Biological Services **Program**
and

Division of Ecological **Services**

HABITAT SUITABILITY INDEX MODELS: PINE WARBLER

Fish and Wildlife Service

U.S. Department of the Interior

The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues that impact fish and wildlife resources and their supporting ecosystems. The mission of the program is as follows:

- To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wild-life resources, particularly in respect to environmental impact assessment.

- To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major changes in land and water use.

- To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decisionmaking process to prevent or minimize the impact of development on fish and wildlife. Research activities and technical assistance services are based on an analysis of the issues, a determination of the decisionmakers involved and their information needs, and an evaluation of the state of the art to identify information gaps and to determine priorities. This is a strategy that will ensure that the products produced and disseminated are timely and useful.

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The Biological Services Program consists of the Office of Biological Services in Washington, D.C., which is responsible for overall planning and management; National Teams, which provide the Program's central scientific and technical expertise and arrange for contracting biological services studies with states, universities, consulting firms, and others; Regional Staffs. who orovide a link to Droblems at theoperating level;and staffs a certain Fish'and Wildlife Service research facilities,-who conduct in-house research studies.

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

HABITAT SUITABILITY INDEX MODELS: PINE WARBLER

by

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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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PINE WARBLER (Dendroica pinus)

HABITAT USE INFORMATION

General

Pine warblers (Dendroica pinus) inhabit pine and pine-hardwood forests (Capen 1979). They are year-round residents throughout the Southeast and are breeding residents in the northcentral and northeastern States. The pine warbler is one of the few breeding species that are generally restricted to pines (Pinus spp.) (Johnston and Odum 1956).

Food

Grasshoppers (Orthoptera), moths (Lepidoptera) and their larvae, beetles (Coleoptera), ants (Hymenoptera), flies (Diptera), and scale insects (Homoptera) are the major summer foods of the pine warbler (Bent 1953). These insectivorous birds are foliage gleaners (Noon et al. 1979) and are character- istic of the tree canopy (Capen 1979). Although they may feed from ground to tree tops (Bent 1953), pine warblers on the Delmarva Peninsula of Maryland usually foraged between 6 and 12 m (20 and 40 ft) from the ground (Morse 1974). In the winter, the warblers may search tree trunks and the forest floor for insects and vegetable food, such as seeds of pine, wild fruits, and berries (Bent 1953).

Water

Information pertaining to the water requirements of the pine warbler was not located in the literature.

Cover and Reproduction

Pine warblers are most abundant in pure stands of pine (Meyers and Johnson 1978). The density of pine warblers in pine forests was reported to be inversely related to the percent of deciduous trees within the stand. A mature hardwood forest will support no breeding pine warblers. Within the oak-pine forest community, the pine warbler was reported to be most abundant in seral pine stands which ranged from 35 to 100 years in age (Evans 1978). Sixteen breeding pairs of pine warblers per 39.4 ha (100 acres) were recorded in a 25-year old Georgia pine forest (Johnston and Odum 1956). The density of the species increased to 34 pairs per 39.4 ha (100 acres) in a 35-year old pine forest and 43 and 55 pairs per 39.4 ha (100 acres) in pine forests which

were 60 and 100 years in age, respectively. The highest densities of pine warblers in Virginia were recorded in mature stands of conifer trees, although the species was also associated with older stands of mixed pine-hardwoods (Conner et al. 1979).

Pine warblers do not generally breed in white pine (P. strobus) stands (Bent 1953; Alsop, pers. comm.) or in stands of pond pine (P. serotina) or sand pine (P. clausa) (Jackson, pers. comm. cited by Alsop, pers. comm.). In southern States, pine warblers show a preference for the longer leafed pines (Bent 1953). In other locations, they nest in jack pine (P. banksiana), red pine (P. resinosa), pitch pine (P. rigida), and other pines with similar structure.

Pine forests with a deciduous tree understory reaching into the upper one-third of the pine canopy are less suitable for breeding pine warblers than pine forests without such an understory (Alsop pers. comm.). As the deciduous tree density in this zone increases, habitat suitability for the pine warbler will decrease.

Pine warbler nests may be constructed on a horizontal branch, in needles at the end of a branch, or in a clump of cones at heights from 9 to 15 m (30 to 50 ft) above the ground (Bent 1953). The heights of five nests in Maryland ranged between 8 and 10 m (26 to 33 ft) (Morse 1974). The nest is constructed of materials from pine trees and lined with softer materials (Bent 1953).

Interspersion

The minimum amount of forested area required to sustain a breeding population of pine warblers in Maryland was estimated to be 30 ha (80 acres) (Robbins 1979). Alsop (pers. comm.) suggests that a contiguous pine stand of 10 to 15 ha (25 to 37.5 acres) in size will support breeding warblers in Tennessee. A mature forested stand in Minnesota, dominated by red pine, supported 0.7 territorial male pine warblers per ha (0.28 per acre) (Mills 1981), the highest density noted in the Forty-fourth Breeding Bird Census (Van Velzen 1981).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model was developed for application within the entire breeding range of the pine warbler in the eastern United States.

