Habitat Evaluation for the Cape Sable Sparrow in East Everglades

Timothy E. O'Meara,[1] *Department of Wildlife and Range Sciences, University of Florida, Gainesville, FL 32611*

Wayne R. Marion, *Department of Wildlife and Range Sciences, University of Florida, Gainesville, FL 32611*

Abstract: In a study of the distribution of the Cape Sable sparrow (*Ammodramus maritima mirabilis*) in East Everglades, data were collected describing vegetation and soil characteristics at points sampled for occurrence of the sparrow. Data were used to assess the utility of a habitat suitability model. Of 13 variables derived from the soil and vegetation data, none were correlated with numbers of sparrows at the sample points. A biologist's independent valuation of habitat suitability, at a subset of the points, was correlated with presence or absence of sparrows, and histograms representing frequency of occurrence suggested relationships between several vegetation variables and presence or absence. Presence-or-absence data may be more valuable than density for appraising habitat suitability for species, such as the Cape Sable sparrow, that have a territorial breeding season, limited reproductive capacities, and specific habitat requirements.

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The Cape Sable sparrow is listed as an endangered species due to its restricted distribution and specific habitat requirements. The subspecies is restricted to extreme southern Florida where most of its habitat lies within areas managed by the National Park Service (Bass and Kushlan 1982). The greatest threat to an extant population is in East Everglades, where habitat is threatened as a result of drainage, frequent fires, invasion of exotic trees, and agricultural and urban development (Kushlan and Bass 1983).

Habitat requirements of the subspecies have been described by Werner (1975), Bass and Kushlan (1982), Kushlan et al. (1982), Kushlan and Bass (1983), Taylor (1983), and Werner and Woolfenden (1983). Vegetation characteristics and fire are primary factors influencing the distribution of the Cape Sable sparrow (Kushlan et

[1]Present address: Florida Game and Fresh Water Fish Commission, 620 South Meridian Street, Tallahassee, FL 32399-1600.

al. 1982). In general, the species occurs in "vast brushless graminoid seasonally flooded interior prairies" (Werner 1975). In a recent survey of the sparrow, muhly (*Muhlenbergia filipes*) and mixed prairie accounted for 96% of the habitat occupied (Bass and Kushlan 1982, Kushlan and Bass 1983). Fire affects quality of these habitats as a result of changes in cover and biomass of living and dead vegetation (Taylor 1983).

Concern over threats to the population in East Everglades prompted development of a habitat suitability index (HSI) model for use in habitat evaluation procedures (HEP) developed by the U.S. Fish and Wildlife Service (1981). In constructing HSI models, suitability index curves are derived to provide numerical estimates of habitat suitability for habitat variables believed to affect the species. These estimates subsequently are combined mathematically through the HSI model, resulting in a numerical value representing habitat suitability. Usually, a direct linear relationship is assumed between the HSI value and carrying capacity (U.S. Fish and Wildl. Serv. 1981).

A draft HSI model for Cape Sable sparrows was produced as a result of a workshop involving participants knowledgeable of the habitat requirements of the sparrow. The goal was to develop an objective means of assessing habitat suitability to facilitate management and protection of sparrow habitat. The resulting model included 5 variables: (1) percent canopy cover of grass and grass-like vegetation, (2) percent of 1-m^2 quadrats with 75% to 100% cover, (3) percent of 1-m^2 quadrats with majority of vegetation in clumps, (4) number of shrubs per hectare, and (5) distance to trees, hammocks, tree islands, etc.

As part of a survey of Cape Sable sparrow distribution in 1985, we collected data describing vegetation characteristics included in the HSI model. Our objective was to test the utility of the model for identifying Cape Sable sparrow habitat and to provide additional information for refining the model.

