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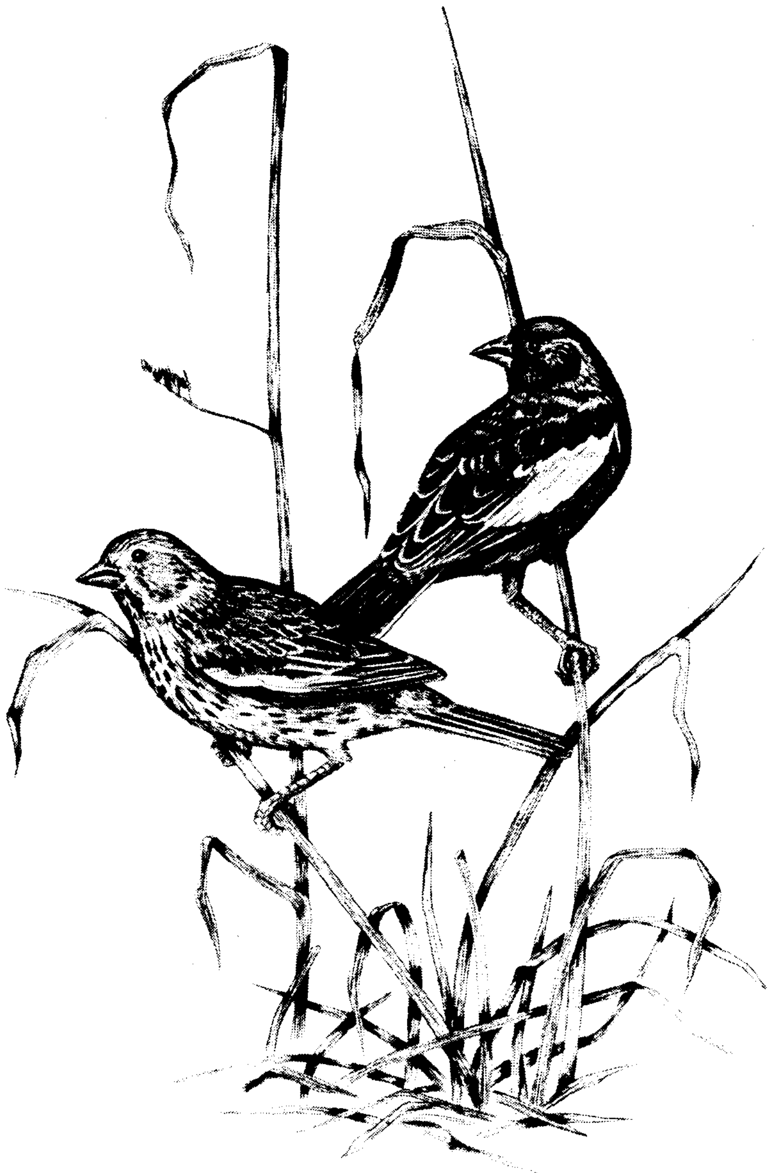
HABITAT SUITABILITY INDEX MODELS: LARK BUNTING



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HABITAT SUITABILITY INDEX MODELS: LARK BUNTING

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is a formalized synthesis of biological and habitat information published in the scientific literature and may include unpublished information reflecting the opinions of identified experts.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

We thank Philip Creighton, Rod DeWeese, Hal Kantrud, Lowell McEwen, Bret Peterson, and Ron Ryder for their advice on the development of the model; Hal Kantrud and A. Lorin Ward reviewed the manuscript. Word processing was provided by Lorraine Kelly, Mary Armstrong, Carolyn Gulzow, Elizabeth Graf, Dora Ibarra, and Trish Gillis. A seminar on wildlife and mitigation taught by Stanley H. Anderson and Wayne Hubert instigated this project. We acknowledge seminar students for their helpful comments. Funding for the development of this model was provided by the U.S. Fish and Wildlife Service and the Army Corps of Engineers.

LARK BUNTING (Calamospiza melanocorys)

HABITAT USE INFORMATION

General

The lark bunting (Calamospiza melanocorys) breeds in native grassland and shrubsteppe habitat from southern Alberta, Saskatchewan, and Manitoba; south to northwestern Texas and New Mexico, and east to Nebraska (Bailey and Niedrach 1965; Baumgarten 1968). In the northern Great Plains, lark buntings reach high populations in a zone extending from southeastern South Dakota to central Montana, then southerly through the shrubsteppe area of Montana and Wyoming into the shortgrass area of northeastern Colorado and the southwestern portion of the Nebraska panhandle (Kantrud 1982). Kantrud (1982) reports sparse populations in a zone extending northwestward from northwestern Nebraska to the southwest corner of Montana. The lark bunting previously nested in Minnesota and Iowa, but the fragmentation of tallgrass prairie apparently caused its breeding range to shrink westward (Roberts 1936; Baumgarten 1968). Its movements are irregular during migration, and it occasionally appears as far east as Connecticut and Mississippi (Gates et al. 1980; Spendelow 1980; Toups and Hodges 1981), and as far northwest as Oregon and British Columbia (Baumgarten 1968). The lark bunting winters in southern California and Nevada, east to north-central Texas and south to central Mexico.