Season. This model was developed to evaluate the breeding season habitat of the pine warbler.

Cover types. This model was developed to evaluate habitat quality in the following cover types: Deciduous Forest (DF) and Evergreen Forest (EF) (terminology follows that of U.S. Fish and Wildlife Service 1981).

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous suitable habitat that is required before an area will be occupied by a particular species. The minimum amount of forested area required to sustain a breeding population of pine warblers is estimated to be 10 ha (25 acres). If less than 10 ha (25 acres) of forested habitat is present, the HSI for the pine warbler will be 0.0.

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

Model Description

Overview. The cover and reproductive needs of the pine warbler are assumed to be met by the same set of habitat characteristics and are, therefore, combined into a single life requisite. It is assumed that food availability will never be more limiting than the cover and reproductive requirements of the species.

The relationship between habitat variables, life requisites, cover types, and the HSI for the pine warbler is illustrated in Figure 1.

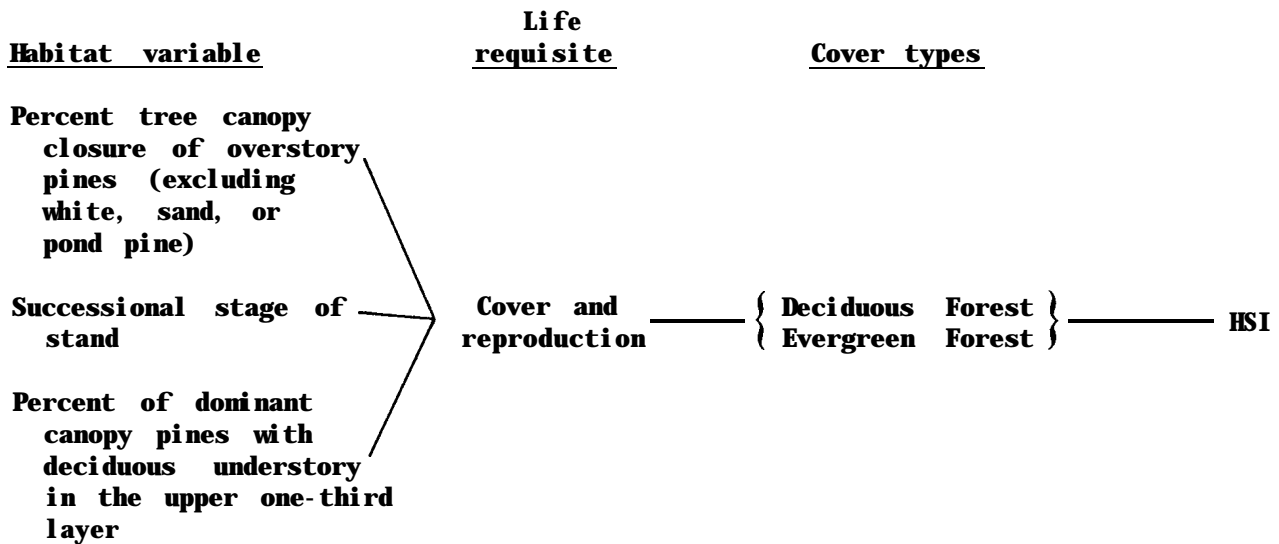| Habitat variable	Life requisite	Cover types	
Percent tree canopy closure of overstory pines (excluding white, sand, or pond pine)			
Successional stage of stand	Cover and reproduction	{ Deciduous Forest } { Evergreen Forest }	HSI
Percent of dominant canopy pines with deciduous understory in the upper one-third layer			

Figure 1. Relationships of habitat variables, life requisites, and cover types in the pine warbler HSI model.

The following sections provide a written documentation of the logic and assumptions used to interpret the habitat information for the pine warbler and 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.

Cover and reproductive component. Optimal cover and reproductive (nesting) habitat for the pine warbler is provided by pure, dense, mature stands of pine (excluding white, pond, and sand pine) lacking a tall deciduous understory. A forest comprised totally of deciduous trees or white, pond, or sand pine will be unsuitable for the pine warbler.

It is assumed that optimal habitats contain 100% tree canopy closure of overstory pines-and that suitability will descrease to zero as the percent of overstory pine approaches zero. Mature or old growth forests are assumed to be optimal, while pole-sapling aged forests are unsuitable. Pine forests with a deciduous understory reaching into the top one-third layer of the dominant pines provide poor habitat. It is assumed that optimal conditions exist when no such deciduous understory is present and that habitats with 100% of the dominant pine layer containing a tall deciduous understory will be unsuitable.

Each of these habitat variables exert a major influence in determining overall habitat quality for the pine warbler. Optimal habitats must contain optimal levels of all variables. Intermediate suitabilities of all variables will produce intermediate habitat values. Low values of any one variable will be partially offset by higher values of the remaining variables.

