FWS/OBS-82/10.83
SEPTEMBER 1984

HABITAT SUITABILITY INDEX MODELS: BREWER'S SPARROW

Fish and Wildlife Service

U.S. Department of the Interior

FWS/OBS-82/10.83
September 1984

HABITAT SUITABILITY INDEX MODELS: BREWER'S SPARROW

by

Henry L. Short
Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
Drake Creekside Building One
2627 Redwing Road
Fort Collins, CO 80526-2899

Western Energy and Land Use Team
Division of Biological Services
Research and Development
Fish and Wildlife Service
U.S. Department of the Interior
Washington, DC 20240

This report should be cited as:

Short, H. L. 1984. Habitat suitability index models: Brewer's sparrow. U.S. Fish Wildl. Serv. FWS/OBS-82/10.83. 16 pp.

PREFACE

This document is part of the Habitat Suitability Index (HSI) Model Series (FWS/OBS-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. The habitat use information provides the foundation for HSI models that follow. In addition, this same information may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

The HSI Model Section documents a habitat model and 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 application information includes descriptions of the geographic ranges and seasonal application of the model, its current verification status, and a listing of model variables with recommended measurement techniques for each variable.

In essence, the model presented herein is a hypothesis of species-habitat relationships and not a statement of proven cause and effect relationships. Results of model performance tests, when available, are referenced. However, models that have demonstrated reliability in specific situations may prove unreliable in others. For this reason, feedback is encouraged from users of this model concerning improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to fish and wildlife planning. Please send suggestions to:

Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
2627 Redwing Road
Ft. Collins, CO 80526-2899

CONTENTS

	Page
PREFACE	iii
ACKNOWLEDGMENTS	vi
HABITAT USE INFORMATION	1
General	1
Food	1
Water	2
Cover	2
Reproduction	2
Interspersion	3
HABITAT SUITABILITY INDEX (HSI) MODEL	3
Model Applicability	3
Model Description	5
Model Relationships	9
Application of the Model	13
SOURCES OF OTHER MODELS	13
REFERENCES	15

ACKNOWLEDGMENTS

I gratefully acknowledge Terrell Rich, Bureau of Land Management, U.S. Department of the Interior, Shoshone, Idaho, for his substantive review of this Brewer's sparrow model. The cover of this document was illustrated by Jennifer Shoemaker. Word processing was provided by Carolyn Gulzow and Dora Ibarra.

BREWER'S SPARROW (Spizella breweri)

HABITAT USE INFORMATION

General

The Brewer's sparrow (Spizella breweri) nests within certain evergreen shrubland and evergreen shrub savannah habitats "from southwestern Yukon, northwestern and interior British Columbia, west-central and southern Alberta, southwestern Saskatchewan and southwestern North Dakota south, generally east of the Cascades and the coast ranges, to eastern and southern California ..., southern Nevada, central Arizona, northwestern New Mexico, central Colorado, southwestern Kansas, northwestern Nebraska, and southwestern South Dakota" (American Ornithologists' Union 1983:701). The bird winters "from southern interior ... California, southern Nevada, western and central Arizona, southern New Mexico, and western and central Texas south to southern Baja California and Sonora ..., in the Mexican highlands to Jalisco and Guanajuato, and to southern Texas" (American Ornithologists' Union 1983:701).

Food

Invertebrates comprise most of the diet of nestling Brewer's sparrows and the bulk of the diet of adults during late spring and early summer. Invertebrates are frequently gleaned from the surface of shrub canopies (Best 1972). Major invertebrate foods include spiders (Arachnida), beetles (Coleoptera), true bugs (Hemiptera) (Best 1972), weevils (Coleoptera), plant lice (Homoptera), and caterpillars (Lepidoptera) (Paine 1968). Stomach contents of Brewer's sparrows collected during May contained weevils, plant lice, caterpillars, spiders, and other invertebrates (Paine 1968). Only 1% of the stomach contents during May and June consisted of plant materials. Weevils and caterpillars comprised nearly 80% of stomach contents during June. Plant materials comprised 20% of stomach contents during July, about 30% during autumn, and 90% during winter.

The Brewer's sparrow occupies a variety of steppe and desert cover types following the late spring-early summer breeding season. Grass and forb seeds were an important component of the diet in these cover types especially from late autumn to early spring (Cody 1971). The Brewer's sparrow may form feeding flocks with other species while on winter range, and gleans seeds from the ground and from seedheads (Cody 1971). A small portion of the bird's diet at this time also consists of insects.

Activities that appreciably increase grass cover, e.g., sagebrush control to increase grass production, change the types of foods available to the sparrows. Animal foods represented larger portions and grass seeds smaller portions of the diet of Brewer's sparrows collected during June and July from an unsprayed sagebrush area than of the diet of sparrows collected from an area where sagebrush had been killed (Best 1972).

Water

The Brewer's sparrow may satisfy daily water requirements from consumed food. The small Brewer's sparrow, with a low daily water requirement coupled with an efficient renal system, has adjusted both behaviorally and physiologically to a xeric environment (Ohmart and Smith 1970). The sparrow drank water nearly equivalent to one-third of its body weight when water was provided under experimental conditions. Other Brewer's sparrows fed in a controlled experiment survived a water deprivation period of 21 days when fed solely a diet of seeds (Ohmart and Smith 1970). The bird drank free water and bathed when surface water is present (Linsdale 1938). The lack of free water, however, is apparently not a limiting factor for the Brewer's sparrow in its habitat selection.

