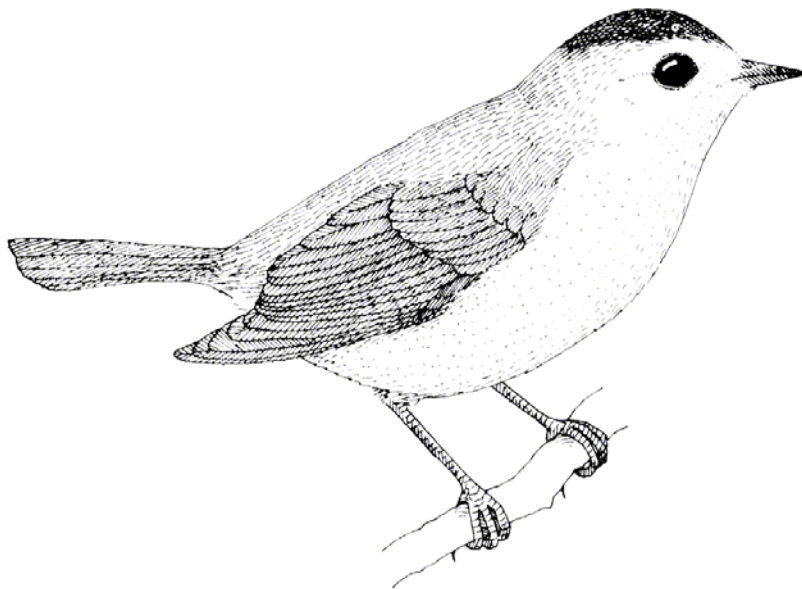**California Wildlife Habitat Relationships Program**
California Department of Fish and Game

HABITAT SUITABILITY MODELS FOR USE WITH ARC/INFO:
WILSON'S WARBLER

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PREFACE

This document is part of the California Wildlife Habitat Relationships (CWHR) System operated and maintained by the California Department of Fish and Game (CDFG) in cooperation with the California Interagency Wildlife Task Group (CIWTG). This information will be useful for environmental assessments and wildlife habitat management.

The structure and style of this series is basically consistent with the "Habitat Suitability Index Models" or "Bluebook" series produced by the USDI, Fish and Wildlife Service (FWS) since 1981. Moreover, models previously published by the FWS form the basis of the current models for all species for which a "Bluebook" is available. As is the case for the "Bluebook" series, this CWHR series is not copyrighted because it is intended that the information should be as freely available as possible. In fact, it is expected that these products will evolve rapidly over the next decade.

This document consists of two major sections. The Habitat Use Information functions as an up-to-date review of our current understanding regarding the basic habitat requirements of the species. This section typically builds on prior publications, including the FWS "Bluebook" series. However, the Habitat Suitability Index (HSI) Model section is quite different from previously published models. All models in this CWHR series are designed as macros (AML computer programs) for use with ARC/INFO geographic information system (GIS) software running on a UNIX platform. As such, they represent a step up in model realism in that spatial issues can be dealt with explicitly. They are "Level II" models in contrast to the "Level I" (matrix) models initially available in the CWHR System. For example, issues such as habitat fragmentation and distance to habitat elements may be dealt with in spatially explicit "Level II" models. Unfortunately, a major constraint remains the unavailability of mapped habitat information most useful in defining a given species' habitat. For example, there are no readily available maps of snag density. Consequently, the models in this series are compromises between the need for more accurate models and the cost of mapping essential habitat characteristics. It is hoped that such constraints will diminish in time.

While "Level II" models incorporate spatial issues, they build on "Level I", nonspatial models maintained in the CWHR System. As the matrix models are field tested, and occasionally modified, these changes will be expressed in the spatial models as well. In other words, the continually evolving "Level I" models are an integral component of the GIS-based, spatial models. To use these "Level II" models one must have (1) UNIX-based ARC/INFO with GRID module, (2) digitized coverages of CWHR habitat types for the area under study and habitat element maps as required for a given species, (3) the AML presented in this document, and (4) a copy of the CWHR database. Digital copies of AMLs are available from the CWHR Coordinator at the CDFG.