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.

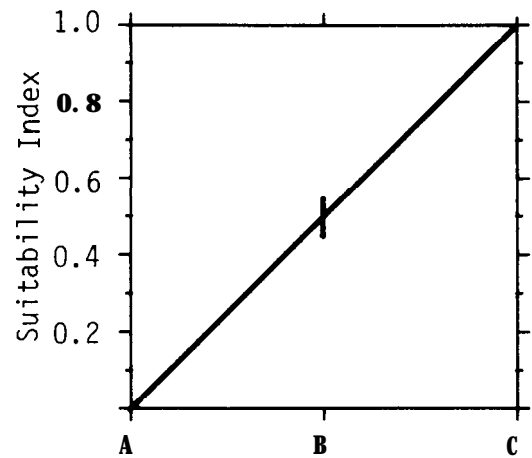| Cover type	Variable		
DF,EF	V_1	Percent tree canopy closure of overstory pines (excluding white, sand, or pond pine).	
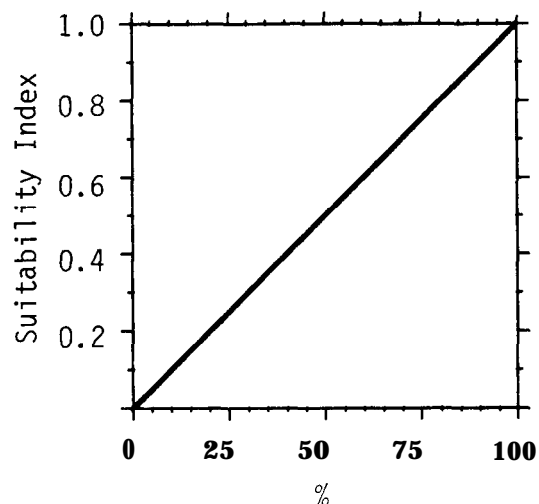
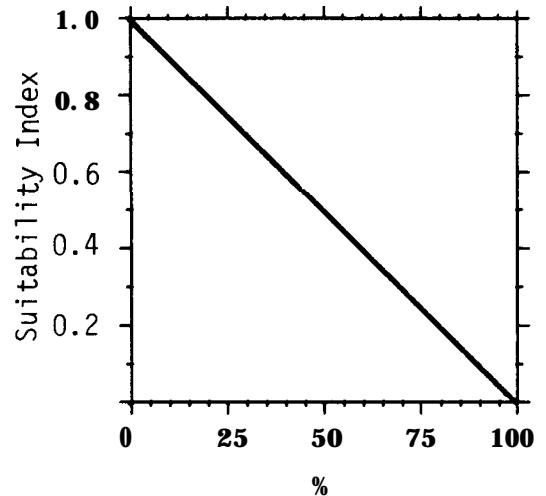DF,EF   V$_2$ **Successional stage of stand.**

A) Pole or sapling
B) Young
C) Mature or old growth

DF,EF   V$_3$ **Percent of dominant canopy pines with deciduous understory in the upper** one-**third layer.**

    Equations. In order to obtain life requisite values for the pine warbler, 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 equation in this model was chosen to mimic these perceived biological relationships as closely as possible. The suggested equation for obtaining a cover and repro- duction value is presented below.

Life requisite	Cover types	Equation
Cover and reproduction	DF, EF	$(V_1 \times V_2 \times V_3)^{1/2}$

HSI determination. Because cover and reproduction were combined into the only life requisite considered in this model, the HSI equals the cover and reproduction value.

Application of the Model

Definitions of variables and suggested field measurement techniques (Hays et al. 1981) are provided in Figure 2.

Variable (Definition)	Cover types	Suggested technique
V_1 Percent tree canopy closure of overstory pines, excluding white, sand, or pond pine. (The percent of the ground surface that is shaded by a vertical projection of the canopies of all over-story pine trees, excluding white, sand, or pond pine.)	DF,EF	Line intercept
V_2 Successional stage of stand. (The structural condition of a forest community which occurs during its devlopment.)	DF,EF	Onsite inspection, remote sensing
V_3 Percent of dominant canopy pines with deciduous understory in the upper one-third layer (self-explanatory, based on canopy cover).	DF,EF	Line intercept

Figure 2. Definitions of variables and suggested measurement techniques.

SOURCES OF OTHER MODELS

No other habitat models for the pine warbler were located.

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16. Abstract (Limit: 200 words)

Habitat preferences of the pine warbler (Dendroica pinus) are described in this publication, which is one of a series of Habitat Suitability Index (HSI) models. Habitat use information is presented in a synthesis of the literature on the species-habitat requirements of the pine warbler, followed by the development of the HSI model. The model is presented in three formats: graphic, word, and mathematical, and is designed to provide information for use in impact assessment and habitat management activities.

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Habitability
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