Cover

The Brewer's sparrow is dependent on a shrub-dominated plant community that provides protective cover, song perches, and nest sites (Johnsgard and Rickard 1957). The Brewer's sparrow has been reported to use sagebrush (*Artemisia* spp.) in the sagebrush-wheatgrass (*Artemisia-Agropyron*) association, rabbitbrush (*Chrysothamnus* spp.) in certain wheatgrass-bluegrass (*Agropyron-Poa*) associations, and hawthorn (*Crataegus* spp.), plum (*Prunus* spp.), and serviceberry (*Amelanchier* spp.) on a relict Idaho fescue (*Festuca idahoensis*) site in southeastern Washington (Johnsgard and Rickard 1957). The abundance of the Brewer's sparrow in its breeding range has been shown to be positively correlated with the percent cover that is bare ground, the percent cover of forbs, the percent cover of shrubs and cacti, and negatively correlated with the percent cover of grasses, and the percent cover of litter (Rotenberry and Wiens 1980). The presence of the bird in its breeding habitat is also negatively correlated with shrub species diversity, the abundance of small shrubs, and the presence of a rocky or rolling surface (Wiens and Rotenberry 1981). The Brewer's sparrow uses tall shrubs and small trees as roosting sites and cover at times other than the breeding season.

Reproduction

The Brewer's sparrow nests in sagebrush (*A. tridentata*) throughout the range of this common shrub and in a variety of other suitable shrubs when sagebrush is not available. Nests are placed low within the shrubs: mean nest height = 16 cm (6.5 inches) in sagebrush 27-63 cm (11-25 inches) in height (Best 1972); 25 cm (10 inches) in sagebrush averaging 65 cm (26 inches) in height (Reynolds 1981); 20 cm (8 inches) in sagebrush 32-67 cm (13-27 inches) in height (Schroeder and Sturges 1975); 25 cm (10 inches) in saltbush (*Atriplex canescens*) in northeastern Colorado (Porter and Ryder 1974);

and 28 cm (11 inches) in sagebrush 67 cm (27 inches) in height (Rich 1980). The nest is placed in the outer branches of the shrub under the densest foliage. The few dead or partially dead sagebrush plants selected as nest sites in sagebrush control areas occurred in the larger and more heavily branched shrubs (Best 1972). Effective sagebrush control reduces habitat use by the Brewer's sparrow (Best 1972). The abundance of Brewer's sparrows did not change on plots where up to 50% of the sagebrush was killed, but a total herbicidal sagebrush kill caused a significant decrease in the number of nesting Brewer's sparrows. Bird use was reduced 67% one year after herbicidal spraying, and 99% two years after herbicidal spraying that defoliated and killed sagebrush in Wyoming (Schroeder and Sturges 1975). Brewer's sparrows continued to nest in ceanothus (Ceanothus velutinus) and manzanita (Arctostaphylos patula) shrubs after herbicidal treatment (Beaver 1976). The herbicide killed the shrubs but did not result in defoliation.

Interspersion

The Brewer's sparrow does not show any obvious dependence on combinations of layers of habitat as occur along the edge between two or more cover types. The sparrow is considered to nest within the terrestrial surface layer (up to 0.5 m into suitable shrubs) and to feed on insects and seeds in both the terrestrial surface and midstory layers of habitat on its breeding range (Short 1983). The sparrow breeds in shrubland habitats, preferably where sagebrush is dominant, and maintains a territory estimated to be about 0.5 ± 0.15 ha (about 1.2 acres) in area (Reynolds 1981). The sparrow occurs during nonbreeding seasons in a variety of bunchgrass steppe, meadow steppe, open fields, and desert communities. Its life requisite requirements during the nonbreeding season include shrubs and small trees suitable for protective perches and an open terrestrial surface where the sparrow can forage for insects and grass, forb, and shrub seeds. I have assumed that the potential limiting factor for the species would be suitable nesting habitat which could be in short supply if extensive land use changes modified the structure of the shrubsteppe (especially big sagebrush) communities in western North America.

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model is applicable throughout the breeding range of the Brewer's sparrow as indicated in Figure 1.

Season. This model produces HSI values for the breeding habitat of the Brewer's sparrow. The model can be used throughout the year to evaluate breeding habitat for the sparrow even though the breeding season only occurs from May to July.

Cover types. This model is intended to evaluate the quality of breeding habitat for the Brewer's sparrow in evergreen shrubland (ES) and evergreen shrub savannah (ESS) cover types (U.S. Fish and Wildlife Service 1981).

