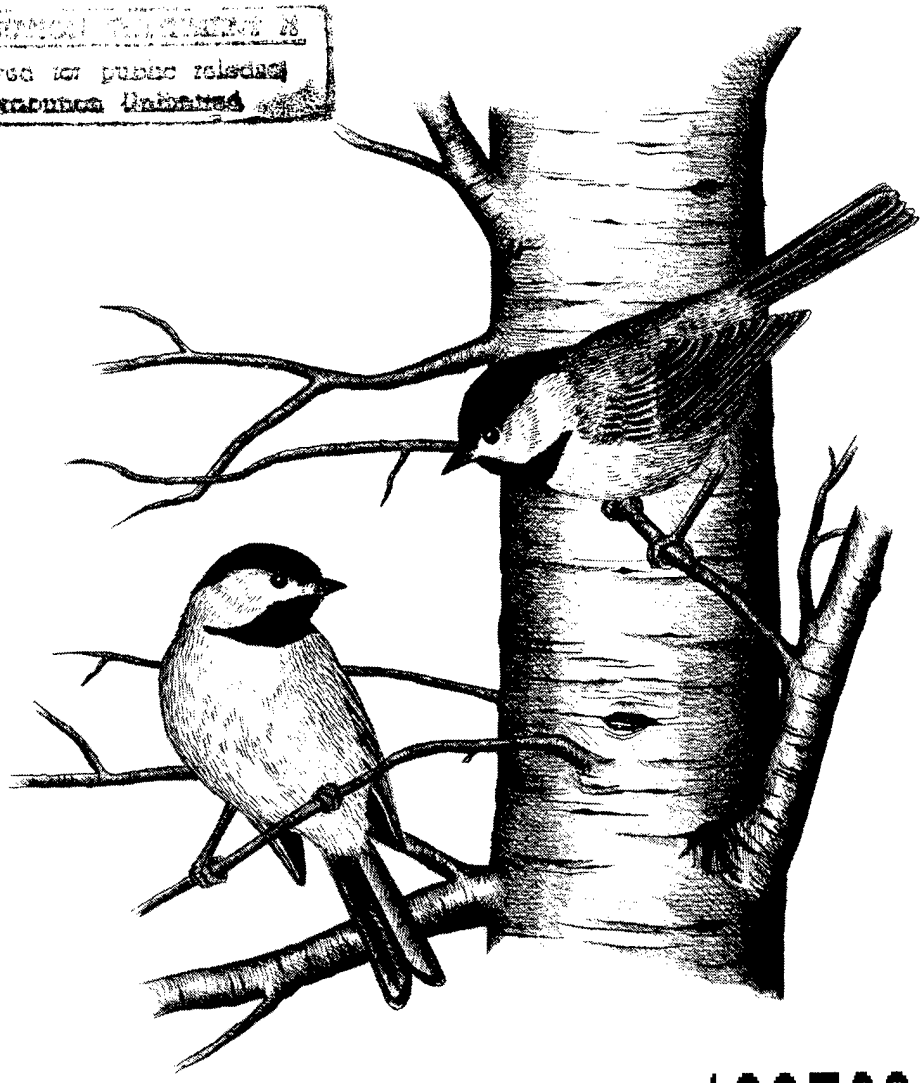
FWS/OBS-82/10.37
APRIL 1983

HABITAT SUITABILITY INDEX MODELS: BLACK-CAPPED CHICKADEE



Fish and Wildlife Service

U.S. Department of the Interior

This model is designed to be used by the Division of Ecological Services in conjunction with the Habitat Evaluation Procedures.

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HABITAT SUITABILITY INDEX MODELS: BLACK-CAPPED CHICKADEE

by

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Washington, DC 20240

This report should be cited as:

Schroeder, R. L. 1982. Habitat suitability index models: Black-capped chickadee. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-82/10.37. 12 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:

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CONTENTS

ACKNOWLEDGMENTS

We gratefully acknowledge Peter Merritt for his review of this habitat model. Funds for the development of this model were provided by the U.S. Fish and Wildlife Service Regional Office in Portland. Publication costs of this model were partially paid for by the U.S. Army Corps of Engineers. The cover of this document was illustrated by Jennifer Shoemaker. Word processing was provided by Carolyn Gulzow and Dora Ibarra.