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Methods

Data Collection

Surveys were conducted in known and suspected sparrow habitat in East Everglades. Sampling was restricted to areas encompassed by 2 U.S. Geological Survey 7.5 minute quadrangle maps (Grossman Hammock and Royal Palm Ranger Station SE). The survey included treeless freshwater marshes and prairies; urban and agricultural areas were excluded. Areas sampled during a 1981 survey (Bass and Kushlan 1982) were inventoried, as well as additional areas of potential habitat within and around critical habitat boundaries. The survey area was gridded into blocks 1 km on a side and plotted on the quadrangle maps. Sparrows were inventoried at locations indicated by intersection of the grid lines between 3 April and 6 May 1985.

Each sample consisted of landing at a point by helicopter and listening for singing Cape Sable sparrows for 12 minutes. Additional sparrows detected when points were revisited for vegetation sampling were recorded. Also, 31 points where sparrows had not been detected on the first 2 visits were each revisited for 5 minutes to increase the completeness of the survey. Numbers of birds seen or heard were recorded. Bird surveys were continued for 3.0 hours following sunrise or until increasing wind velocity inhibited singing by territorial males.

Vegetation sampling was conducted to describe variables used in the habitat model derived by Schroeder and Armbruster (1985). All points, with the exception of 11, were revisited in late morning and early afternoon for vegetation sampling. The 11 points that were not revisited occurred in agricultural areas (4), on roads (1), and in areas where tree and shrub densities precluded use by Cape Sable sparrows (6).

Herbaceous cover, soil depth, and woody plant densities were described in each vegetation sample. Distance to the nearest tree island in each quadrant was estimated to assess habitat openness. Trees were defined as woody plants >4 m tall. To assess herbaceous cover and soil depth, a 1-m^2 frame was placed at 24 sample points evenly spaced at 8-m intervals around a square that was 48 m on a side and centered at the survey point. At each placement of the frame, 4 variables were measured or estimated: (1) Percent cover of herbaceous vegetation, living and dead; (2) number of clumps of vegetation were counted where a clump was defined as a bunch-grass-type growth form with a basal diameter $\geq$5 cm; (3) percent of total herbaceous vegetation cover in clumped growth form; and (4) soil depth was measured by inserting a sharpened steel rod (120 cm long, 5 mm in diameter, and calibrated in cm) into the soil to bedrock at each of the 4 corners of the frame. Soil depths >110 cm were recorded as 120 cm. Shrub densities were estimated by counting shrubs within the 48 × 48-m squares.

Subsequent to completion of all sampling, 49 points were revisited with O. L. Bass, Jr., (South Florida Research Center, Everglades National Park) to get a separate assessment of habitat suitability for Cape Sable sparrows. Points were selected that represented a variety of vegetation conditions over the survey areas. At each point, Bass recorded his estimate of relative habitat suitability on a scale of 1 to 10.

Data Analysis

Thirteen variables were derived from the soil and vegetation data (Table 1), and their values were determined for each point for comparison with sparrow occurrence. COVER was derived to quantify the amount of herbaceous vegetation at each point. CLUMPNO, CLUMPCOV, and CLFREQ were calculated as alternative

Table 1. Habitat variables described at points sampled for Cape Sable sparrows in East Everglades.

Variable	Definition (units)
COVER	Mean % cover of herbaceous vegetation
COVERCV	Coefficient of variation of COVER (%)
COVFREQ	Percent of frames with COVER ≥75%
CLUMPNO	Mean number of clumps of bunch-grass-type growth
CLNOCV	Coefficient of variation of CLUMPNO (%)
CLUMPCOV	Mean % of total cover in bunch-grass-type growth form
CLCOVCV	Coefficient of variation of CLUMPCOV (%)
CLFREQ	Percent of frames with CLUMPCOV ≥50%
SHRUBDEN	Shrub density (shrubs/ha)
TREEMEAN	Mean of distances to closest tree or tree island in each quadrant (m)
TREEMIN	Distance to closest tree or tree island (m)
TREEDENS	$10{,}000/\text{TREEMEAN}^2$ (tree islands/ha)
SOIL	Mean soil depth (cm)
HSI	Habitat suitability index value

indicators of the amount of vegetation in bunch-grass-type growth form. COVERCV and COVFREQ were used as alternative methods of assessing the "patchiness" of herbaceous vegetative cover or the "evenness" with which cover was distributed. Similarly, CLCOVCV and CLNOCV were used as indicators of the distribution of clumped vegetation. SHRUBDEN was determined from the number of shrubs within the 48 × 48-m square.