Food

Lark buntings forage primarily on the ground. The diet of adult lark buntings is approximately 80% animal matter (primarily insects) and 20% vegetable matter (primarily seeds) during the breeding season (Langdon 1933; Baldwin 1970). Grasshoppers (Orthoptera) compose from 60% to 80% of the insect matter, followed by beetles (Coleoptera) (10% to 35%), ants (Formicidae) (2% to 15%), and miscellaneous material (Kalmbach 1914; Langdon 1933; Baldwin 1970). Baldwin (1970) calculated an index of utilization by dividing the proportion of each food item in the diet by its proportion in sod samples from the Pawnee National Grasslands. The analysis revealed that Pawnee lark buntings, in May, preferred grasshoppers and seeds of Buchloe, Amaranthus, Lithosperum, and sedges (Carex spp.) while ignoring more abundant scarab beetles, ants, and seeds of Helianthus and Avena.

The nestling diet is composed entirely of invertebrates (Creighton 1974). During the early part of the nestling period, lark bunting nestlings in the Pawnee Grasslands were fed a variety of insect orders fairly equally, but by the end of summer, orthopterans accounted for 85% of the total dry weight of the nestling diet. In this study, high lark bunting densities were associated with grasshopper densities of ≥8 individuals/30 m^2 (estimated from Bhatnager and Pfadt 1973; Creighton 1974).

Water

The black plumage of the male lark bunting may create water balance problems at high air temperatures. When male lark buntings were irradiated at 10, 30, and 35 °C, evaporative water loss increased 150% at 35 °C compared to nonirradiated birds at the same temperature (Wunder 1979). The effect of irradiation was not important at 10 °C. Insects in the diet probably supply most of the water needed by lark buntings. Behavioral modification may reduce evaporative water losses (Wunder 1979).

Cover

Lark buntings breed in shortgrass and mixedgrass prairies, grass-shrub habitats, weedy fallow croplands, and fields of introduced legumes (Wiens 1973; Creighton 1974; Pleszczynska and Hansell 1980; Kantrud 1981; Kantrud and Kologiski 1982, 1983). Wiens (1973) recorded grassland bird species occurrences at seven International Biome Program (IBP) grassland biome sites and reported that breeding lark buntings only occurred at the two shortgrass sites in Colorado and Oklahoma. The Pawnee Grasslands site in Colorado was dominated by *Bouteloua gracilis* and *Buchloe dactyloides* while the Oklahoma site was dominated by *B. gracilis* and *Aristida longiseta*. Buntings in north-central Colorado were commonly found in *Sporobolus cryptandrus* grasslands associated with rabbitbrush (*Chrysothamnus nauseosus*) (Fairbanks et al. 1977). In the study by Kantrud and Kologiski (1982), plants that exceeded average mean areal cover on plots supporting large numbers of lark buntings were *Agropyron* spp., *Opuntia polycantha*, and *Artemisia tridentata*. Pleszczynska and Hansell (1980) reported high densities of lark buntings in a South Dakota field of alfalfa (*Medicago sativa*) and sparse grasses. Lark buntings also breed in sagebrush habitats in Montana (Thompson and Sullivan 1979), greasewood (*Sarcobatus vermiculatus*) and saltbush (*Atriplex* spp.) habitats in Utah (Porter and Egoscue 1954), and *Acacia* meadows in Texas (Quillin 1935).

Studies by Wiens (1970) and Creighton (1974) support the idea that grass height and cover, and percentage of bare ground are important habitat variables affecting lark bunting populations. Creighton (1974) compared habitat occupancy patterns of four grassland bird species in the Pawnee National Grasslands and found that buntings preferred areas with greatest total grass cover (shortgrass, 65.6% and midgrass, 4.7%), and greater sedge, forb, and shrub cover (7.8%, 7.2%, and 2.1%, respectively). Overall vegetative cover, including cactus, totalled 89.6%, while the area of bare ground and rocks was only 10.4%. Wiens (1970) also reported high grass cover estimates (81% on winter grazed plots and 70% on summer grazed plots) on Pawnee areas occupied by buntings, but percent of bare ground was somewhat higher (16%).

