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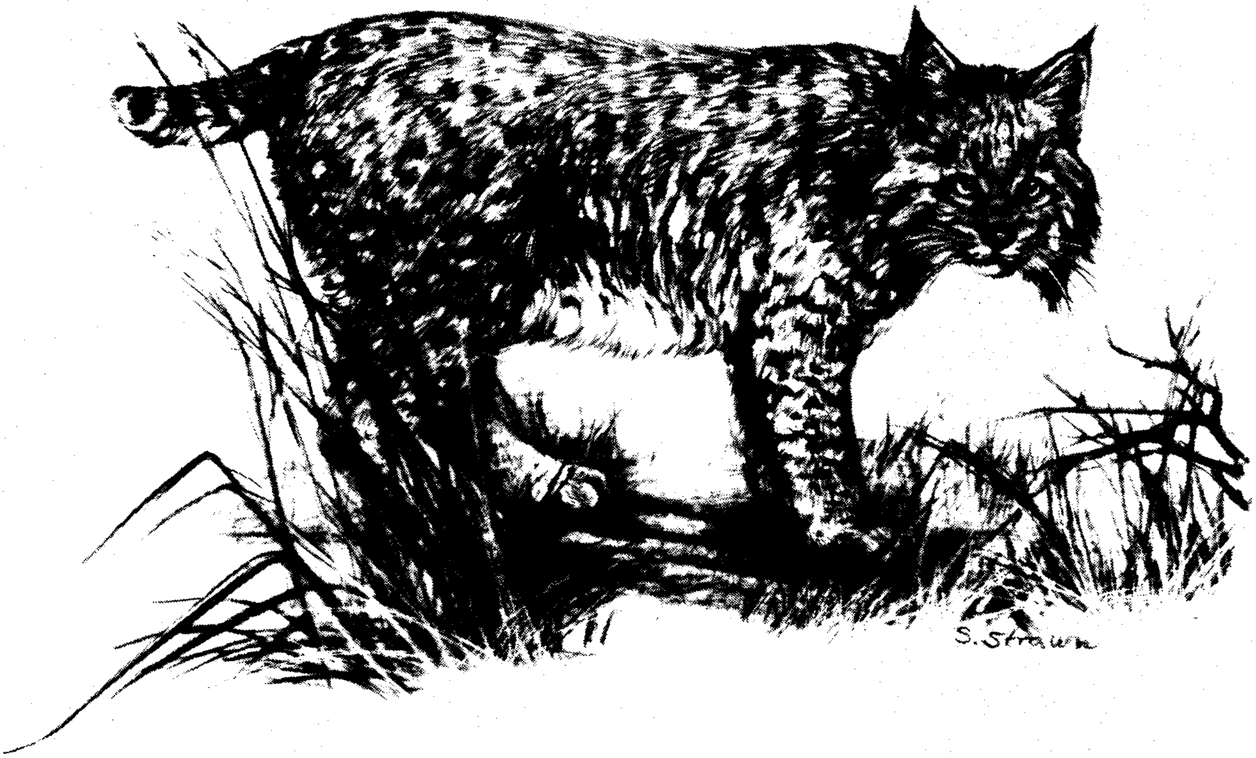
HABITAT SUITABILITY INDEX MODELS: BOBCAT



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HABITAT SUITABILITY INDEX MODELS: BOBCAT

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is a formalized synthesis of biological and habitat information published in the scientific literature and may include unpublished information reflecting the opinions of identified experts.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 suitability 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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FIGURES

ACKNOWLEDGMENTS

Mr. Adrian Farmer and Mr. Patrick Sousa, National Ecology Center, U.S. Fish and Wildlife Service, provided the framework of the model and assisted in its development; Dr. Lyndon C. Lee, Savannah River Ecology Laboratory, and Mr. Prescott Brownell, U.S. Fish and Wildlife Service, also assisted in model development. Dr. S. Douglas Miller (National Wildlife Federation, Washington, DC) and Mr. David Buie (Iowa State University, Ames, IA), provided critical reviews of earlier drafts of the manuscript.

The cover of this document was illustrated by Susan Strawn. Word processing was provided by Dora Ibarra. Kay Lindgren assisted with literature search and acquisition.