Three alternative indices of tree or tree-island density were used. TREEMEAN and TREEMIN were measures of distance from the sampling point to nearest tree or tree island, while TREEDENS served as an index to the areas around each point without trees or tree islands (i.e. density). SOIL was recorded as a possible indicator of vegetative characteristics. HSI was calculated from COVER, COVFREQ, CLFREQ, SHRUBDEN, and TREEMIN as described by Schroeder and Armbruster (1985).

Correlation was used to identify relationships between the 13 habitat variables, HSI values, and the number of sparrows detected at each point. Two sets of correlation analyses were done: one using all sample points and one using only sample points where birds were detected. Stepwise multiple regression also was used to identify the variables most useful for predicting the number of birds at a sample point using all sample points and sample points where birds were detected. Significance levels were set at $P \leqslant 0.15$ for entering and retaining variables in both regression models. Models were constructed using only 9 of the 13 habitat variables. CLUMPNO and CLUMPCOV were omitted from this analysis because they were highly correlated with CLFREQ. When no clumps were detected at a sample point, CLNOCV and CLCOVCV could not be calculated. As a result, CLNOCV and CLCOVCV were omitted from the regression analyses to maximize sample sizes. HSI was not included in regression analyses because it did not represent vegetative characteristics that could be used to describe sites.

To better examine the relationships between habitat characteristics and sparrow occurrence, sample points were grouped based on values of each habitat variable. The percentage of sample points in each group at which birds were found was determined. In other words, the range of data values for each habitat variable was divided into 3 to 13 groupings. Sample points were then placed in these groupings based on the value of the respective variable. The percentage of sample points in each grouping at which birds were detected was then plotted as a histogram for each variable.

Results

Of the 14 variables tested, none were correlated with numbers of sparrows when all points were included (Table 2). When the 14 variables were correlated with numbers of sparrows only at points where sparrows occurred, 3 correlations were identified (Table 3).

Stepwise regression resulted in only 1 variable being included in each of the 2 models derived with significance levels set at $P \leq 0.15$. Coefficients of determination were low in both cases. The regression for bird numbers at all points resulted in the model:

$$y = 0.0026 \text{ (TREEMIN)} + 0.37, (r^2 = 0.02, P = 0.143).$$

The regression for bird numbers only at points where birds were detected resulted in the model:

$$y = 0.059 \text{ (CLFREQ)} + 1.34, (r^2 = 0.16, P = 0.022).$$

Linear regression indicated a correlation ($r = 0.47$) between Bass's subjective index of habitat suitability and number of sparrows at a point. Regression of his

Table 2. Correlations of habitat variables with numbers of Cape Sable sparrows detected per point for all points sampled in East Everglades.

Variable	*r*	*N*	*P*
COVER	0.001	120	0.991
COVERCV	−0.011	120	0.905
COVFREQ	−0.107	120	0.243
CLUMPNO	0.174	120	0.057
CLNOCV	−0.012	79	0.918
CLUMPCOV	0.137	120	0.135
CLCOVCV	−0.060	79	0.599
CLFREQ	0.101	120	0.273
SHRUBDEN	−0.080	121	0.385
TREEMEAN	0.118	123	0.194
TREEMIN	0.166	124	0.066
TREEDENS	−0.131	123	0.148
SOIL	−0.097	111	0.309
HSI	0.104	124	0.248

Table 3. Correlations of habitat variables with numbers of Cape Sable sparrows per point at points where sparrows were detected in East Everglades.