Unlike many HSI models produced for the FWS, this series produces maps of habitat suitability with four classes of habitat quality: (1) None; (2) Low; (3) Medium; and (4) High. These maps must be considered hypotheses in need of testing rather than proven cause and effect relationships, and proper use of the CWHR System requires that field testing be done. The maps are only an initial "best guess" which professional wildlife biologists can use to optimize their field sampling. Reliance on the maps without field testing is risky even if the habitat information is accurate.

The CDFG and CIWTG strongly encourage feedback from users of this model and other CWHR components concerning improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to wildlife management planning.

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WILSON'S WARBLER (*Wilsonia pusilla*)

HABITAT USE INFORMATION

General

Wilson's warbler (*Wilsonia pusilla*) inhabits riparian deciduous shrubbery or thickets throughout the western states and Canada (American Ornithologists' Union 1983). In California, they are a common migrant and summer visitor frequenting riparian thickets of the coastal belt and interior mountain ranges (Brown et al. 1979). In northern California, they are common breeders in the North Coast, Klamath, Cascade, and Sierra Nevada ranges (Zeiner et al. 1990). They are uncommon during the summer in the southern mountains but are locally common on the southern coast (Garrett and Dunn 1981). During the spring migration, Wilson's warblers are common to abundant in lowlands throughout the state. During the fall migration, however, they are common in both the lowlands and mountains. During the winter, Wilson's warblers are rare in coastal and interior areas (Zeiner et al. 1990).

Food

Though Wilson's warblers are primarily insectivores, small amounts of seeds, berries, and fruits are consumed (Zeiner et al. 1990). Insects are captured while flycatching or are gleaned from the foliage (Grinnell and Miller 1944; Bent 1953; Stewart et al. 1973). In California, Wilson's warblers foraged by gleaning 49% of the time and the remainder by flycatching or hovering (Stewart et al. 1977). Foraging heights have been reported to vary from 1.8 m (6 ft) (Grinnell and Storer 1924) to 12.2 m (40 ft) (Stewart et al. 1977). An examination of stomach contents by Beal (1907) of 52 Wilson's warblers revealed a diet consisting of 93% animal matter with the remainder composed almost entirely of fruit pulp. The major portion of the diet consisted of Hemiptera (> 35%), Hymenoptera (wasps and ants) (31%), Diptera (flies) (11%), Coleoptera (beetles) (8%), caterpillars (5%), and spiders (1%). In the western Sierra Nevada, stomach contents of eight Wilson's warblers contained 95.7% animal matter, 3.3% vegetable material, and 1% mineral material (Dahlsten et al. 1985). Adult Curculionoidea, Mycetophilidae, Hymenoptera, and Araneida were found in the stomach samples. In Wyoming, the diet of Wilson's warblers contained 53 families of arthropods (Raley and Anderson 1990). Coleoptera were ranked as the most preferred food group followed by Ephemeroptera, Plecoptera, Diptera, Hymenoptera, Hemitera, Trichoptera-Lepidoptera, Araneae larvae, and Homoptera. Larger prey items were captured more frequently than expected given their limited availability.

Water

Wilson's warblers nest primarily in riparian vegetation. No other water requirements were found for this species.

Cover

Along the coast, Wilson's warblers nest in moist thickets usually near water. They breed in aspen (*Populus tremuloides*) and montane riparian habitats below the lodgepole pine (*Pinus contorta* var. *murrayana*) belt, as well as coastal valley foothill riparian habitats (Zeiner et al. 1990). Wilson's warblers have been documented breeding away from free water in north coastal scrub habitat (Shuford 1993).