BOBCAT (*Felis rufus*)

HABITAT USE INFORMATION

General

The geographic range of the bobcat (*Felis rufus*) extends almost throughout the contiguous United States. The major exception is a large area (including most of Iowa, Illinois, Indiana, Ohio, and Missouri, as well as parts of several other States) where intensive agriculture apparently precludes habitation by bobcats (McCord and Cardoza 1982). Bobcat range is gradually expanding northward into Canada as boreal forests are interspersed with areas of farming, logging, and settlement (Rollings 1945; McCord and Cardoza 1982). Samson (1979) used regional differences in bobcat morphology to define 11 subspecies; however, the distinguishing characteristics are probably of little biological significance (McCord and Cardoza 1982).

Bobcats are generally most abundant in early to mid-successional habitats, and often concentrate their activities on human-modified areas (Hall and Newsom 1976; Miller and Speake 1979). However, bobcats can occupy a variety of habitat types (Pollack 1951). The bobcat is a territorial animal, and thus habitat is partitioned by the home ranges of resident individuals (Bailey 1974; Rolley 1983).

Food

In captivity, adult bobcats require a minimum of 55 g of food/kg of body weight/day, and young individuals (3 to 4 kg) fed *ad libitum* consume approximately 130 g/kg/day (Golley et al. 1965a). Free-ranging bobcats generally take prey in the 150 to 5,500 g size range, presumably because larger prey present difficulty in capture, whereas smaller prey provide a lower return on the energy invested in capture (Rosenzweig 1966). Juvenile bobcats usually capture smaller prey than adults (Fritts and Sealander 1978a; Toweill 1982; Knick et al. 1984). Bobcats are assumed to require only animal foods; however, vegetable material, primarily grass, often is found in stomach and fecal samples (Kight 1962; Buttrey 1979).

Bobcats in the Southeast rely heavily on two species, the eastern cottontail (*Sylvilagus floridanus*) and the cotton rat (*Sigmodon hispidus*), for food throughout the year (Miller and Speake 1978a; Story et al. 1982; King et al. 1983). On the Savannah River Plant (SRP), South Carolina, in 1961, cotton rats ranked first in frequency of occurrence in the diet, and cottontails ranked first in weight among diet items (Kight 1962). Birds, squirrels, snakes, and various other animals were present in minor amounts.

In 1969, when white-tailed deer (Odocoileus virginianus) had become abundant and were being hunted, deer appeared in the diet of SRP bobcats (Bara 1970). Whether deer meat is obtained primarily as carrion or as live prey remains uncertain.

In central Florida, the marsh rabbit (Sylvilagus palustris) is an additional component of the bobcat's diet (Guenther 1980). In the Interior Highlands of Arkansas, squirrels (Sciurus niger, S. carolinensis) are an important food (Fritts and Sealander 1978a), and in the mountains of eastern Tennessee and western North Carolina, the pine vole (Microtus pinetorum) and various species of birds are important foods for bobcats (Buttrey 1979; Kitchings and Story 1979; King et al. 1983).

In the West, as in the Southeast, the primary food items are rodents and lagomorphs (Bailey 1972; Beasom and Moore 1977; Jones and Smith 1979). During periods of food scarcity, western bobcats diversify their diets to include deer and some livestock (Beasom and Moore 1977; Pearson and Caroline 1981). Deer are of special importance to bobcats in the North because cached deer meat can sustain life when deep snows (>15 cm) restrict movement (McCord 1974). Deer and snowshoe hare (Lepus americanus) are the primary foods of New England bobcats (Hamilton and Hunter 1939; Westfall 1956; McCord 1974).

Water

No specific information on the water requirements of the bobcat was found in the literature. Water is not likely to be a critical factor to bobcats in the East, because in this region there are probably few areas that do not offer adequate free water. In some portions of the West, riparian habitats are preferred by bobcats (Lawhead 1984), but how directly this preference relates to the bobcat's water requirements is not known.

Cover

The cover requirements of the bobcat also vary by region. In the North, stands of dense, evergreen vegetation, such as Norway spruce (Picea abies) plantations, are heavily used by bobcats during winter (McCord 1974). In the West, caves and rockpiles are used year-round and apparently are critical features of bobcat habitat (Bailey 1974; Zezulak and Schwab 1979). In the relatively moderate climate of the Southeast, features such as thickets, hollow stumps, and logging debris offer adequate cover for both resting and denning (Young 1958; Miller 1980; Kitchings and Story 1984). These features are widely available in southeastern habitats. However, bottomland hardwood areas often are selected for loafing and travel (Hall and Newsom 1976; Buie 1980), possibly because the closed canopy and dense midstory of these areas supply shade during periods of high temperatures (Heller 1982).