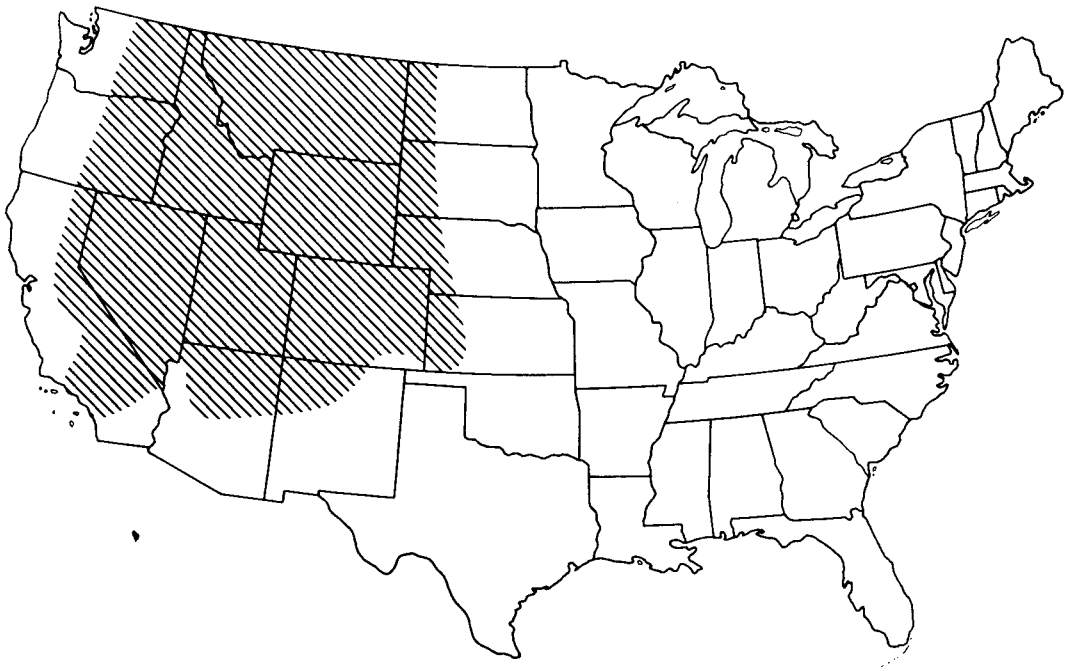


Figure 1. Distribution of the Brewer's sparrow in its breeding range (shaded area) in the western United States (adapted from a map prepared by D. B. Inkley and C. M. Raley, Wyoming Coop. Fish and Wildl. Unit, Laramie, from American Ornithologists' Union, 1983).

Minimum habitat area. Minimum habitat area is the minimum amount of contiguous habitat that is required before an area will be occupied by a species. Rich (pers. comm.) found singing males in patches of sagebrush 0.2 ha (0.46 acres) in area. It is assumed in this model that the HSI value for a habitat will equal 0.0 if less than 0.2 ha of potentially suitable habitat is available.

Verification level. This model was developed from descriptive information about nest sites and from correlative associations between nest sites and habitat variables that are identified in the literature. This HSI model describes the potential of an area to serve as nesting habitat for the Brewer's sparrow. The present model is intended to rank the nesting habitat as would an expert thoroughly familiar with the reproductive requirements of the Brewer's sparrow. The model should not be expected to rank habitats as they would be ranked by population data because many nonhabitat related criteria significantly impact populations and the biomass of wildlife species.

Model Description

Overview. This HSI model for the Brewer's sparrow considers the quality of habitat for fulfilling the life requisites of the sparrow in its nesting habitat in evergreen shrubland (ES) and evergreen shrub savannah (ESS) cover types. The model assumes that a suitable insect fauna will be associated with the shrub foliage during the breeding season and that grasses and forbs in the understory will produce some seeds useful to the sparrow.

The following sections document the logic and assumptions used to translate habitat information for the Brewer's sparrow into the variables selected for the HSI model. Specifically, these sections identify the variables used in the model, define and justify the suitability level of each variable, and describe the assumed relationship between variables.

The logic used to identify the habitat variables important to the selection of nesting habitat by the Brewer's sparrow is illustrated in Figure 2. A tree diagram identifying the variables important to the Brewer's sparrow is presented in Figure 3.

Habitat components. Wiens and Rotenberry (1981:39) suggested that, at least in shrubsteppe habitats, birds like the Brewer's sparrow may occupy a general habitat type if it has a "proper structural configuration" and then may refine their distribution based on the presence of particular plant species. They also indicated that densities of the Brewer's sparrows seemed greatest in open flatland habitats in shrubsteppe communities in the northwestern Great Basin.

This model describes several parameters that seem to provide a "proper structural configuration" to a habitat. Thus, a block of habitat must be at least 0.2 ha in area and contain woody scrub vegetation to be considered breeding habitat for the Brewer's sparrow. In addition, the habitat block must occur on terrain whose slope does not exceed 30°, and the terrestrial surface of this habitat block should be covered by soil rather than rocky outcrops. The model then incorporates a series of habitat variables that tend to refine the structure of habitat within scrublands and emphasize the importance of particular shrub species to the Brewer's sparrow. These variables indicate that the percent canopy closure and the height of dominant shrubs seem to influence the utility of shrubland habitat by the sparrow and emphasize that different shrub species seem to vary in their importance as nest substrates for this bird.

Rich (pers. comm.) found singing male Brewer's sparrows in patches of sagebrush that were surrounded by farmland which is unsuitable habitat for the sparrow. These patches of shrubland were no greater than 0.2 ha (0.46 acres) in area. The singing males within these small patches were within hearing distance of other singing males. Suitability index values for patches of shrubland habitat are assumed to be 1.0 if habitat patches are 0.2 ha or greater in size. SI values of 0.0 are given to patches of shrubland vegetation less than 0.2 ha in area.