Variable	r	N	P
COVER	0.223	34	0.205
COVERCV	−0.242	34	0.167
COVFREQ	0.046	34	0.797
CLUMPNO	0.486	34	0.004
CLNOCV	−0.314	28	0.103
CLUMPCOV	0.449	34	0.008
CLCOVCV	−0.335	28	0.081
CLFREQ	0.396	34	0.020
SHRUBDEN	0.070	33	0.700
TREEMEAN	−0.034	34	0.848
TREEMIN	−0.061	34	0.734
TREEDENS	0.116	34	0.515
SOIL	−0.133	33	0.462
HSI	0.101	34	0.570

index with frequency of occurrence based on presence or absence, however, resulted in a higher correlation:

$$y = 0.9\ (\text{index}) - 1.9\ (r^2 = 0.87,\ P < 0.01).$$

Discussion

If the purpose of a habitat suitability model is to predict habitat quality for a species, then some objective measure should be defined for evaluating effectiveness of the model. The ultimate determinant of a habitat's suitability is its ability to support a population that will contribute to the future gene pool of the species (Fretwell 1972). Most often, density is used as an alternative indicator of habitat suitability (Van Horne 1983).

Although correlation analyses indicated that several measures of vegetation clumping were correlated with sparrow numbers at sites where sparrows occurred, multiple regression did not produce a good predictor of sparrow numbers. The poor performance of the habitat variables in predicting sparrow numbers was reflected in the poor correlation between the HSI model values and sparrow counts. Maurer (1986) also found that regression models performed poorly in predicting densities of 3 other species of grassland sparrows.

The inability of the HSI model to predict sparrow numbers may have been due to several factors. Constraints on vegetation sampling could have resulted in vegetation data that did not characterize specific areas actually used by the sparrows. Vegetation sampling, by necessity, was restricted to the vicinity of the sample points, whereas sparrows were detectable up to 200 m from sample points. For a habitat model to be useful it should specify how it is to be applied in the field. For example, should vegetation be sampled randomly or systematically over an area, or should vegetation types be stratified prior to sampling? Methods of quantifying variables used in the model also should be detailed. Variables that involve subjectivity in quantification, such as the percent cover estimates used in this model, may result in discrepancies between what the model intends and how it works in implementation. To the extent practicable, models should require objectively measured variables, and techniques for obtaining measurements should be specified.

Alternatively, the failure of the HSI model to predict sparrow numbers may have resulted from a failure of density to correspond with habitat quality rather than a shortcoming of the model. Density may not be a good indicator of habitat quality, especially where territoriality restricts densities in favorable habitat or where site tenacity in breeding passerines produces local densities that reflect past, rather than current, habitat quality (Van Horne 1983). Both phenomena could have influenced results. Taylor (1983) found elevated Cape Sable sparrow densities in unsuitable habitat as a result of destruction of nearby suitable habitat by fire. It also is conceivable that adult sparrows could continue to establish breeding territories in areas where they had successfully bred in the past despite degradation of the habitat as a result of post-fire succession. Conversely, suitable habitat may remain unused due to a lack of individuals available to colonize them, especially for endangered species with low population levels such as the Cape Sable sparrow.

Frequency of habitat use may serve as a better index to habitat suitability than density, particularly for species with low mobility, specific habitat requirements, and high detectability (Schamberger and O'Neil 1986). For example, Lancia et al. (1982) used frequency of occurrence in different vegetation types, as determined by radio-telemetry, to test the performance of a habitat suitability model for bobcats (*Lynx rufus*). This technique may not be applicable to species, such as the Cape Sable sparrow, that have restricted home ranges, and can establish territories within relatively homogenous blocks of vegetation. For species such as these, where density or frequency of use may not be measurable or correlated with habitat suitability, presence or absence data may provide a quantifiable method of assessing habitat quality.