The status of a bobcat population is determined by juvenile survival (McCord and Cardoza 1982), and juvenile survival is largely determined by prey availability (Bailey 1972; Blankenship and Swank 1979). Therefore, for many bobcat populations, the major significance of cover probably lies in its relation to prey availability. Bobcat prey usually are not abundant in forested cover types. In extensive small-mammal trapping on the Savannah River

Plant, few cotton rats were captured in forested areas (Golley et al. 1965b; Briese and Smith 1974), and those captured were thought to be only dispersing through unfavorable habitat (Briese and Smith 1974). In contrast, dense populations of cotton rats (approximately 20/ha) were found in nonforested areas characterized by "broomsedge-vine" vegetative cover (Andropogon spp. with shrubs and shrubby vines such as Bignonia radicans, Lonicera japonica, and Rubus spp.) (Golley et al. 1965b). The shrubby vegetative component provides structural diversity that is essential to good cotton rat habitat. Broomsedge stands with no shrubs had markedly lower cotton rat populations, possibly because cotton rats are vulnerable to avian predation where cover is lacking (Schnell 1968). Like the cotton rat, the cottontail is not abundant in habitats lacking shrubby cover (Heard 1963). Cottontails in Mississippi were trapped almost twice as frequently in areas of "mixed grass, weeds, brush, and briars" as in relatively pure stands of broomsedge. The shrubby vegetation served as escape cover when cottontails were experimentally chased with dogs.

Favorable environments for bobcat prey in the Southeast are presently available on clearcuts and young (≤5 yrs) pine (Pinus spp.) plantations (Heller 1982). These habitats are widely scattered and short-lived, however, and thus their prey populations are slowly acquired and quickly lost. The cover types that prevailed in the Southeast subsequent to widespread abandonment of farmland (1940's-1950's) were probably considerably more productive of bobcat prey (Fendley and Buie 1982).

Reproduction

Bobcat reproduction requirements in the Southeast do not appear to differ from cover requirements. Habitat features such as thickets, stumps, and logging debris serve as denning sites as well as resting sites for bobcats. Various types of rock features serve a similar dual function in the West (Gashwiler et al. 1961; Bailey 1979). McCord and Cardoza (1982) reported that, in Massachusetts, bobcat courtship is invariably performed in the vicinity of rocky ledges. However, specific habitat requirements for courtship have not been reported elsewhere.

Interspersion and Composition

In the relatively demanding environments of the North and West, special cover features such as evergreen stands and rock outcrops must be included in bobcat home range. In the Southeast, however, a single habitat type, characterized by grass/forb-shrub vegetation, appears to be capable of satisfying all the food, water, cover, and reproduction requirements of bobcats. Therefore, interspersion of habitats is assumed to be unnecessary. However, within the grass/forb-shrub cover types, interspersion of grass/forb area and shrub area is necessary to ensure accessibility of food and cover for bobcat prey (Schnell 1968; Allen 1984).

Grass/forb-shrub cover types are highly productive of bobcat prey, whereas other cover types are relatively nonproductive (Kitchings and Story 1978). Where a high proportion of grass/forb-shrub cover types exist, bobcat prey may be produced in excess of bobcat food needs ("excess" food is possible for bobcats because bobcat population density is ultimately limited through competition for space, i.e., territory, rather than food) (Bailey 1972; Zezulak and Schwab 1979). Therefore, grass/forb-shrub cover types can be interspersed with moderate amounts of less productive habitats with no detriment to the effective quality of an area.

Special Considerations

Habitat management for the bobcat is possible within the framework of timber management. Normally, small mammal populations peak 1 to 3 years after clearcutting and planting, and decrease sharply thereafter (Umber and Harris 1974). Delaying the canopy closure of newly planted stands would allow small mammals to remain in abundance for longer periods (Heller 1982). Canopy closure can be delayed in several ways, including increased spacing (to approximately 3 m) of original planting, and early and extensive thinnings. Small mammals also benefit from the practice of natural regeneration, which produces an abundance of seeds and ground forage. If clearcutting is done in small blocks, small-mammal habitat (i.e., regenerating stands) is better interspersed and therefore more rapidly colonized.