BLACK-CAPPED CHICKADEE (Parus atricapillus)

HABITAT USE INFORMATION

General

The black-capped chickadee (Parus atricapillus) inhabits wooded areas in the northern United States, Canada, and the higher elevations of mountains in southern Appalachia (Tanner 1952; Brewer 1963; Merritt 1981). The black-capped chickadee nests in cavities in dead or hollow trees (Nickell 1956), in a variety of forest types (Dixon 1961).

Food

Black-capped chickadees are insectivorous gleaners (Brewer 1963; Sturman 1968b) that select prey in proportion to its availability (Brewer 1963). Insect food is mostly gleaned from tree bark on twigs, branches, and boles; or from the foliage, fruits, and flowers of trees (Brewer 1963). Caterpillars are an important food for nestling chickadees (Odum 1942; Kluyver 1961; Sturman 1968a). Insect and spider eggs make up a large portion of the winter diet, and, although the use of plant material for food is low during much of the year, seeds of trees and shrubs may account for about half of the winter diet (Martin et al. 1961). Seeds of weedy plants, such as giant ragweed (Ambrosia spp.), are favorite winter foods (Fitch 1958).

Black-capped chickadees are versatile in their foraging habits and forage from the ground to the tree tops in a variety of habitats, although they prefer to forage at low or intermediate heights in trees and shrubs (Odum 1942). Chickadees in British Columbia showed a preference for foraging within 1.5 m (5.0 ft) of the ground (Smith 1967).

Black-capped chickadees in western Washington selected their territories before the amount of insect food (especially caterpillars) was apparent, and it appeared that canopy volume of trees was the proximate cue used by the chickadees to determine potential food supply, since chickadee abundance showed a strong positive correlation with canopy volume (Sturman 1968a). Caterpillars eat foliage and their abundance should vary directly with total foliage weight. There was a strong positive correlation between total foliage weight and canopy volume, and, hence, canopy volume provided a good estimate of potential insect abundance. The highest chickadee densities occurred at canopy volumes of about 10.2 m^3 of foliage/1 m^2 of ground surface (33.5 ft^3/ft^2).

Water

Drinking water requirements are met with surface water and snow (Odum 1942).

Cover

The black-capped chickadee occurs in both deciduous and evergreen forests in the eastern United States, although it is restricted to deciduous forests along streams in the Northern Great Plains, northern Rocky Mountains, and Great Basin areas (Dixon 1961). In some areas where the ranges of the black-capped chickadee and Carolina chickadee (P. carolinensis) come together, apparently suitable habitat exists where neither chickadee occurs (Tanner 1952; Brewer 1963; Merritt 1981). Deciduous forest types are preferred in western Washington (Sturman 1968a) and commonly used in Oregon (Gabrielson and Jewett 1940). Fall and winter roosts in New York were mostly on dense conifer branches, with some use of cavities (Odum 1942). Black-capped chickadees in Oregon and Washington excavated winter roost cavities in snags (Thomas et al. 1979). Winter roosts in deciduous forests of Minnesota were on the branches of trees and bushes that had retained their foliage (Van Gorp and Langager 1974).

Black-capped chickadee populations in Kansas tended to concentrate along edges between forest and early successional areas (Fitch 1958). The availability of suitable tree cavities for roosting may have been a limiting factor in this study area.

Reproduction

The black-capped chickadee nests in a cavity, usually in a dead or hollow tree (Nickell 1956). The presence of available nest sites, or trees that could be excavated, appeared to determine the chickadee's choice of nesting habitat. Two important factors affecting the use of stub trees in Michigan were height and the suitability of the tree for excavation (Brewer 1963). Willows (Salix spp.), pines (Pinus spp.), cottonwoods and poplars (Populus spp.), and fruit trees of the genera Pyrus and Prunus are frequently chosen for nest sites (Brewer 1961).