In the context of presence or absence, a habitat suitability index with a scale of 0–1 should represent the probability of finding the species at a site with given characteristics. The regression of percent occurrence of the species on the index should have an intercept of 0 and a slope of 1. Bass's subjective index to habitat suitability approached these criteria. It is not surprising that Bass's subjective evaluation was correlated with sparrow numbers as the sparrow was found in a limited area which he had previous experience surveying. However, his index was more highly correlated with presence or absence than with an index of density. Subjective evaluations have been used in other habitat assessments as an index to habitat quality (Ellis et al. 1979). Mimicking assessments of workshop participants was a stated goal in the workshop that developed the HSI model for the Cape Sable sparrow. Bass's assessment does not provide an independent data set for validating the HSI model (Lancia et al. 1982), but it does suggest that predicting presence or absence may be a suitable goal for the HSI model.

Although HSI was not correlated with presence or absence data, several his-

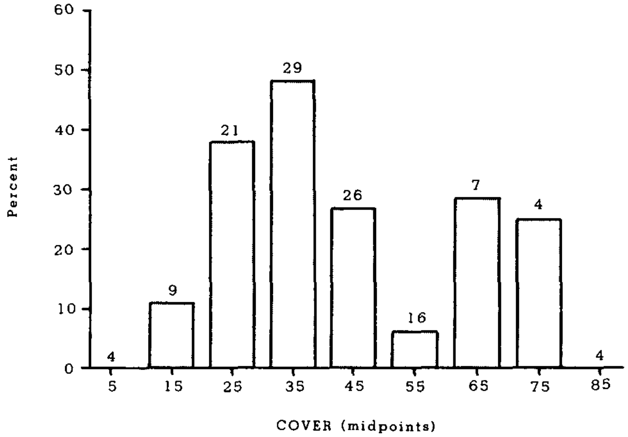

Figure 1. Percentage of points at which Cape Sable sparrows were detected, grouped by COVER values, and numbers of points in each grouping.

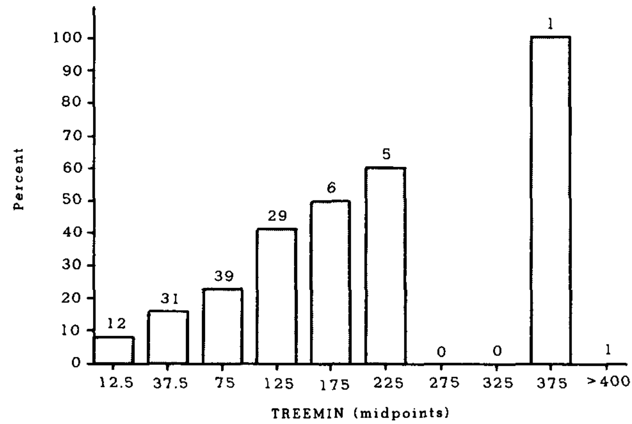

Figure 2. Percentage of points at which Cape Sable Seaside sparrows were detected, grouped by TREEMIN values, and number of points in each grouping.

tograms representing frequency of occurrence at different parameter values of the habitat variables suggested relationships between the parameters and sparrow occurrence. For example, sparrows occurred at the greatest percent frequency between 25% and 75% herbaceous vegetation cover (COVER, Fig. 1), which was in agreement with the opinion of the workshop participants that cover densities between 50% and 75% were preferred (Schroeder and Armbruster 1985). The habitat model derived by workshop participants also indicated that areas within 50 m of trees or tree islands were not suitable habitat. Sparrow occurrence data suggested a linear relationship between distance from trees and sparrow utilization (Fig. 2).

For the Cape Sable sparrow, frequency of presence in habitats with varying characteristics may be a better indicator of habitat quality than sparrow density. Assuming that sparrows select areas that are best able to satisfy life and breeding requirements, they should most often be found in areas of most suitable habitat. Less suitable habitats may be used in years when numbers are high and upper limits on density force birds into marginal habitats (Van Horne 1983). Conversely, when numbers are low, suitable habitats may be vacant. Multi-annual surveys may be necessary to identify habitats used (Schamberger and O'Neil 1986). Presence-or-absence data may be more valuable than density data for appraising habitat suitability for endangered species, such as the Cape Sable sparrow, that have a territorial breeding system, limited reproductive capacities, and specific habitat requirements.

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