At the Pawnee site, lark buntings preferred taller (13.4 cm) and denser (32.2 plants/0.1 m^2) vegetation than horned larks (*Eremophila alpestris*) or chestnut-collared longspurs (*Calcarius ornatus*) (Creighton 1974). The percent canopy cover of vegetation taller than the dominant grass stratum on shortgrass sites occupied by buntings ranged from approximately 5% to 15% (estimated from Wiens 1973; Creighton 1974). In shrub savanna types used by lark buntings, shrubs are an important component of nesting habitat (Woolfolk 1945) and tall plant cover values are probably much higher. Wiens (1970) indicated that lark buntings were associated with taller vegetation on the winter grazed Pawnee plot, but the birds tended to occupy areas with generally lower vegetation structure than that characterizing the plot as a whole. Kantrud and Kologiski (1982) indicated that tall, weedy annual plants sometimes increased on sites where bare ground was exposed through grazing or trampling. These plants formed a sparse canopy of tall vegetation and attracted lark buntings to sites that would otherwise have been avoided.

In arid, shortgrass areas, heavy grazing is detrimental to lark buntings (Rand 1948; Finzel 1964; Giezentanner and Ryder 1969; Giezentanner 1970a,b; Wiens 1971; Ryder 1980). In the northern Great Plains, however, numbers of lark buntings were highest where grazing was moderate in the eastern and northern subregions, light in the southern and shrubsteppe, and heavy in the transition (Kantrud and Kologiski 1983). Intensity of winter grazing had little effect on breeding lark bunting densities in the Pawnee Grasslands, but summer grazing intensity had a negative effect (Giezentanner 1970a; Wiens 1971, 1973; Ryder 1980). Lark bunting densities were four to five times greater on heavily grazed winter plots and lightly grazed summer plots than on heavily grazed summer plots (Wiens 1971; Ryder 1980). Coverage and density of forbs, cacti, and shrubs (Artemisia, Atriplex) were greater on the winter grazed plot (Wiens 1973) as were vertical vegetation density (the total number of vegetative contacts with a point passed vertically through the vegetation), effective vegetation height (height at which a narrow board was 90% obscured by vegetation within 3 cm of the board), and emergent vegetation height (Wiens 1970). Emergent vegetation is defined here as any plant taller than the mean height of the dominant grass stratum on the study area. At the Pantex site in Oklahoma, lark buntings were slightly more abundant on the grazed site (Giezentanner 1970b; Wiens 1973), which had higher grass cover and lower percentages of bare ground and patchiness (Wiens 1973). The ungrazed site apparently was poor quality bunting habitat regardless of grazing intensity, presumably because there was not adequate protective cover.

Grazing regimes may have indirect effects on lark bunting densities by directly affecting other habitat variables. Grazing resulted in decreased vegetative height on all soils (Kantrud and Kologiski 1982). Highest densities of lark buntings occurred on plots with short to moderate vegetation heights (5 to 23 cm), whereas lowest densities were associated with vegetation heights ranging from 17 to 30 cm. Lark bunting densities peaked on tallgrass plots that were heavily cropped to 18 cm. In addition, bunting densities were highest on plots with bare ground coverage ranging from 8% to 13%. Low to moderate densities were found on plots with relatively lower (e.g., 3% to 8%) or higher (12% to 25%) percentages of bare ground. The percentage of bare soil was positively related to grazing intensity on all soils. Apparently, heavy grazing served lark bunting populations when the original vegetation had greater canopy coverage and taller grasses than buntings preferred. Increased canopy height may reduce visibility for foraging or courtship displays.

Kantrud and Kologiski (1982, 1983) studied the effects of grazing and soil type on grassland bird populations on 615 plots of native rangeland in North and South Dakota, Wyoming, Montana, Nebraska, and Colorado. They found that increased grazing intensity resulted in much lower lark bunting densities on warm, dry soils. However, the effects of grazing on lark bunting populations varied greatly among soil types. On cool, moist typic borolls, grazing had little influence on population density, but on aridic borolls and borollic Aridisols, moderate or heavy grazing seemed to favor larger populations. Heavily grazed plots on typic ustolls supported the highest densities of lark buntings.

Reproduction

Male lark buntings use flight displays to establish and defend territories and possibly to attract females (Taylor and Ashe 1976). In a South Dakota alfalfa field, lark buntings were polygynous, forming a dense "colony" (Pleszczynska and Hansell 1980), but in the Pawnee Grasslands, they were monogamous with larger territories (P.D. Creighton, Department of Biological Sciences, Towson State University, Towson, Maryland; pers. comm.). At the Pawnee site, males established breeding territories in early May and initiated nests later than other ground-foraging species (Creighton 1971, 1974; Strong and Ryder 1971). Nesting peaked from late May through mid-June and ended by mid-July (Creighton 1974). Numbers of lark bunting nests initiated per week were significantly correlated with grasshopper density (Creighton 1974). Nesting density was 0.3/ha in Creighton's (1974) study whereas Baldwin et al. (1969) reported 0.02 to 0.05 nests/ha.