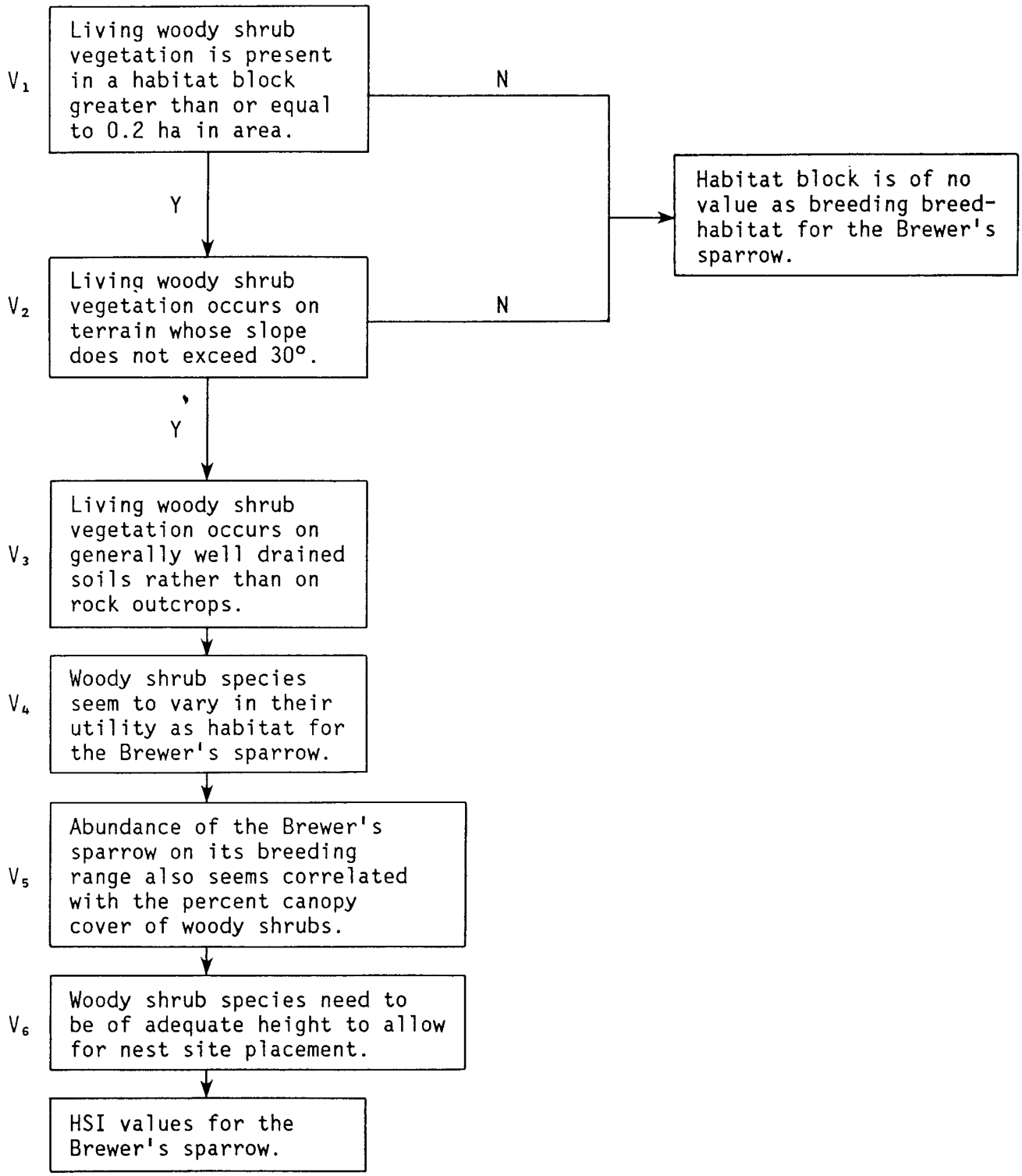


Figure 2. Logic used to develop the HSI model to evaluate the breeding habitat of the Brewer's sparrow.