Practical management of bobcat populations includes the regulation of annual bobcat harvest. Since harvest tends to correspond to pelt value rather than abundance (Rolley 1985), local extirpations can result (Fuller et al. 1985). After the Endangered Species Act of 1973 prohibited the importation of endangered cat species, the value of pelts of North American cats increased dramatically (Erickson et al. 1981). During 1972-78, the West experienced steadily declining bobcat populations (Knowlton and Tzilkowski 1979), whereas in 1978 most southeastern States reported stable or increasing populations (Miller and Speake 1978b). Pelt prices peaked in 1980 (Fuller et al. 1985), and present bobcat population trends are unclear. However, any observation of decreasing mean age and decreasing male:female sex ratio, as well as declining abundance in a harvested bobcat population, may indicate the need for a reduced harvest (Fritts and Sealander 1978b; Gilbert 1979; Rolley 1985).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This HSI model was developed for application in the Piedmont and Coastal Plains regions of the Southeast, with special reference to the Savannah River Plant (SRP), South Carolina. The SRP is representative of the Upper Coastal Plain region (Figure 1).

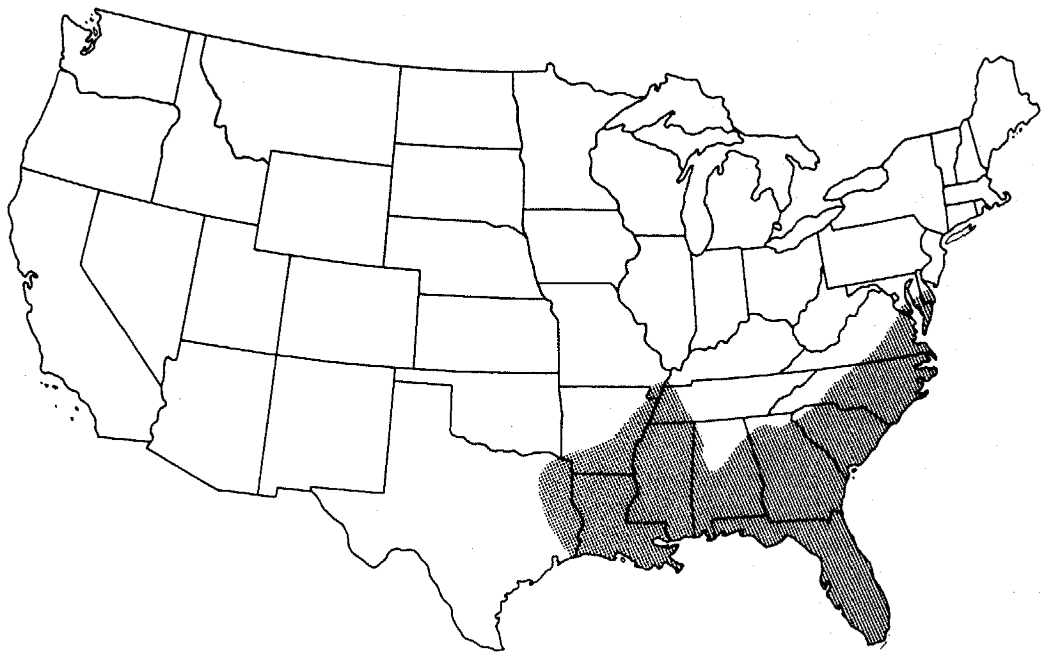

Figure 1. Geographic applicability of the bobcat HSI model.

Season. This model was developed to evaluate the year-round habitat requirements of the bobcat.

Cover types. This model was developed for application in the following cover types (definitions follow U.S. Fish and Wildlife Service 1981): Evergreen Forest (EF), Deciduous Forest (DF), Evergreen Shrubland (ES), Deciduous Shrubland (DS), Deciduous Forested Wetland (DFW), Deciduous Scrub/Shrub Wetland (DSW), Grassland (G), and Forbland (F). Only those wetlands that are not permanently flooded should be evaluated with this model.