Black-capped chickadees are only able to excavate a cavity in soft or rotten wood (Odum 1941a, b). Trees with decayed heartwood, but firm sapwood, are usually chosen (Brewer 1961). Black-capped chickadees almost always do some excavation at the nest site (Tyler 1946), although they will use existing woodpecker holes, natural cavities, man-made nest boxes, and open topped fence posts (Nickell 1956). The average tree diameter at nest sites was 11.4 cm (4.5 inches), and preferred tree stubs apparently ranged from 10 to 15 cm (3.9 to 5.9 inches) in diameter (Brewer 1963). The minimum dbh of cavity trees used by black-capped chickadees is 10.2 cm (4 inches) (Thomas et al. 1979). Heights of 18 nests in New York ranged from 0.3 to 12.2 m (1 to 40 ft), although only three nests were higher than 4.6 m (15 ft) and 11 nests were under 3.0 m (10 ft) (Odum 1941b).

Nests in New York were usually located in open areas, commonly in young forests, hedgerows, or field borders (Odum 1941a). Willow, alder (Alnus spp.) and cottonwood trees were common nest trees in Washington (Jewett et al. 1953). Black-capped chickadees used second growth alder for nesting sites in British Columbia (Smith 1967).

Interspersion

Black-capped chickadees maintain a territory during the breeding season and flock in the winter months (Odum 1941b; Stefanski 1967). Territory size during nest building in Utah averaged 2.3 ha (5.8 acres) (Stefanski 1967).

Territory size in New York varied from 3.4 ha to 6.9 ha (8.4 to 17.1 acres), with an average size of 5.3 ha (13.2 acres) (Odum 1941a). The larger territories were in open or sparsely wooded country; the size of the territory decreased as the nesting period progressed. The mean home range size of winter flocks was 9.9 ha (24.4 acres) in Kansas (Fitch 1958), 15.0 ha (37 acres) in Michigan (Brewer 1978), and 14.6 ha (36 acres) in New York (Odum 1942) and in Minnesota (Ritchison 1979).

Black-capped chickadees nesting on forest islands in central New Jersey did not nest in forests less than 2 ha (4.8 acres) in size (Galli et al. 1976). However, this apparent dependency on a minimum size forest may have been due to a lack of nesting cavities.

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model was developed for the entire breeding range of the black-capped chickadee.

Season. This model was developed to evaluate the breeding season habitat needs of the black-capped chickadee.

Cover types. This model was developed to evaluate habitat in Deciduous Forest (DF), Evergreen Forest (EF), Deciduous Forested Wetland (DFW), and Evergreen Forested Wetland (EFW) areas (terminology follows that of U.S. Fish and Wildlife Service 1981). It should be noted that, although the chickadee occurs in both deciduous and evergreen forests over much of its range, apparently there are geographic differences in use of cover types that limit the use of evergreen forests in parts of its range. Users should be familiar with the chickadee's major cover type preferences in their particular area before applying 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. Although Galli et al. (1976) report that black-capped chickadees may be dependent on certain forest sizes, other studies state that these chickadees will nest in hedgerows and field borders. This model assumes that

forest size is not an important factor in assessing habitat suitability for the black-capped chickadees.

Verification level. Previous drafts of this model were reviewed by Peter Merritt, and his specific comments have been incorporated into the current draft (Merritt, pers. comm.).

Model Description

Overview. This model considers the ability of the habitat to meet the food and reproductive needs of the black-capped chickadee as an indication of overall habitat suitability. Cover needs are assumed to be met by food and reproductive requirements and water is assumed not to be limiting. The food component of this model assesses vegetation conditions, and the reproduction component assesses the abundance of suitable snags. The relationship between habitat variables, life requisites, cover types, and the HSI for the black-capped chickadee is illustrated in Figure 1.