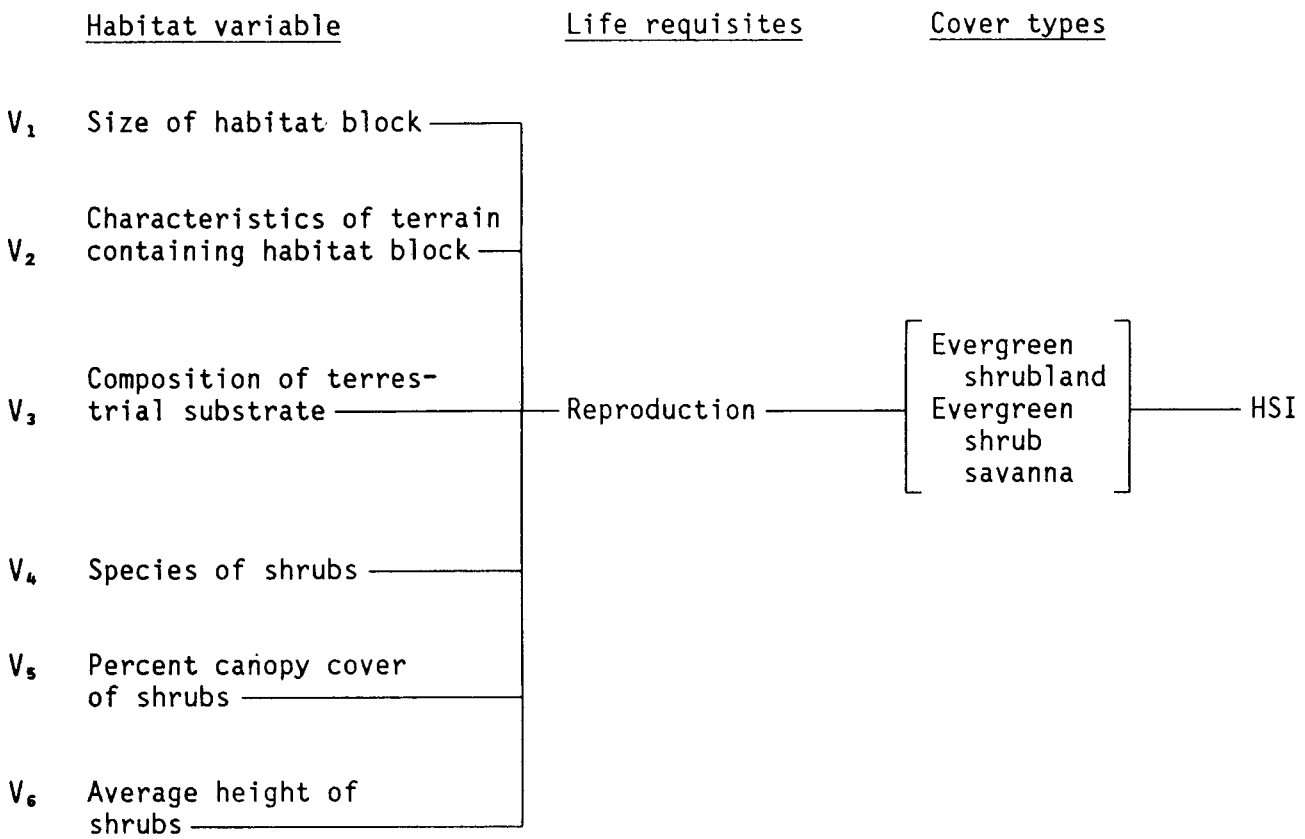


Figure 3. Relationships of habitat variables, life requisites, and cover types in the HSI model for the Brewer's sparrow.

Brewer's sparrows, at least in the northwestern Great Basin, are associated with open flatland habitats rather than with rocky outcrops (Wiens and Rotenberry 1981). Rich (pers. comm.) also found that the number of Brewer's sparrows tended to diminish as the quantity of rocky substrates increased. Rich (pers. comm.) additionally found that although the sparrow was most numerous in flatlands or in gently rolling terrain, it also occurred in suitable habitats with slopes up to about 30°. SI values in the model are assigned values equal to 1.0 if the slope of potential habitats does not exceed 30°. SI values of 0.0 are assigned to those potential habitats possessing slopes greater than 30°.

Results of a principal component analysis associating the presence of the Brewer's sparrow with a variety of habitat criteria demonstrated that the presence of the sparrow was inversely associated with the amount of rockiness, the amount of dead vegetation and shrubs, and increasing shrub diversity (Wiens and Rotenberry 1981). Rich (pers. comm.) suggested that habitats with rock surface cover values up to 30% may be used by the sparrow but that the use of habitats with more than 30% rock cover may be appreciably diminished. A suitability index value of 1.0 is assigned to Variable 3 in the model if rock surface cover values do not exceed 30%. The suitability index values diminishes rapidly for habitats with greater than 30% rock cover. Rich (pers. comm.) suggests that a SI value of 0.0 should probably be realized when percent rocks in the terrestrial surface substrate equals or exceeds 60%.

Maximum densities of 5.3 Brewer's sparrows per ha (Wiens and Rotenberry 1981) and 5.2 Brewer's sparrows/ha (Rich pers. comm.) have been observed in shrublands dominated by sagebrush. Sagebrush shrub types are given an HSI value of 1.0 in the model. The sparrow also has been reported to nest at densities of 40 to 50 pair/40 ha (about 2.5 Brewer's sparrows/ha) in a remnant Symphoricarpos/festuca habitat in southeastern Washington where nests were placed in hawthorn, chokecherry, and serviceberry (Johnsgard and Rickard 1957). These shrub species are given a suitability index value of 0.5 in variable 4 of the HSI model. The sparrow also has been found nesting in a variety of other shrubs like saltbush (Porter and Ryder 1974), greasewood (Sarcobatus spp.) (Fautin 1946), hopsage (Grayia spp.) (Linsdale 1938), ceanothus, manzantia, and currant (Ribes spp.) (Beaver 1976). The sparrow seems to occur at reduced densities when nesting in this group of shrubs. For example, the density of nesting Brewer's sparrows was 12.5 pair per 40 ha (0.6/ha) on a shortgrass prairie habitat where the birds nested in isolated saltbushes (Porter and Ryder 1974). The SI values for this group of shrub species is estimated at about 0.1. Thus, the potential of these habitats to support populations of Brewer's sparrows is assumed to be only about 10% of the most favorable sagebrush sites. Open woody shrubs with thin canopies and no structural support for nest placement are assumed to be of no use as nesting habitat for the Brewer's sparrow.