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before an area will be occupied by a species. Specific data regarding minimum habitat area for the bobcat was not found in the literature. When habitat conditions are optimal and bobcat home range size is at a minimum, density is approximately 1 bobcat/km^2 (Miller 1980). However, bobcats are subject to fairly severe fluctuations in population density (Griffith and Fendley 1982a). An outbreak of feline panleukopenia may result in 60% to 90% mortality (Bittle 1981). To ensure that at least a pair of bobcats survives such an outbreak, a population should consist of at least 20 individuals, and thus at least 20 km^2 of optimal habitat (or a larger area of suboptimal habitat) is needed. Yet, bobcat populations frequently occupy relatively small areas. Transient individuals (i.e., young bobcats in the process of dispersal) often travel long distances to locate unoccupied areas of suitable habitat (Griffith and Fendley 1982b). Therefore, although resident populations of small areas occasionally fail to maintain occupancy, new populations are readily established.

Verification level. Earlier drafts of this model were reviewed by Dr. S.D. Miller (National Wildlife Federation, Washington, DC) and Mr. D.E. Buie (Iowa State University, Ames, IA). The current model has not been field tested and empirical relationships between model outputs and bobcat abundance, reproductive success, or other parameters are unknown.

Model Description

Overview. Water and cover do not appear to be limiting factors in the Southeast, and bobcat habitat suitability is defined in this model by food suitability. Bobcat prey are supported by areas of grass/forb-shrub vegetation. In each cover type, grass/forb-shrub vegetation is evaluated in regard to abundance (percent coverage) and apportionment (distribution of coverage between the grass/forb and shrub components). Interspersion is not measured directly in the model. Because food is the only resource considered in this model, the need does not exist to evaluate interspersion between resources such as between food and cover, cover and water, or food and denning sites. The primary drawback to this approach is that the distribution of a resource (or resources) across a sampling area must be assumed to be adequate for the species. In this model, a sampling scheme based on a typical "home range" area at least partially offsets this potential drawback. By sampling bobcat "home ranges," it can be assumed that all resources within the sample area will be available to bobcats; the problem of assuming an even distribution of resources across a sampling area is thereby minimized. By determining habitat suitability on several home range sample areas, an estimate of how well distributed the food resources are across the evaluation area can be made.

Food component. Shrubby vegetation provides escape cover in open habitats for the two major prey species of the bobcat, and thus the presence of shrubs enhances habitat quality. However, where shrubs strongly dominate the habitat, conditions are again less than optimal for bobcat prey. Cottontails can feed on either grass or shrub material (Chapman et al. 1982), but cotton rats depend primarily on grasses (Goertz 1964). Therefore, to provide food and cover for both bobcat prey species, and thus sustain optimal prey production for the bobcat, a grass/forb-shrub habitat with a fairly equal mixture of the two components is needed.

To evaluate food suitability in this model, two variables must be measured. The first variable (Figure 2a) is the percentage of the sample area covered by grass/forb-shrub. This measurement can be taken in a variety of cover types; in an open cover type, areas not in grass/forb-shrub are likely to consist of bare ground, whereas in a forested cover type such areas may be covered by materials such as detritus, ferns, and tree stems. Extensive forested areas with no grass/forb-shrub cover are assumed to be capable of supporting bobcat populations but at densities that are much less than can be achieved under optimum conditions. Where grass/forb-shrub vegetation exists on a sample area, a second habitat variable can be measured, the percentage of