Lark bunting nests are placed on the ground in shallow depressions, closely associated with protective plant cover (Creighton 1971, 1974). Woolfolk (1945) reported that 100% of 18 nests found in Montana pastures were associated with three species of sagebrush (Artemisia tridentata, A. cana, and A. frigida). In a study near Chugwater, Wyoming, lark buntings placed approximately 80% of their nests under the tall forb, pricklepoppy (Argemone spp.) (B. Peterson, U.S. Fish and Wildlife Service, Fort Collins, Colorado; pers. comm.). Creighton (1971) reported that 62.7% of 43 nests were associated with red threeawn (Aristida longiseta), 23.2% were shaded by rabbitbrush, and the remaining nests were protected by saltbush (Atriplex canescens), eriogonum (Eriogonum effusum), and sage (Salvia reflexa). Nests associated with red threeawn and eriogonum were highly successful (67% and 100% success). Wiens (1973) reviewed several lark bunting studies from the Pawnee Grasslands and found greatest nest association (47%) with saltbush, while red threeawn, eriogonum, and rabbitbrush were secondarily important. Most nests were placed on the east or southeast side of tall plants, affording protection against the afternoon sun and the prevailing northwest winds. Lark buntings have also been reported to nest under tumbleweeds (Cycloloma atriplicifolium) in Montana (Whittle 1922) and acacia (Acacia spp.) clumps in Texas (Quillin 1935).

Pleszczynska and Hansell (1980) suggested that protective cover from solar radiation at the nest was the most crucial factor for breeding in lark buntings. The best predictor of bachelor, monogamous, or polygynous behavior in an alfalfa field in South Dakota was intensity of light (measured 10 cm above the ground) on male territories (Pleszczynska 1978; Pleszczynska and

Hansell 1980). Territories with two nesting females had the lowest light values, whereas bachelor territories had the least amount of shading. When shading was artificially increased by attaching plastic leaves to alfalfa plants or decreased by plucking alfalfa leaves the mating status of males was altered (Pleszczynska and Hansell 1980). Areas improved to a bigamous cover quality were settled by bigamists; areas improved or impoverished to a monogamous level were chosen by monogamists; and areas altered to a bachelor quality were settled by bachelors. Reproductive success was negatively correlated with increased light penetration at the nest (Pleszczynska 1978). Early nesting favored survival because illuminance was lowest before vegetation began to dry and wilt.

Nesting success in lark buntings can be affected by the rate of brood parasitism by brown-headed cowbirds (Molothrus ater). Lark buntings are not heavily parasitized (Friedmann 1963), possibly because their blue eggs contrast sharply with the cowbird's speckled eggs. Nevertheless, in 18 nests examined by Allen (1874), three contained one cowbird egg, two contained two cowbird eggs, and one had three cowbird eggs. Hill (1976) reported that, in Kansas, 15.5% of 142 lark bunting nests were parasitized and only 7% of the parasitized nests fledged young.

Interspersion and Composition

Based on Pleszczynska's (1978) data, we estimated the average territory size of the lark bunting to be about 0.2 ha. In the Pawnee Grasslands, where densities were lower, average territory sizes estimated from the multiflush technique and location-mapping were 0.5 ha and 0.75 ha, respectively (Creighton, pers. comm.). Giezentanner (1970a) indicated that lark bunting territory size was difficult to measure accurately because unmated males often displayed within the boundaries of another male's territory.

Breeding densities of lark buntings fluctuate greatly from year to year (Wiens and Dyer 1975). In the shortgrass prairie of the Pawnee Grasslands, densities ranged from 7.2 to 13.8 birds on six 8.1 ha plots (Giezentanner 1970a). Wiens (1971) reported an average of 125 buntings/100 ha on heavily grazed winter plots at the Pawnee site and only 20 to 50 buntings/100 ha on heavily grazed summer plots. In Oklahoma, bunting densities were only 20 birds/100 ha on grazed and ungrazed plots in shortgrass prairie. Wiens and Dyer (1975) indicated that relative frequencies of lark buntings were higher in shortgrass (56% of census) and shrub (40%) habitats than in mixed shrub-steppe (29%), mixedgrass (5%), and tallgrass (0%). Highest densities were reported by Pleszczynska and Hansell (1980) who recorded 22 territorial male buntings on a 4 ha field of alfalfa in South Dakota.

Lark bunting males form seminomadic flocks during the breeding season, which leads to a high degree of clumping (Rotenberry and Wiens 1976). Flocking behavior in males may be in response to localized food supplies such as swarming grasshoppers (Shotwell 1930; Welch 1936). The gregarious behavior of both sexes is especially prominent on the wintering grounds, where flocks of hundreds have been observed (Baumgarten 1968).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This HSI model is intended for use within the breeding range of the lark bunting (Figure 1).