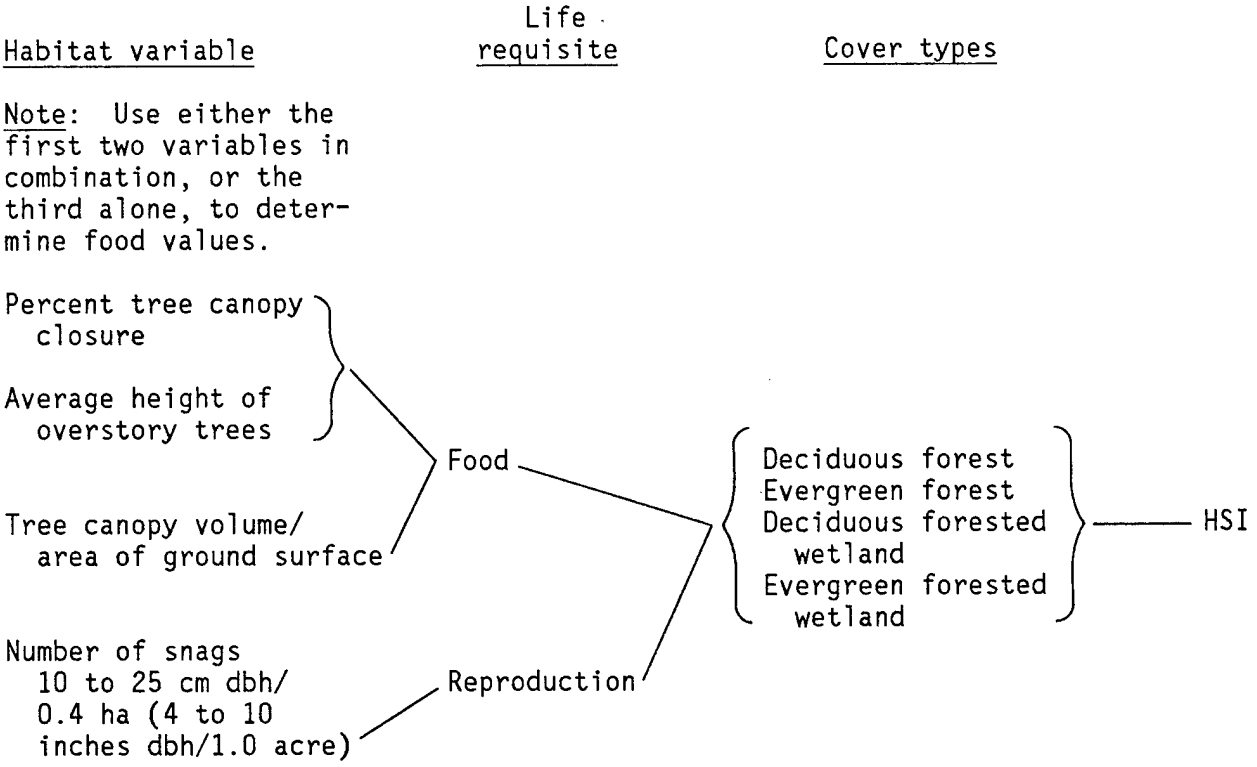


Figure 1. Relationship of habitat variables, life requisites, and cover types in the black-capped chickadee model.