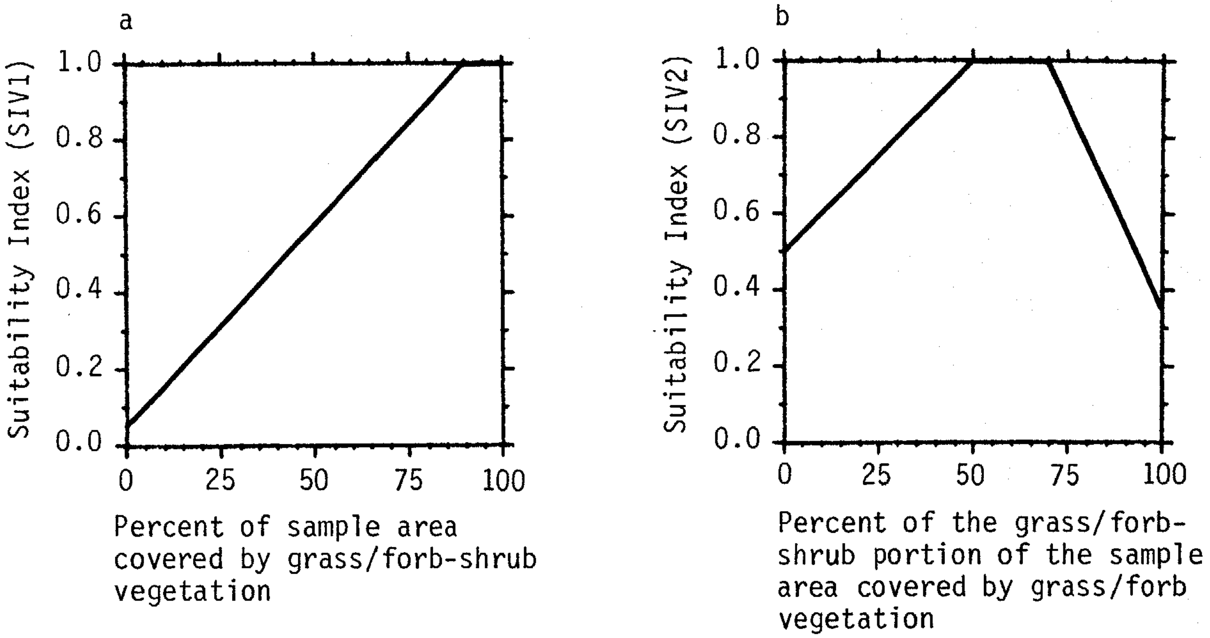

Figure 2. Relationships between variables used to evaluate food suitability for the bobcat and suitability levels for the variables.

the grass/forb-shrub covered area that is covered by grass/forb (Figure 2b). Both habitat variables can be ocularly estimated, either on site or from aerial photographs.

Habitats productive of bobcat prey were widespread on the SRP during the 1960's, and bobcat density was at a maximum. The 1965 estimates of bobcat home range size, <5 km² (Marshall and Jenkins 1966), are among the lowest in the literature, including later SRP reports (Buie 1980). Assuming that bobcat habitat on the SRP in the 1960's represented optimal conditions, high quality cover in the Southeast can be characterized as having a high proportion of the area in cover types(s) that meet the following criteria (based on 1965 aerial photography of SRP):

(1) >90% of the cover type area supports grass/forb-shrub vegetation (Figure 2a); and

(2) 50%-70% of the grass/forb-shrub area is in grass/forb vegetation (Figure 2b).

A pure grass/forb habitat is suboptimal for cottontails (Allen 1984), and cotton rats might be only about 5% as abundant as in a mixed habitat (Golley et al. 1965b). The maximum winter cover/food suitability for cottontails in a pure grass/forb habitat is estimated to be 0.6 (on a 0 to 1.0 scale), presuming that 100% canopy cover of persistent herbaceous vegetation is present (Allen 1984). In areas with minimal snow cover, dense herbaceous vegetation that is nonpersistent also may provide winter cover. Although winter cover/food suitability for cottontails is expected to vary with the canopy cover of persistent and/or dense herbaceous vegetation (Allen 1984), it is assumed in this model that, on the average, winter cover/food suitability for cottontails will be 0.3 in a pure grass/forb habitat. The estimated bobcat food suitability in a pure grass/forb habitat is, therefore, assumed to be 0.35, based on an estimated suitability of 0.30 for cottontails and 0.05 for cotton rats (Figure 2b). In a pure shrub habitat with complete canopy closure, cotton rats presumably would be absent, but winter cover/food suitability for cottontails would be about 50% of that expected in a mixed habitat (Allen 1984). Therefore, the food suitability for bobcat in a pure shrub habitat is assumed to be 0.50 (Figure 2b).

Area size should be noted during the sampling procedure. If the area being evaluated is very small (<4 ha) and isolated, its food production potential is assumed to be limited. The cottontail requires a minimum habitat area of 4 ha (Allen 1984); therefore, a smaller area would lack one of the two major bobcat foods. The suitability of such areas is limited compared to larger areas supporting both prey species.

The food suitability index (FSI) is calculated with Equation 1 for areas ≥4 ha, and with Equation 2 for areas <4 ha enclosed by areas of minimal food suitability:

$$\text{FSI} = \text{lowest of SIV1 and SIV2} \quad (1)$$

$$\text{FSI} = \text{lowest of SIV1, SIV2, and 0.6} \quad (2)$$

In the recommended sampling scheme, vegetation is sampled using a circular plot with a radius of 1.78 m (area = 1/1000 ha) or a 2 x 5 m rectangular plot to determine food suitability of each cover type. Other plot dimensions may be used provided they are sufficiently large to adequately sample the shrub component. Sampling in relatively small dimensions such as these will presumably result in suitability data that reflect the degree of interspersion (and thus resource accessibility) experienced by bobcat prey.