The density of nesting Brewer's sparrows is positively associated with percent canopy closure of woody shrubs and the percent of bare ground within transect plots (Wiens and Rotenberry 1981). The density of nesting Brewer's sparrows also diminishes as the percent grass cover increases. A weak inverse relationship between shrub canopy closure and herbaceous cover also generally

exists (Daubenmire 1970). Presumably as shrub canopy closure increases there will be accompanying trends of reduced grass cover and increased quantities of bare ground. This interaction is treated in the model with a single variable - variable 5, percent canopy cover. The SI value for V_5 is based on a relationship suggested by Rich (pers. comm.). He determined that the density of Brewer's sparrows on sagebrush sites could be estimated with the following multiple regression equation:

Number of Brewer's sparrows/ha = 1.23 + 0.12 (% canopy coverage of sage)

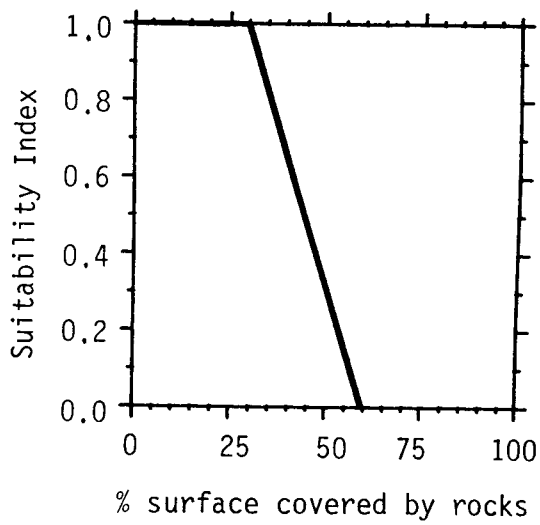
- 0.06 (% rock substrate)

I have assumed that this equation is relevant to the structure of a variety of shrublands in addition to the structure of sagebrush habitats. I then solved the regression equation for a sagebrush habitat with five Brewer's sparrows/ha (about the maximum density cited by Wiens and Rotenberry 1981, and Rich (pers. comm.) under conditions of a very limited rock substrate on the terrestrial surface. The regression equation would predict a density of five Brewer's sparrows/ha when shrub canopy closure equaled about 30%. Values of shrub canopy closure equal to or greater than 30% are given SI values of 1.0 in the model.

The height of shrubs should be sufficient so that nests can be placed in dense cover at least 25 cm (10 inches) above the terrestrial surface. Rich (pers. comm.) suggests that shrubs about 50 to 70 cm (20 to 28 inches) in height seem to possess a structure favorable for nest placement but that the density of nesting birds was reduced when the height of shrubs averaged 114 cm (45 inches). The SI for V_6 in the model is estimated to be 1.0 at shrub heights of 50 to 70 cm and to diminish to 0.1 at shrub heights of 120 cm (about 48 inches).

Model Relationships

Suitability Index (SI) graphs for habitat variables. This section contains suitability index graphs that illustrate the habitat relationships described in the previous section.

Cover type	Variable		Suitability index
ES,ESS	V_1	Size of habitat block.	SI_1 = 1.0 if the size of the habitat block is equal to or greater than 0.2 ha = 0.0 if the size of the habitat block is less than 0.2 ha
	V_2	Characteristics of terrain containing habitat block.	SI_2 = 1.0 if habitat block occurs on slopes that are equal to or less than 30° = 0.0 if habitat blocks occur on slopes greater than 30°
	V_3	Composition of terrestrial substrate.	

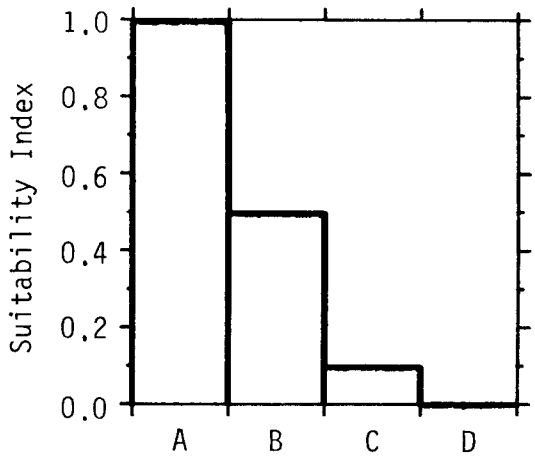
V_4 Species of shrubs.

A. Shrub community consists mostly of sagebrush.

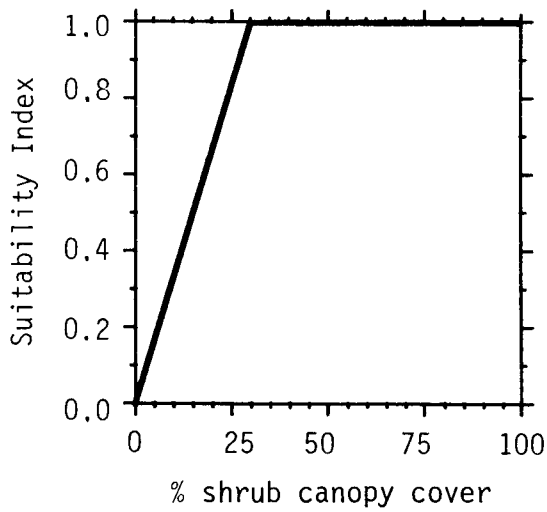
B. Shrub community consists mostly of hawthorn, plum, service-berry, bitter-brush, or rabbitbrush.