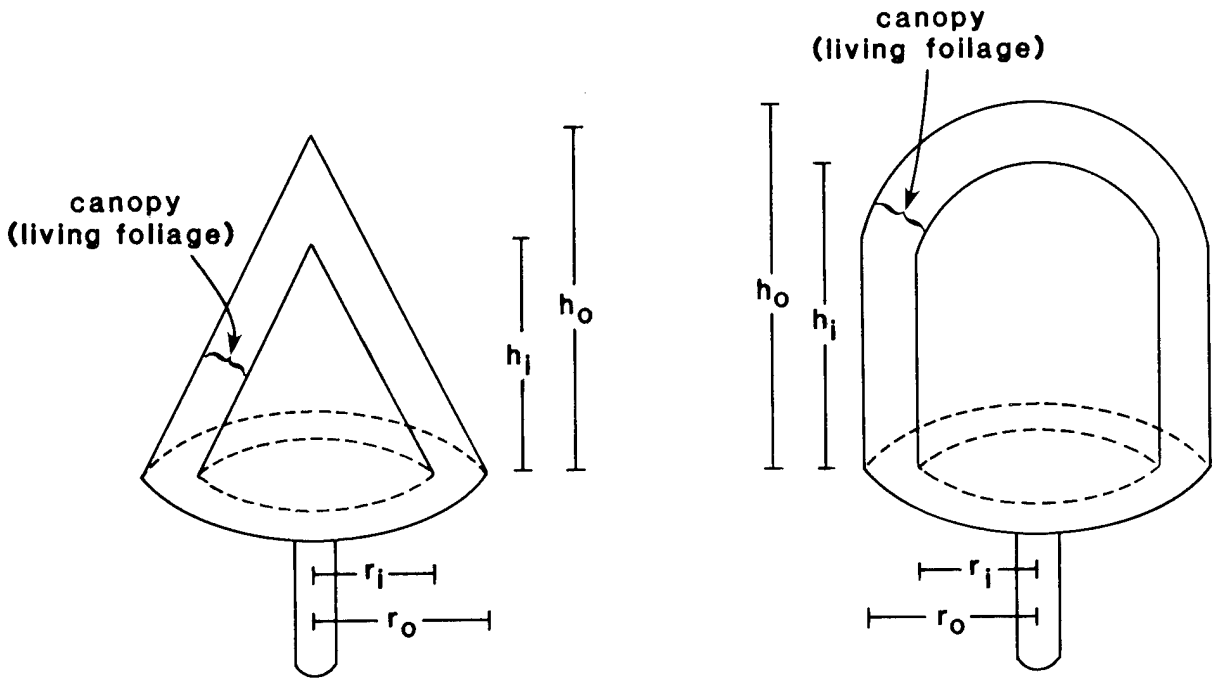
The following sections provide a written documentation of the logic and assumptions used to interpret the habitat information for the black-capped chickadee in order to explain the variables and equations that are used in the HSI model. Specifically, these sections cover the following: (1) identification of variables that will be used in the model; (2) definition and justification of the suitability levels of each variable; and (3) description of the assumed relationship between variables.

Food component. The majority of the year-round food supply of the black-capped chickadee is associated with trees. It is assumed that an accurate assessment of food suitability for the chickadee can be provided by a measure of either: (1) tree canopy closure and the average height of overstory trees; or (2) canopy volume of trees per area of ground surface. It is assumed that optimum canopy closures occur betwen 50 and 75%. A completely closed canopy will have less than optimum value due to an assumed lack of foliage in the middle and lower canopy layers. It is assumed that optimum habitats contain overstory trees 15 m (49.2 ft) or more in height. Habitats with a low canopy closure can provide moderate suitability for black-capped chickadees if tree heights are optimum. Likewise, habitats with short trees may have moderate suitability if canopy closures are optimum.

The canopy volume of an individual tree is equal to the area occupied by the living foliage of that tree, as shown in Figure 2 for deciduous and coniferous trees. Optimum canopy volume per area of ground surface exceeds 10.2 m^3 of foliage/m^2 of ground surface (33.5 ft^3 of foliage/ft^2 of ground surface). Suitability will decrease to zero as canopy volume approaches zero.

The field user should measure either: (1) tree canopy closure and tree height; or (2) tree canopy volume per area of ground surface. Tree canopy closure and tree height measurements are probably the most rapid method to assess food suitability. However, the suitability levels of these variables were not based on strong data sources. The suitability levels of tree canopy volume were based on data from Sturman (1968a).

Reproduction component. Black-capped chickadees nest primarily in small dead or hollow trees and can only excavate a cavity in soft or rotten wood. Therefore, reproduction suitability is assumed to be related to the abundance of small snags. It is assumed that snags between 10 and 25 cm (4 and 10 inches) dbh are required. Thomas et al. (1979) and Evans and Conner (1979) provide methods to estimate the number of snags required for cavity nesting birds. Assuming a territory size of 2.4 ha (6.0 acres) and a need for one cavity per year per chickadee pair, the method of Thomas et al. (1979) estimates that optimum habitats provide 5.9 snags/ha (2.4/acre), and the method of Evans and Conner (1979) estimates that 4.1 snags are needed per ha (1.67/acre) to provide optimum conditions. This model assumes that optimum suitability exists when there are five or more snags of the proper size per ha (2/acre), and that suitability will decrease to zero as the number of snags approaches zero.