After breeding, some Wilson's warblers move upslope, above normal breeding ranges. They have been recorded above 3,048 m (10,000 ft) in the Sierra Nevada (Grinnel and Storer 1924). In migration, they are found in all woodland and shrub habitats.

Reproduction

Wilson's warblers breed from late April into early August, with the peak of nesting activity occurring in June (Zeiner et al. 1990). Males arrive on the breeding grounds in Marin County between late March and early April (Stewart 1973); in the high Sierra, males arrive in late May (Stewart et al 1977). Nests are generally located in wet meadows or near water, and, though typically placed on the ground under dense shrub cover, they may be as high as 0.9 m (3 ft) above ground in dense shrubs (Grinnell and Miller 1944). In coastal Marin County, nests averaged 0.7 m (2.3 ft) above ground and were typically supported by blackberry (*Rubus* spp.) tangles (Stewart 1973). In the Sierra Nevada, nests were located at the base of willow (*Salix* spp.) bushes either on the ground or in depressions up to 5 cm (2 in) in depth (Stewart et al. 1977). Parasitism of Wilson's warbler nests by brown-headed cowbirds (*Molothrus ater*) has been reported by Stewart et al. (1977).

Interspersion and Composition

In central Marin County, breeding pairs of Wilson's warblers occupied territories averaging 0.6 ha (1.4 ac) and varying from 0.2 to 1.3 ha (0.5 to 3.2 ac) (Stewart 1973). Individuals were found at distances from their nests varying from 125-300 m (410-984 ft). Territory sizes in the high Sierra ranged from 0.7-2.0 ha (1.7-5.0 ac) with an average size of 1.2 ha (2.9 ac) (Stewart et al. 1977). In the western Sierra Nevada, density estimates of nesting Wilson's warblers range from five birds/40 ha (100 ac) in open-canopy mixed conifer forest to 21 birds/40 ha (100 ac) in open-canopy red fir (*Abies magnifica*) forest (Beedy 1981).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area.

The California Wildlife Habitat Relationships (CWHR) System (Airola 1988; Mayer and Laudenslayer 1988; Zeiner et al. 1990) contains habitat ratings for each habitat type predicted to be occupied by Wilson's warblers in California.

Season.

This model is designed to predict the suitability of habitat for Wilson's warblers during the breeding season when they are in California.

Cover types.

This model can be used anywhere in California for which an ARC/INFO map of CWHR habitat types exists. The CWHR System contains suitability ratings for reproduction, cover, and feeding for all habitats Wilson's warblers are predicted to occupy. These ratings can be used in conjunction with the ARC/INFO habitat map to model wildlife habitat suitability.

Minimum habitat area.

Minimum habitat area is defined as the minimum amount of contiguous habitat required before a species will occupy an area. Specific information on minimum areas required for Wilson's warbler during the breeding season was not found in the literature. This model assumes two home ranges is the minimum area required to support a Wilson's warbler population during the breeding season.

Verification level.

The spatial model presented here has not been verified in the field. The CWHR suitability values used are based on a combination of literature searches and expert opinion. We strongly encourage field testing of both the CWHR database and this spatial model.

Model Description

Overview.

This model uses CWHR habitat type as the initial factor determining suitability of an area for this species. In addition, proximity to water is used to further constrain suitability.

Further spatial modeling was not performed on this species. Our habitat maps had no patches smaller than two hectares. More than three Wilson's warbler home ranges will fit in each habitat patch. If geographic data of a higher resolution were available, this model could be modified to include additional spatial analysis. If the cover value is greater than zero and the cell is close enough to water, it is included as suitable habitat.

A CWHR habitat type map must be constructed in ARC/INFO GRID format as a basis for the model. The GRID module of ARC/INFO was used for these models because of it's superior functionality for spatial modeling. Only crude spatial modeling is possible in the vector portion of the ARC/INFO program and much of the modeling done here would have been impossible without the abilities of the GRID module. In addition to more sophisticated modeling, the GRID module's execution speed is very rapid, allowing a complex model to run in less than 30 minutes.