Season. This model was developed to evaluate habitat suitability for the lark bunting during the breeding season (May through July).

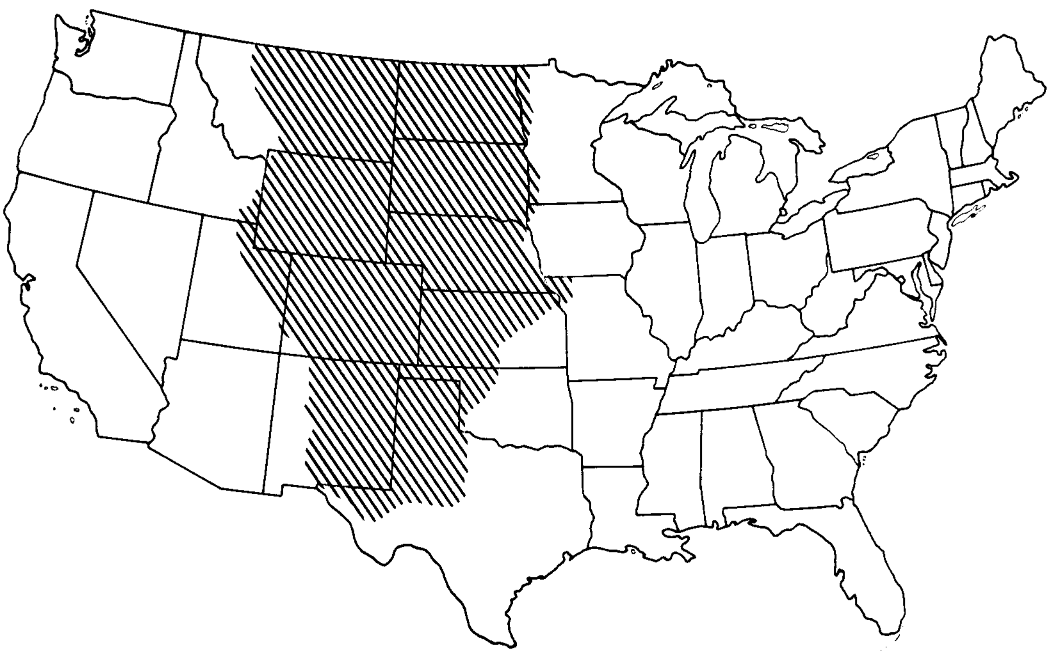

Figure 1. Geographic applicability of the lark bunting HSI model in the contiguous United States.

Cover types. This model can be used to evaluate habitat in the following cover types (terminology follows that of U.S. Fish and Wildlife Service 1981): Grassland (G) and Shrub Savanna (SS). Lark buntings are apparently also found in croplands and pasture/hayland (Pleszczynska 1978; Pleszczynska and Hansell 1980; H.A. Kantrud, Northern Prairie Wildlife Research Center, Jamestown, ND, pers. comm.), but avoid mowed hayland (Kantrud 1981). There is not enough information in the literature to determine habitat variables for these latter cover types.

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. Territories of male lark buntings range from approximately 0.2 ha to 0.75 ha. Although the minimum habitat area is probably >0.75 ha due to the gregarious nature of this species, no information was found in the literature to more accurately define the minimum habitat area. It is the responsibility of the user to define minimum area to be considered as lark bunting habitat.

Verification level. This model is intended to provide information useful for baseline assessments and habitat management where lark buntings are a species of interest. We have reviewed the lark bunting literature, selected the criteria described below, supplied values for each (including optimum), and have suggested an aggregation mechanism. This approach, when carried to completion, will produce a single index representing the assumed relative suitability of a site for lark bunting food/reproduction requirements. Our description of these requirements is based on the assumption that sites supporting male territories occupied by more than one female represent optimum feeding/reproduction conditions (our standard of comparison) for lark buntings. The identified criteria should serve as hypotheses of habitat use by the species, but their evaluation individually, or in total, against long-term demographic data, awaits further research.

Comments and suggestions from H. Kantrud, R.A. Ryder, and A.L. Ward on an earlier draft of this model have been incorporated where possible. Use of the reviewers' names does not necessarily imply that they concur with each section of the model, or with the model in its entirety.

Model Description

Overview. All of the breeding habitat requirements of the lark bunting can be satisfied within grasslands or areas where grasses are the dominant vegetation. Food, especially invertebrates, is assumed to be the principal source of water. We have assumed that all cover requirements are met with a characterization of suitability of nesting cover.

Food/reproduction component. Suitable feeding and nesting sites for lark buntings can be provided by native grasslands and grass/shrub associations. This includes prairie grasses with an upper stratum of midgrasses and a dense understory of shortgrasses. A thin layer of shrubs, bunchgrasses, or midgrasses provides shade and is assumed to be an important feature of nesting habitat.