CONIFEROUS

$$CV = \pi/3(h_o r_o^2 - h_i r_i^2)$$

DECIDUOUS

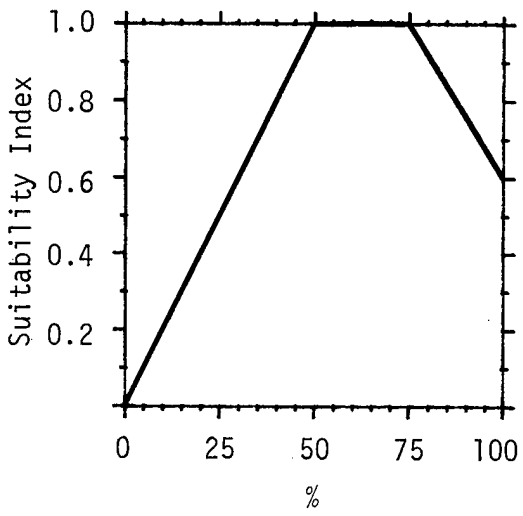
$$CV = 2\,\pi/3(h_o r_o^2 - h_i r_i^2)$$

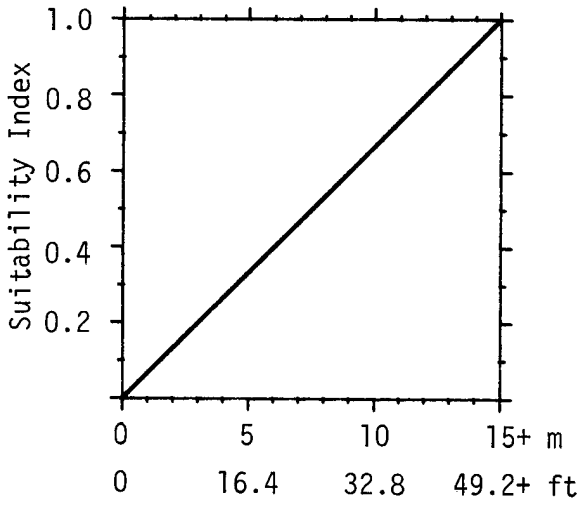
where: h_i = inner height
h_o = outer height
r_i = inner radius
r_o = outer radius

Figure 2. Tree shapes assumed and formulae used to calculate canopy volume (CV). (From Sturman 1968a).