C. Shrub community consists mostly of saltbush, greasewood, hop-sage, ceanothus, manzanita, or currant.

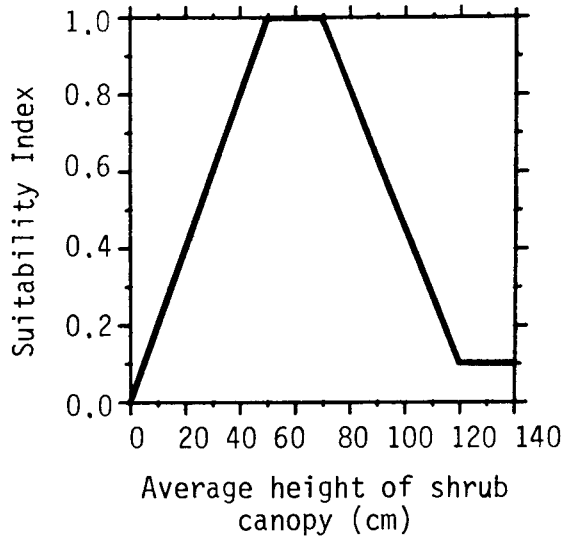
D. Shrub community consists mostly of open shrubs without dense branches within 1.0 m of the ground and with-out a dense canopy cover.



V_5 Percent canopy cover of shrubs.



V_6 Average height of shrubs.



Equations. The SI values for appropriate variables can be combined with the use of equations to provide an estimate of the quality of habitat within a cover type for the Brewer's sparrow. The form of this equation is inferred from a hypothesis developed by Wiens and Rotenberry (1981:39). They suggested that shrubsteppe bird species may occupy a "general habitat type that is 'proper' in its structural configuration, then further refine their distribution in association not with a finer resolution of physiognomic features, but with reference to plant species composition." The importance of particular species of plants may be the provision of particular arthropod prey species. Thus, the equation considers (1) criteria describing a proper habitat configuration - proper size of a habitat block, presence of a level to gently sloping terrain, limited amount of rock on the terrestrial surface, and the percent cover and height of the shrub canopy, and (2) plant species composition. The suggested equation for determining an HSI value is:

$$[(V_1 \times V_2)(V_3 \times V_5 \times V_6)^{1/3} \times V_4]^{1/2}$$

The intent of this model is to suggest some of the parameters that may describe the niche space of the Brewer's sparrow. Habitat quality as described by an HSI measure is intended to estimate the quantity of niche spaces available to the sparrows. Habitats with higher HSI values are assumed to provide more niche spaces than do habitats with lower HSI values. A greater number of niche spaces present in an area may frequently be accompanied by a greater number of individuals occurring in that area. It is emphasized that the SI values are estimates based on descriptive and correlative data published in the literature.

Application of the Model

Biologists using this model for a block of shrub or shrubsteppe habitat within the breeding range of the Brewer's sparrow should determine (1) the size of the block of habitat containing living woody shrub vegetation, (2) the slope of the habitat block containing shrub vegetation, and (3) the texture of the soil substrate at least to the point of measuring or estimating the quantity of rock on the soil surface. The biologist should then identify the dominant species of shrubs available as nest sites and measure the canopy cover and height of the dominant shrubs within the study area. The logic for the model is presented in Figure 2 and the procedures for measuring the selected habitat variables are described in Figure 4.

Definitions of variables and suggested field measurement techniques are listed below.

SOURCES OF OTHER MODELS

A pattern recognition model was developed and tested for the Brewer's sparrow on the northern Great Plains during the late spring-early summer breeding season (Kling 1980). That model emphasized topographic relief, distance to water, canopy cover, height, and density of sagebrush. The pattern recognition model was tested for three sites with known populations of Brewer's sparrows. The model correctly distinguished the habitat site with the highest density of Brewer's sparrows but was unable to distinguish between other sites with intermediate and low populations (Seitz et al. 1982). Additional tests with (1) a habitat suitability index model, which was a precursor to the model described in this manuscript, and (2) with personal opinion assessments of habitat quality, each correctly ranked the three habitats with regard to the relative densities of Brewer's sparrows nesting in those habitats (Seitz et al., op. cit.).

Rich (pers. comm.) determined from the analysis of field data that the density of Brewer's sparrows/ha could be estimated from the following multiple regression relationship:

Number of Brewer's sparrows per ha = 1.23 + 0.12 (% canopy cover of sagebrush) - 0.06 (% rock covering the terrestrial surface)

Rotenberry and Wiens (1980) used a principal component analysis to assess the relationships between vegetational structure, spatial heterogeneity, avian community structure, and the ecological responses of breeding birds in shrub-steppe habitats. Nest sites of the sparrow were often correlated with shrub canopy closure, percent bare ground, horizontal patchiness, and diminished grass cover.

Variable (definition)		Cover types	Suggested technique
V_1	Size of habitat block.	ES,ESS	Use dot grid (Hays et al. 1981) to estimate habitat block size if a current, aerial photograph has been interpreted or if a map that has been developed from an aerial photograph is being evaluated. Calculate block size if a map of blocks of shrub vegetation has been prepared from a field survey of the study area.
V_2	Characteristics of terrain containing habitat block.		The slope upon which a block of habitat exists can be measured from an appropriate topographic map (Hays et al. 1981) or with a clinometer (Hays et al. 1981) when field surveys of the study area are made.
V_3	Composition of terrestrial substrate.		Point intercept procedures (Hays et al. 1981).
V_4	Species of shrubs.		Taxonomic identification of dominant shrub species.
V_5	Percent canopy cover of shrubs.		Point intercept procedures (Hays et al. 1981).
V_6	Average height of shrubs.		Measured rule.

Figure 4. Definition of variables and suggested measurement techniques.

The present model for the Brewer's sparrow incorporates parameters considered in each of the models cited above. The HSI model described by Seitz et al. (1982) is in some ways a precursor to the present model. The relationship noted by Rich (pers. comm.) was used to describe the Suitability Index for Variable 5 in the present model. The association between shrub canopy closure and the density of Brewer's sparrows determined by Rotenberry and Wiens (1980) is also represented in Variable 5 of the present model.