We have assumed that certain measures of plant structure can be used to evaluate the suitability of a site for both the food and nesting requirements of lark buntings. For example, lark buntings specialize on grasshoppers as a food source for both adults and nestlings (Baldwin 1970; Creighton 1974). Orthopteran density has been linked to percent grass cover (Anderson 1964). High densities of grasshoppers are associated with grass cover values >60% (Anderson 1964). In this model, percent canopy cover of grasses between 60% and 90% is assumed optimal for food, whereas areas with <30% grass cover are considered unsuitable (Figure 2a).

The intensity of light measured at 10 cm above ground has been correlated with the number of female lark buntings nesting on male territories (Pleszczynska and Hansell 1980) and reproductive success (Pleszczynska 1978). We have assumed that these two nesting parameters (number of females/territory and success) are functions of habitat suitability. Because light levels can be difficult to assess in the field, we elected to use the degree of shading at ground level as a surrogate for the above relationship. We have assumed that shading is a function of both percent canopy of grasses (SIV1) and the mean height of the grass canopy during the growing season (SIV2). A mean height for the dominant grass stratum (i.e., the layer of greatest coverage) of 8 to 20 cm is assumed optimal. A grass stratum shorter than 3 cm is unsuitable because light penetration is too great, and no nest concealment is provided. A grass canopy with a mean height >50 cm is assumed to be unsuitable because of restricted visibility for foraging (Figure 2b).

Lark buntings forage and nest on the ground, and we have assumed that some bare ground is necessary to facilitate these activities. Optimal conditions are assumed to exist if the amount of the ground that is bare is <15%. Suitability is assumed to decrease as the percentage of bare ground increases (Figure 2c). Levels of >60% bare ground are considered undesirable because of reduced coverage of grasses and increased light penetration.

The percent canopy cover of vegetation taller than the dominant grass stratum (shrubs, bunchgrasses, tall forbs, cactus, mid- and tallgrasses) is considered important in evaluating nest site availability for lark buntings. In some regions, shrubs may be more valuable as nest sites than tallgrasses and forbs because of their persistence (Woolfolk 1945), but lark bunting populations can attain high densities in habitats devoid of shrubs (Kantrud 1981). Optimal percent canopy cover of vegetation taller than the dominant grass stratum is considered to be 10% to 30% (Figure 3). Coverage >70% is assumed to be unsuitable. If tall plant coverage is <10%, habitat is considered suboptimal, but not totally unsuitable for lark buntings.

<u>HSI determination</u>. The specific aggregation mechanism chosen for this model attempts to mimic perceived relationships between the individual criteria as closely as possible. The suggested equation for obtaining the food/reproduction suitability index (SIFR) for lark buntings in grasslands and shrub savannas is as follows:

$$SIFR = \left[\left(\frac{SIV1 + SIV2 + SIV3}{3}\right) \times SIV4\right]^{1/2} \qquad (1)$$