The following sections document the logic and assumptions used to interpret habitat suitability.

Cover component.

A CWHR habitat map must be constructed. The mapped data (coverage) must be in ARC/INFO GRID format. A grid is a GIS coverage composed of a matrix of information. When the grid coverage is created, the size of the grid cell should be determined based on the resolution of the habitat data and the home range size of the species with the smallest home range in the study. You must be able to map the home range of the smallest species with reasonable accuracy. However, if the cell size becomes too small, data processing time can increase considerably. We recommend a grid cell size of 30 m (98 ft). Each grid cell can be assigned attributes. The initial map must have an attribute identifying the CWHR habitat type of each grid cell. A CWHR suitability value is assigned to each grid cell in the coverage based on its habitat type. Each CWHR habitat is rated as high, medium, low or of no value for each of three life requisites: reproduction; feeding; and cover. The cover value was used to determine the base value of the cell for this analysis (for this species cover and feeding suitabilities are identical). The geometric mean would have resulted in a base map with very little suitable habitat since the CWHR models only show Wilson's warblers breeding in riparian habitat. This species breeds in small riparian inclusions within other habitat types. Most of these patches are too small to appear on our habitat map. Any habitat suitable for cover was also considered to be potential habitat if it was within one home range diameter of a lake or stream.

Distance to water.

Wilson's warblers breed in riparian vegetation. No other water requirement was found for this species. Any habitat suitable for cover was considered to be potential habitat if it was within one home range diameter of a lake or stream.

Species' distribution.

The study area must be manually compared to the range maps in the CWHR Species Notes (Zeiner et al. 1990) to ensure that it is within the species' range. All grid cells outside the species' range have a suitability of zero.

Spatial analysis.

Ideally a spatial model of distribution should operate on coverages containing habitat element information of primary importance to a species. For example, in the case of woodpeckers, the size and density of snags as well as the vegetation type would be of great importance. For many small rodents, the amount and size of dead and down woody material would be important. Unfortunately, the large cost involved in collecting microhabitat (habitat element) information and keeping it current makes it likely that geographic information system (GIS) coverages showing such information will be unavailable for extensive areas into the foreseeable future.
The model described here makes use of readily available information such as CWHR habitat type, elevation, slope, aspect, roads, rivers, streams and lakes. The goal of the model is to eliminate areas that are unlikely to be utilized by the species and lessen the value of marginally suitable areas. It does not attempt to address all the microhabitat issues discussed above, nor does it account for other environmental factors such as toxins, competitors or predators. If and when such information became available, this model could be modified to make use of it.

In conclusion, field surveys will likely discover that the species is not as widespread or abundant as predictions by this model suggest. The model predicts potentially available habitat. There are a variety of reasons why the habitat may not be utilized.

Application of the Model

A copy of the ARC/INFO macro (AML) can be found in Appendix 1.

To create the HSI Coverage, the first step is to eliminate areas too far from water. If the grid cell is more than 180 m from water, it receives a suitability value of zero. All other grid cells retain their original values. Since the home range size of the Wilson's warbler at 0.6 ha (6071 m²) is much smaller than the size of our habitat patches at 2.02 ha (20,235 m²), no additional spatial analysis is necessary.

Problems with the approach

Habitat map accuracy.

The resolution of the CWHR habitat map (2.02 ha) is probably too low to give an accurate assessment of how much area is available to this species.

Riparian inclusion map.

This species commonly breeds in riparian inclusions. Without a map of this habitat element, it is very difficult to accurately predict the occurrence of this species. This model produces a map of potential habitat for this species that overestimates the true value.

Element map accuracy.

