 ft) tall].	DFW,EF,DF,ETS, DTS,ES,DS,ESS, DSS	Line intercept, quadrat
Percent of shrub crown cover comprised of soft mast producing shrubs (the relative percent of the amount of soft mast producing shrubs compared to all shrubs, based on crown cover).	DFW,EF,DF,ETS, DTS,ES,DS,ESS, DSS	Line intercept, quadrat
Type of crop (the present or last crop grown. Categories are: corn or soybeans; other grains; and other crops).	C	Observation, local data
Overwinter crop management (an evaluation of the winter availability of agricultural crops based on management. Categories are: > 5% of crop left unharvested; 1 to 5% of crop left unharvested; crop harvested, spring plowed; crop harvested, fall plowed).	C	Observation, local data

Figure 8. (continued).

Variable (definition)	Cover types	Suggested technique
Percent tree canopy closure [the percent of the ground surface that is shaded by a vertical projection of the canopies of woody vegetation ≥ 5.0 m (16.4 ft) in height].	DFW,EF,DF,ETS, DTS	Remote sensing, line intercept
Average dbh of overstory trees [the average diameter at 1.4 m (4.5 ft) above the ground of those trees that are ≥ 80% of the height of the tallest tree in the stand].	DFW,EF,DF,ETS, DTS	Cruise for tallest trees in stand. Sample with optical range finder and Biltmore stick on strip quadrat.
Percent of forest canopy comprised of evergreens (the relative percent of the amount of evergreen tree canopy compared to the total tree canopy).	DFW,EF,DF,ETS, DTS	Line intercept, remote sensing

Figure 8. (concluded).

6. The abundance of insects for broods is directly related to the biomass and structure of herbaceous vegetation.

7. Interspersion of life requisites (fall, spring, winter food; cover; and summer food/brood habitat) is only a concern when a cover type does not provide one or more of these life requisites.

8. For individual life requisites, optimal overall conditions are provided by a specific mix of both quantity and quality of an area providing the requisite. It is assumed that optimum overall conditions for a life requisite may still exist, even if individual cover types contain less than optimum quality, if this lack of quality can be compensated for by an increased quantity of the resource being present.

SOURCES OF OTHER MODELS

Williamson and Koeln (1980) developed a linear additive model to define areas of different habitat suitability for wild turkeys in forested areas of Virginia. Seven habitat factors are used in the model, with each factor given a value depending on its condition, and also given a relative weighting factor in comparison to other factors. The value of a particular forest stand is equal to the sum of all habitat factors. The seven habitat factors are: mast species diversity; proximity to permanent water; proximity to forest openings; mast availability; competition; forest contiguity; and proximity to roost sites.

Armbruster and Lewis (1980) developed an additive habitat model for eastern wild turkeys in central Missouri. The model assesses various habitat characteristics in bottomland hardwoods, upland hardwoods, old fields, pastures and haylands, and croplands, and determines a numerical value for each of these cover types. The model does not provide a method to determine a single value for a composite of several different cover types. Habitat characteristics in this model include: tree species; number of food plant species; habitat edge; grazing pressure; tree size class and canopy closure; nesting cover; crop practices; and distances between cover types.

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16. Abstract (Limit: 200 words)

A review and synthesis of existing information were used to develop a Habitat Suitability Index (HSI) model for the eastern wild turkey (Meleagris gallopavo sylvestris). The model consolidates habitat use information into a framework appropriate for field application, and is scaled to produce an index between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). HSI models are designed to be used with Habitat Evaluation Procedures previously developed by the U.S. Fish and Wildlife Service.

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