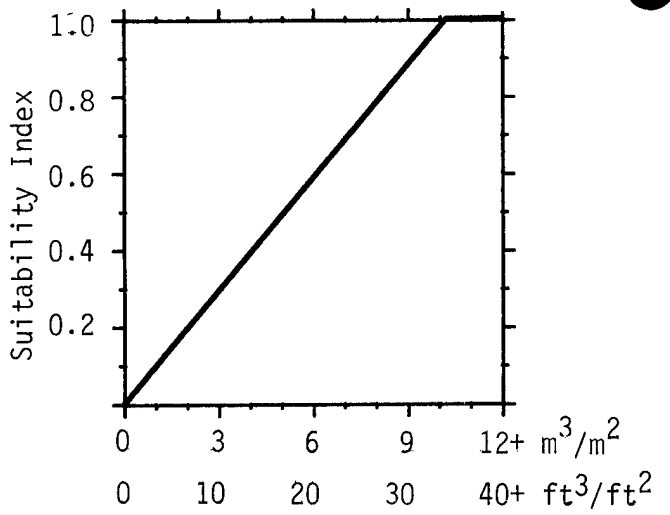
Model Relationships

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

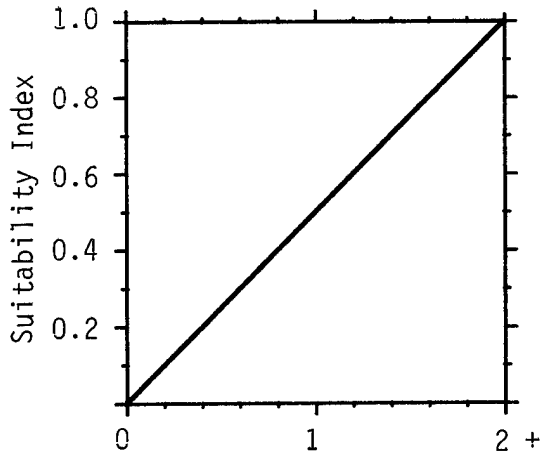
Cover type	Variable		Suitability graph
DF,EF, DFW,EFW	V_1	Percent tree canopy closure.	

DF,EF, DFW,EFW	V_2	Average height of overstory trees.	

DF,EF, DFW,EFW	V_3	Tree canopy volume/ area of ground surface.



DF,EF, DFW,EFW	V_4	Number of snags 10 to 25 cm dbh/ 0.4 ha (4 to 10 inches dbh/1.0 acre).



Equations. In order to determine life requisite values for the black-capped chickadee, the SI values for appropriate variables must be combined through the use of equations. A discussion and explanation of the assumed relationships between variables was included under Model Description, and the specific equations in this model were chosen to mimic these perceived biological relationships as closely as possible. The suggested equations for obtaining food and reproduction values are presented below.

Life requisite	Cover type	Equation
Food	DF,EF,DFW,EFW	$(V_1 \times V_2)^{1/2}$ or V_3 (See page 5 for discussion on which to use)
Reproduction	DF,EF,DFW,EFW	V_4

HSI determination. The HSI for the black-capped chickadee is equal to the lowest life requisite value.

Application of the Model

Definitions of variables and suggested field measurement techniques (from Hays et al. 1981, unless otherwise noted) are provided in Figure 3.

Variable (definition)		Cover types	Suggested technique
V_1	Percent tree canopy closure [the percent of the ground surface that is shaded by a vertical projection of the canopies of all woody vegetation taller than 5.0 m (16.5 ft)].	DF,EF,DFW,EFW	Line intercept
V_2	Average height of overstory trees (the average height from the ground surface to the top of those trees which are ≥ 80 percent of the height of the tallest tree in the stand).	DF,EF,DFW,EFW	Graduated rod, trigonometric hypsometry
V_3	Tree canopy volume/area of ground surface (the sum of the volume of the canopies of each tree sampled divided by the total area sampled).	DF,EF,DFW,EFW	Quadrat and refer to Figure 2 on page 6

Figure 3. Definitions of variables and suggested measurement techniques.

Variable (definition)		Cover types	Suggested technique
V_4	Number of snags 10 to 25 cm dbh/0.4 ha (4 to 10 inches dbh/1.0 acre) [the number of standing dead trees or partly dead trees in the size class indicated that are at least 1.8 m (6 ft) tall. Trees in which at least 50% of the branches have fallen, or are present but no longer bear foliage, are to be considered snags].	DF,EF,DFW,EFW	Quadrat

Figure 3. (concluded).

SOURCES OF OTHER MODELS

Sturman (1968a) developed a multiple regression model for the black-capped chickadee in western Washington in which the canopy volume of trees accounted for 79.6% of the variation in chickadee abundance. Canopy volume of bushes and canopy volume of midstory trees were the next two most important variables, and their addition into the regression accounted for over half of the residual variation remaining after the canopy volume of trees was entered.

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50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. FWS/OBS-82/10.37	2.	3. Recipient's Accession No.
4. Title and Subtitle: Habitat Suitability Index Models: Black-capped Chickadee			5. Report Date: April 1983 6.
7. Author(s): Richard L. Schroeder			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		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 Washington, DC 20240		13. Type of Report & Period Covered 14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

A review and synthesis of existing information was used to develop a habitat model for the black-capped chickadee (Parus atricapillus). The model is scaled to produce an index of habitat suitability between 0 (unsuitable habitat) and 1 (optimally suitable habitat) for areas of the continental United States. Habitat suitability indexes are designed for use with Habitat Evaluation Procedures previously developed by the U.S. Fish and Wildlife Service.