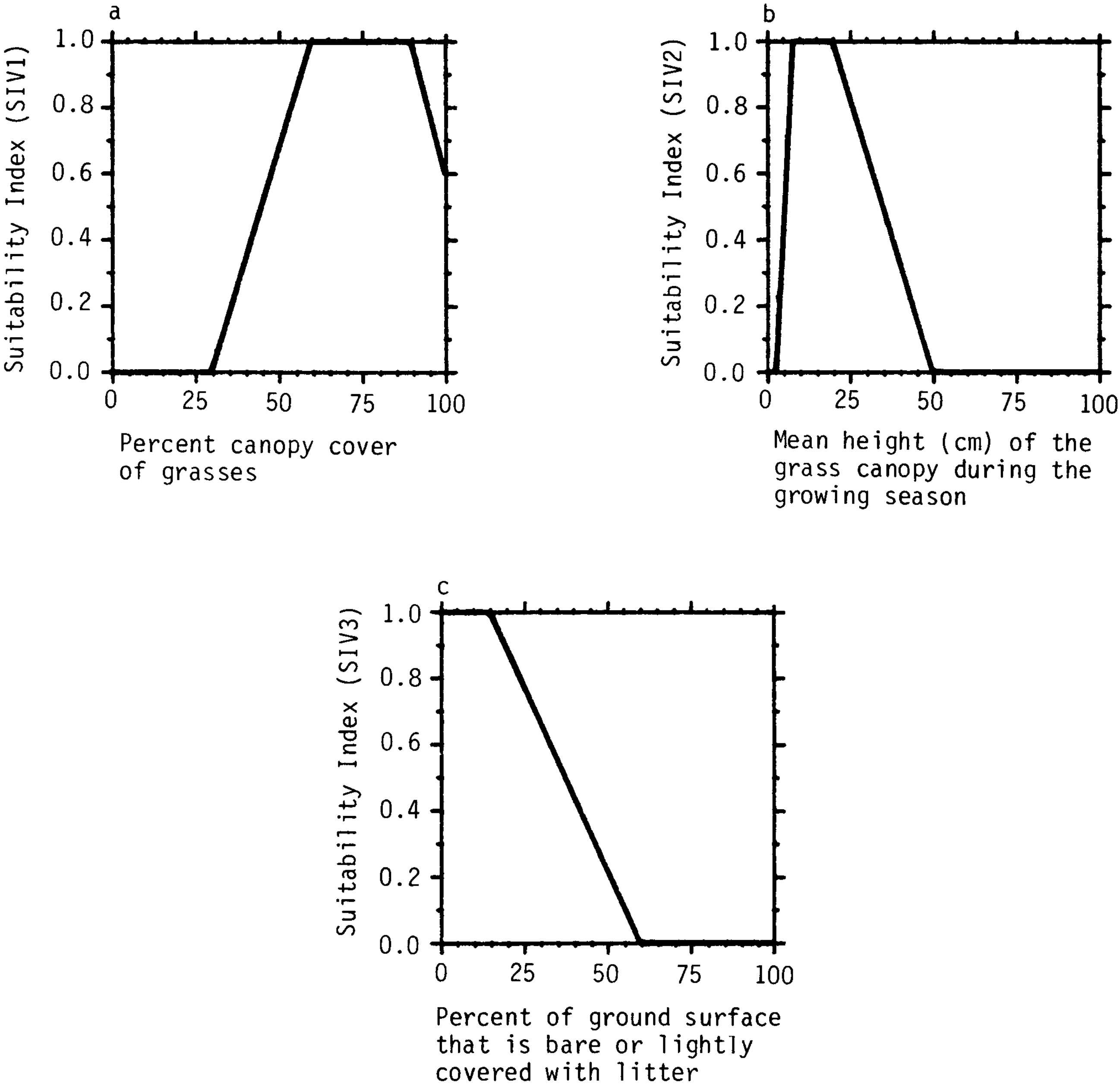

Figure 2. The relationships between vegetation cover variables and suitability index (SI) values for lark bunting habitat quality.

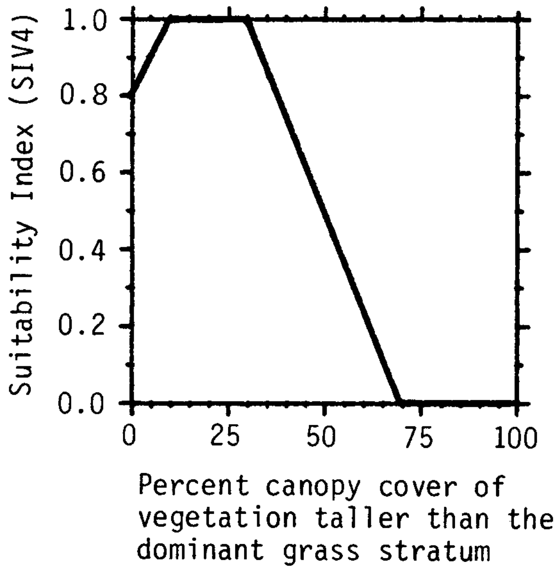

Figure 3. The relationship between percent canopy cover of vegetation taller than the dominant stratum of grass and a suitability index (SI) for lark bunting nesting requirements.

The percent canopy cover of grasses (SIV1), mean height of the grass canopy during the growing season (SIV2), and percent of bare ground (SIV3) are assumed to be equal in value and are combined with an arithmetic mean in equation 1. Percent canopy cover of vegetation taller than the dominant grass stratum (SIV4) is incorporated into equation 1 as the major nest quality component of the HSI model, and is assumed to be of equal value to the mean of the three preceding variables. A geometric mean is used to combine SIV4 with the first three variables because it is assumed that ≥70% canopy cover of vegetation taller than the dominant grass stratum will render a site unsuitable for lark buntings. The HSI is equal to the SIFR.

<u>Application of the Model</u>

<u>Summary of model variables</u>. Four habitat variables are used in this model to determine a food/reproduction suitability index for the lark bunting. The relationships between habitat variables, life requisites, cover types, and an HSI value are summarized in Figure 4.