Since this model is based almost solely on stream location, it is vital that the stream coverages be accurate. The stream coverages we were provided were accurate at 1 to 250,000. This accuracy is unacceptable. We edited these files to include all water courses identified on 1:24,000 USGS quadrangles. This may still be insufficient since some small permanent and intermittent streams are not included on these maps. Many of these streams support small patches of riparian habitat suitable for use by Wilson's warblers.

SOURCES OF OTHER MODELS

No other habitat models were found for the Wilson's warbler.

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APPENDIX 1: Wilson's Warbler Macro

```
/*        WILSON'S WARBLER

/* wiwmodel.aml - This macro creates an HSI coverage for the
/*          Wilson's Warbler .

/* Version:  Arc/Info 6.1 (Unix), GRID-based model.

/* Authors:  Irene Timossi, Sarah Miller, Wilde Legard,
/*        and Reginald H. Barrett
/*          Department of Forestry & Resource Management
/*          University of California, Berkeley

/* Revision: 2/10/95

/* -----------------------------------------------------------------

/* convert .ID to uppercase for info manipulations

&setvar .ID [translate %.ID%]

/* Start Grid

grid

/*

&type (1)  Initializing Constants...

/*   StreamDist: The distance in feet from perennial streams that is suitable
/*   for Wilson's Warblers (StreamDist).

&setvar SpecCode = B463

&if %.Measure% = Meters &then
  &do
    &setvar StreamDist = 90
    &setvar AcreCalc   = 4047
  &end
&else
  &if %.Measure% = Feet &then
    &do
      &setvar StreamDist = 295
      &setvar AcreCalc   = 43560
    &end
  &else
    &do
      &type Measurement type incorrect, check spelling.
      &type Only Meters and Feet are correct.
      &goto &BADEND
    &end

/*   The following global variables are declared in the menu:

/*   WHR grid name (.WHRgrid): the name of the grid containing all
/*   the WHR information.
/*
/*   Boundary grid name (.Bound): the grid containing only the
```

9

```
/*   boundary of the coverage. All cells inside the boundary
/*   have a value of 1. All cells outside the boundary must
/*   have a value < 1.
/*
/*   Identifier (.ID): a 1 to 4 character code used to identify
/*   the files produced by this program. You may prefer
/*   to use an abbreviation of the species' common name
/*   (e.g. use `fis1` for fisher).
/*
/*   Euclidean distance to perennial streams grid (.Stream).
/*   Create this coverage (using GRID's eucdistance function and
/*   a permanent stream source-grid) before running this macro.
/*
/*   .SizeOfCell (Cell size): the size (width) of the cells
/*   used in the coverage grids. All grids used in the
/*   analysis must have the same cell size.

&type (2)  Creating a Stream-buffer-HSI grid...

/*    Create an HSI grid (%.ID%HSI) based on the HSI value of the
/*    WHR grid (%.WHRgrid%).

/*    All cells within StreamDist of a permanent stream receive their
/*    reproductive value (e.g. %.WHRgrid%.A044_r).


docell
  if (%.Stream% <= %StreamDist%)
    %.ID%HSI  = %.WHRgrid%.%SpecCode%_c
   else
    if (%.Bound% == 1)
      %.ID%HSI = 0
    endif
   endif
end

/*  quit from grid and run the additem to add acres

Q

&type (3)  Add the acres field.....

/*  add acre item to grid coverage and index on value

additem %.ID%HSI.vat %.ID%HSI.vat acres 10 10 i

indexitem %.ID%HSI.vat value

&type (4)  Calculating acres.....

/*  use info to fill in acreage field.  Multiply the number of
/*  cells by the cell size squared and divide by the number of
/*  square meters per acre (4047).

&data arc info
arc
select %.ID%HSI.VAT
CALC ACRES = ( COUNT * %.SizeOfCell% * %.SizeOfCell% ) / %AcreCalc%
Q STOP
```

&END

/* index item since info changed vat

indexitem %.ID%HSI.vat value

&label BADEND

&type -------------- All done! ----------------

&return