17. Document Analysis a. Descriptors

Mathematical models, Wildlife, Birds, Habitability.

b. Identifiers/Open-Ended Terms

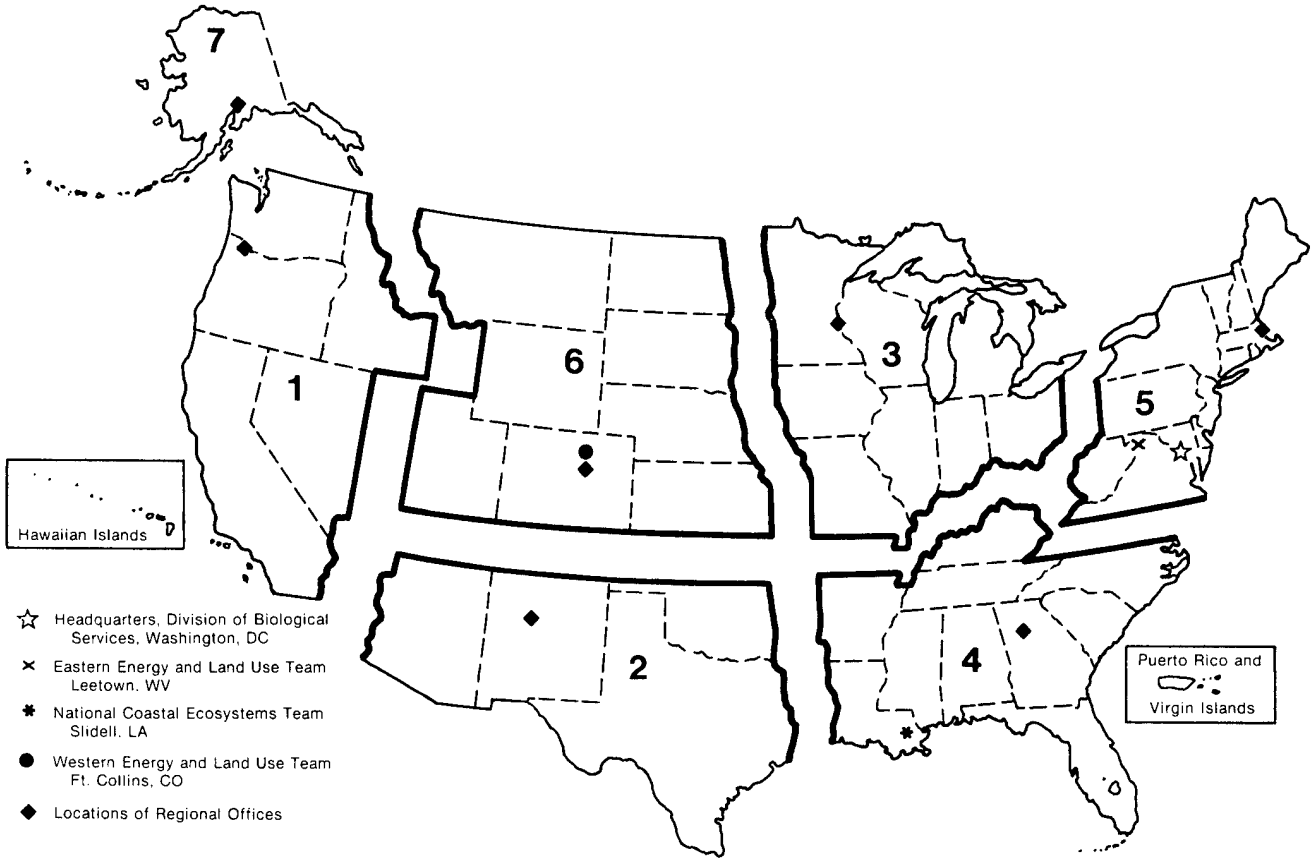
Black-capped chickadee
Parus atricapillus
Habitat Suitability Indexes (HSI)

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release Unlimited	UNCLASSIFIED	12
	20. Security Class (This Page) UNCLASSIFIED	22. Price

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—679-517/293 REGION NO. 8



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