Interspersion and composition component. Although habitat quality depends on food production, the interspersion of food-productive with non-food-productive cover types does not necessarily detract from the effective habitat suitability of an area. The assumed relationship between food abundance and habitat suitability terminates at the point where further increase in the proportion of optimal food-productive cover types results in no further increase in bobcat density (i.e., when a population reaches a territorial limitation). The estimate of this proportion is based on relationships observed between habitat composition and bobcat density. On the SRP in the early 1960's, 35% of the land area was in fields and young (≤5 yrs) pine stands (Langley and Marter 1973). However, canopy closure was extensive during the late 1960's and only 7% of the land remained in an open condition by 1972. Coinciding with the loss of open habitat was a steady decline in the bobcat population, indicated by the annual SRP furbearer census (Jenkins et al. 1979). Thus, 35% is a conservative estimate of the food-optimal area required to sustain a maximal density of bobcats (Figure 3).

In the recommended sampling scheme, habitat composition is sampled using a "home range" sample area, which is a replica in size and shape of bobcat home range as it exists under conditions of optimal habitat quality. Based on bobcat home range dimensions observed on high-quality habitat in Alabama (Miller 1980), this sample area is defined to be 2.5 km^2 in size and elliptical (or, for convenience, rectangular) in shape, with the longer axis approximately 1.5 times the length of the shorter one (the rectangular shape would be 1.9 x 1.3 km). Sampling in these dimensions results in suitability data that reflect the accessibility of bobcat prey to bobcats.

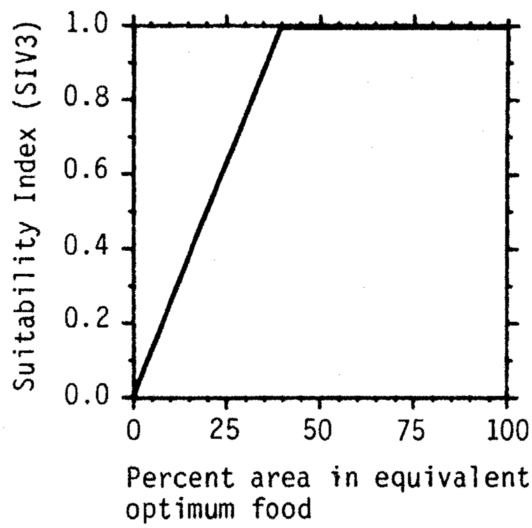

Figure 3. Relationship between the percent of an area providing equivalent optimum food, and a suitability index within a sample area.

HSI determination. Within each "home range" sample area, cover types are delineated, and within each cover type, food suitability is determined. Either of the two habitat variables, represented by their suitability index values (Figure 2a,b), can limit the food suitability index (FSI) as depicted by Equations 1 and 2. The weighted (by area) average of the food suitabilities by cover type gives the percent of the area in optimal food suitability (PAOFS) for the "home range" sample area, as in Equation 3:

$$PAOFS = \sum_{i=1}^{n} [FSI \times ((A_i / \sum_{i=1}^{n} A_i) \times 100)] \quad (3)$$

where n = the number of cover types in the "home range" sample area

A_i = the area of cover type i

FSI_i = the food suitability index in cover type i

For each "home range" sample area, the percent of the area providing optimal food is converted to a suitability index (Figure 3). The mean of these suitability indices gives the overall HSI for the study area.

Application of the Model

Summary of model variables. Figure 4 illustrates the relationships of habitat variables, life requisites, and cover types to an HSI for the bobcat. Figure 5 defines the habitat variables and the recommended techniques by which they are measured (Hays et al. 1981).

Model assumptions. The major assumptions in this model are as follows.

1. Habitat features that meet the water, cover, and reproductive requirements of the bobcat are readily available in the habitats of the Southeast. Food is the critical factor to southeastern bobcats.

2. Food availability is strongly related to vegetational characteristics. Bobcat food is most abundant in grass/forb-shrub cover types. Habitat suitability for cottontails in a pure grass/forb habitat is assumed to be a constant. Allen (1984) provides a model to estimate habitat suitability for cottontails in greater detail, if desired.