REFERENCES

American Ornithologists' Union. 1983. Check-list of North American birds. 6th edition. 877 pp.

Beaver, D. L. 1976. Avian populations in herbicide treated brush fields. Auk 93(3):543-553.

Best, L. B. 1972. First year effects of sagebrush control on two sparrows. J. Wildl. Manage. 36(2):534-544.

Cody, M. L. 1971. Finch flocks in the Mohave Desert. Theor. Pop. Biol. 2(2):142-158.

Daubenmire, R. 1970. Steppe vegetation of Washington. Wash. Agric. Exp. Stn. Tech. Bull. 62. Pullman. 131 pp.

Fautin, R. W. 1946. Biotic communities of the northern desert shrub biome in western Utah. Ecol. Monog. 16(4):251-310.

Hays, R. L., C. Summers, and W. Seitz. 1981. Estimating wildlife habitat variables. U.S. Fish Wildl. Serv. FWS/OBS-81/77. 111 pp.

Johnsgard, P. A., and W. H. Rickard. 1957. The relation of spring bird distribution to a vegetation mosaic in southeastern Washington. Ecol. 38(1):171-174.

Kling, C. L. 1980. Pattern recognition for habitat evaluation. M.S. Thesis, Colorado State Univ., Ft. Collins. 244 pp.

Linsdale, J. M. 1938. Environmental responses of vertebrates in the Great Basin. Am. Midl. Nat. 19(1):1-206.

Ohmart, R. D., and E. L. Smith. 1970. Use of sodium chloride solutions by the Brewer's sparrow and tree sparrow. Auk 87(2):329-341.

Paine, R. T. 1968. Brewer's sparrow. Pages 1208-1217 in A. C. Bent, ed. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies. U.S. Natl. Mus. Bull. 237 (Part 2).

Porter, D. K., and R. A. Ryder. 1974. Avian density and productivity studies and analyses on the Pawnee site in 1972. U.S. Int. Biol. Progr. Grassland Biome Tech. Rep. 252. 77 pp.

Reynolds, T. D. 1981. Nesting of the sage thrasher, sage sparrow, and Brewer's sparrow in southeastern Idaho. Condor 83:61-64.

Rich, T. 1980. Nest placement in sage thrashers, sage sparrows, and Brewer's sparrows. Wilson Bull. 92(3):362-368.

_____. Personal communication (letter dated June 1, 1984). U.S. Bur. Land Manage., Shoshone, ID 83352.

Rotenberry, J. T., and J. A. Wiens. 1980. Habitat structure, patchiness, and avian communities in North American steppe vegetation: A multivariate analysis. Ecology 61(5):1228-1250.

Schroeder, M. H., and D. L. Sturges. 1975. The effect on the Brewer's sparrow of spraying big sagebrush. J. Range Manage. 28(4):294-297.

Seitz, W. K., C. L. Kling, and A. H. Farmer. 1982. Habitat evaluation: A comparison of three approaches on the northern great plains. Trans. N. Am. Wildl. and Nat. Resour. Conf. 47:82-95.

Short, H. L. 1983. Wildlife guilds in Arizona desert habitats. U.S. Bur. Land Manage. Tech. Note 362. 258 pp.

U.S. Fish and Wildlife Service. 1981. Standards for the development of habitat suitability index models. 103 ESM. U.S. Fish Wildl. Serv., Div. Ecol. Serv. n.p.

Wiens, J. A., and J. T. Rotenberry. 1981. Habitat associations and community structure of birds in shrubsteppe environments. Ecol. Mono. 51(1):21-41.

REPORT DOCUMENTATION PAGE	1. REPORT NO. FWS/OBS-82/10.83	2.	3. Recipient's Accession No.
4. Title and Subtitle: Habitat Suitability Index Models: Brewer's Sparrow			5. Report Date: September 1984 6.
7. Author(s): Henry L. Short			8. Performing Organization Rept. No.
9. Performing Organization Name and Address	Habitat Evaluation Procedures Group Western Energy and Land Use Team U.S. Fish and Wildlife Service Drake Creekside Building One 2627 Redwing Road Fort Collins, CO 80526-2899		10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) (G)
12. Sponsoring Organization Name and Address	Western Energy and Land Use Team Division of Biological Services Research and Development Fish and Wildlife Service U.S. Department of the Interior Washington, DC 20240		13. Type of Report & Period Covered 14.
15. Supplementary Notes			

16. Abstract (Limit: 200 words)

This document is part of the Habitat Suitability Index (HSI) model series, which provides habitat information useful for impact assessment and habitat management for the Brewer's sparrow (Spizella breweri). Several types of habitat information are provided. A Habitat Use Information Section can be used to drive quantitative relationships between key environmental variables and habitat suitability.

The HSI Model Section documents a habitat model and 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).

17. Document Analysis a. Descriptors

Birds
Habitability
Mathematical models
Wildlife

b. Identifiers/Open-Ended Terms

Brewer's sparrow
Spizella breweri
Habitat suitability

c. COSATI Field/Group

18. Availability Statement: Release unlimited	19. Security Class (This Report): Unclassified	21. No. of Pages: 16
	20. Security Class (This Page): Unclassified	22. Price

☆U.S. GOVERNMENT PRINTING OFFICE: 1984-781-436/9534