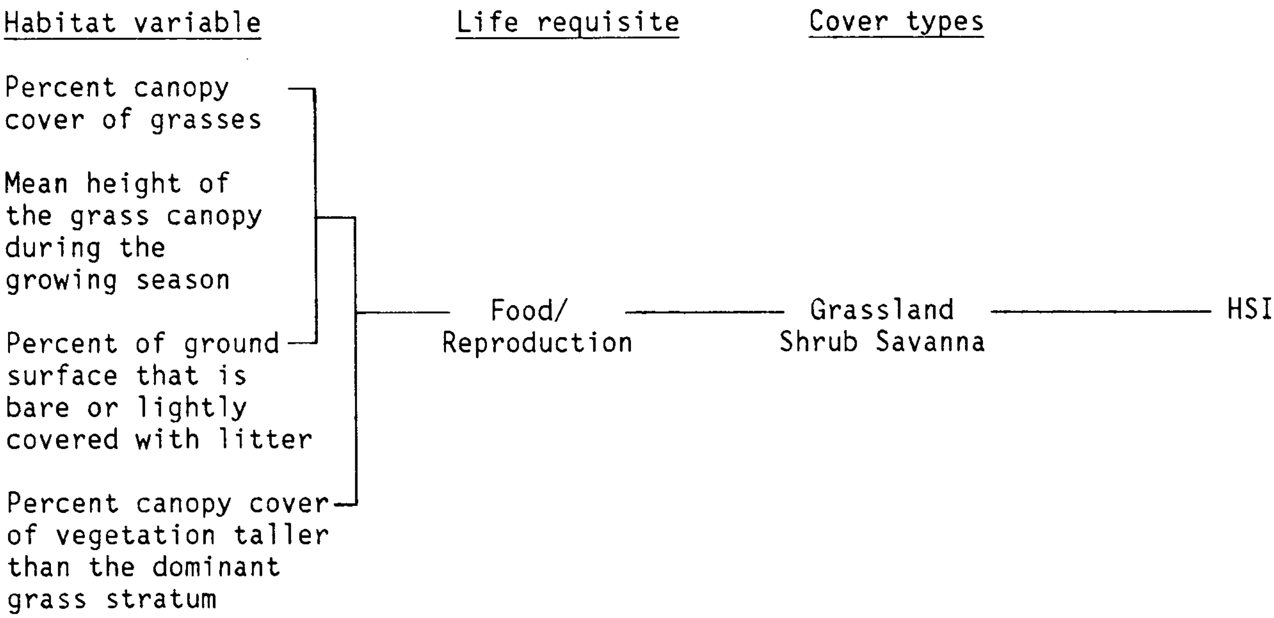

Figure 4. Relationship of habitat variables, life requisites, and cover types in the lark bunting HSI model.

Definitions of variables and suggested field measurement techniques (Hays et al. 1981) are provided in Figure 5.

Model assumptions. This model was developed to assess the habitat suitability of grasslands and shrub savannas for supplying the food and reproductive needs of lark buntings. The model is not intended to produce outputs that reflect actual population densities at any particular time, but rather it attempts to estimate the potential of a site to supply the habitat requirements as defined above, regardless of nonhabitat variables influencing populations. Model variables and relationships are based on information obtained from studies disjunct in time, space, techniques, and objectives. As such, the model is a collection of hypotheses and should not be interpreted as statements of proven cause and effect. Users should not hesitate to make refinements in the model that are perceived to correspond to, or better represent, localized conditions, if local data sets or authorities on the species' requirements substantiate the changes.

Habitat variable	Cover types	Suggested technique
Percent canopy cover of grasses (the percent of the ground surface that is shaded by a vertical projection of grasses).	G,SS	Line intercept, quadrat
Mean height of the grass canopy during the growing season (cm) (the mean distance from the ground surface to the dominant height stratum in the grass canopy, when the grass canopy is at its tallest point).	G,SS	Line intercept, graduated rod
Percent of ground surface that is bare or lightly covered with litter [the percent of the ground surface that is unvegetated or covered with vegetative litter that is <5.1 cm (2 inches) in depth].	G,SS	Line intercept, quadrat, remote sensing
Percent canopy cover of vegetation taller than the dominant grass stratum (the percent of the ground surface that is shaded by a vertical projection of crowns of all woody and herbaceous vegetation, including mid- and tall-grasses, taller than the average canopy height of the dominant grass stratum).	G,SS	Line intercept, quadrat

Figure 5. Definitions of variables and suggested measurement techniques.

Summer grazing intensity may affect lark bunting densities negatively, positively, or not all, depending on vegetation type. In tallgrass types, heavy grazing can cause an increase in bunting populations, but in shortgrass prairies, heavy grazing can cause a decline. When vegetation height is taller than buntings prefer (e.g., >30 cm), heavy grazing can improve habitat quality by decreasing canopy height. In shortgrass types, heavy grazing is detrimental because percent of bare ground is drastically increased and food, shade, and nest site availability are reduced. Thus, lark buntings apparently respond to a change in vegetation height and cover rather than to grazing intensity per se. Grazing intensity was therefore not used as a variable in this model.

SOURCES OF OTHER MODELS

No other habitat models for the lark bunting were located in the literature.

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A review and synthesis of existing information were used to develop a Habitat Suitability Index (HSI) model for the lark bunting (Calamospiza melanocorys). 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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