3. When food is very abundant, space rather than food becomes the limiting factor on bobcat populations.

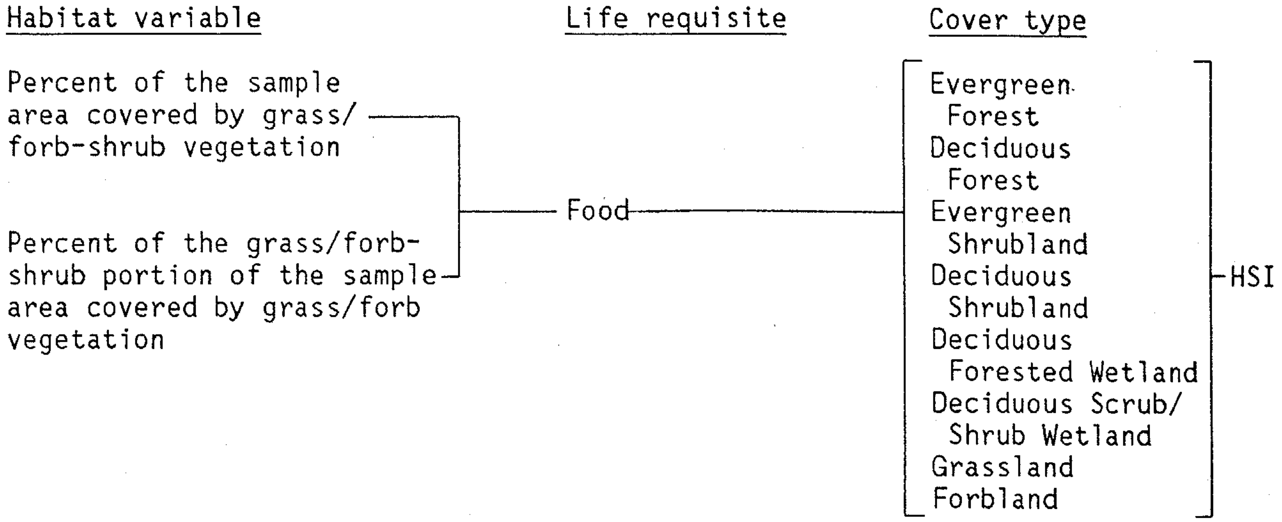

Figure 4. Relationships of habitat variables, life requisites, and cover types to an HSI for the bobcat.

Variables (definition)	Cover types	Suggested technique
Percent of the sample area covered by grass/forb-shrub vegetation (an estimate of the extent of coverage of grass/forb-shrub vegetation. Determined by dividing the area supporting such vegetation by the total sample area and multiplying it by 100).	Undeveloped, non-flooded lands	Quadrat (0.001 ha plot: circle with a 1.78 m radius, or 2 x 5 m rectangular plot)
Percent of the grass/forb-shrub portion of the sample area covered by grass/forb vegetation (an estimate of the proportion of the grass/forb-shrub vegetation made up by the grass/forb component. Determined by dividing the area supporting grass/forb vegetation by the total area supporting grass/forb-shrub vegetation and multiplying it by 100).	Undeveloped, non-flooded lands	Quadrat (0.001 ha plot: circle with a 1.78 m radius, or 2 x 5 m rectangular plot)

Figure 5. Definitions of habitat variables and suggested measurement techniques.

This model represents a simple approach to evaluating bobcat habitat suitability in the Southeast. In the evaluation of food suitability, the model disregards the land-use history of an area. Yet, newly suitable areas may not be as productive of bobcat prey as otherwise similar areas of longer standing suitability (Heller 1982). Also, the model disregards the issue of cover suitability although bobcat cover requirements are not fully understood. Cover appears to be an important factor in habitat suitability in other regions (Rollings 1945; Bailey 1974; McCord 1974), and it may play a similar role in some nontypical areas of the Southeast.

SOURCES OF OTHER MODELS

Lancia et al. (1982) developed a model of bobcat habitat suitability and performed a radiotelemetry study in North Carolina for validation. The correlation between expected and observed habitat usage was fairly good, although the model overestimated usage of some habitats and underestimated others. The Lancia et al. (1982) model is in agreement with this one in assuming general cover to be adequate in all undeveloped habitats. However, it does require the evaluation of reproductive cover and, consequently, it may be somewhat more difficult to use.

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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 bobcat (Felis rufus). 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 U.S. Fish and Wildlife Service.

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