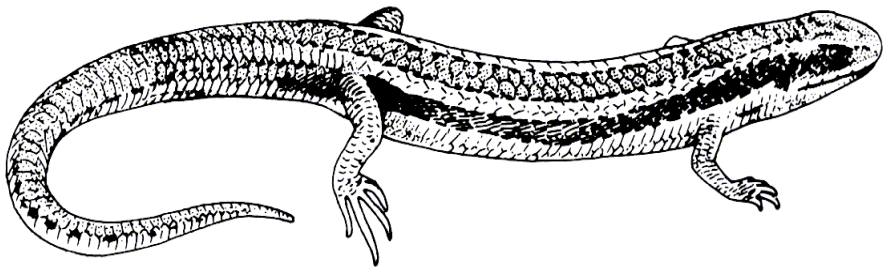
California Wildlife Habitat Relationships Program
California Department of Fish and Game

HABITAT SUITABILITY MODELS FOR USE WITH ARC/INFO: WESTERN SKINK



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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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ACKNOWLEDGMENTS

The primary credit for this document must go to the field biologists and naturalists that have published the body of literature on the ecology and natural history of this species. They are listed in the References section. Ecological information of this sort is generally very expensive and time-consuming to obtain. Yet this basic ecological understanding is exactly what is needed most if the goal of accurately predicting changes in distribution and abundance of a particular species is ever to be achieved. The CWHR System is designed to facilitate the use of existing information by practicing wildlife biologists. We hope it will also stimulate funding for basic ecological research. Funding for producing this model was provided by the California Department of Forestry and Fire Protection and the University of California Agricultural Experiment Station.

We thank Barry Garrison, Karyn Sernka, and Sandie Martinez of the California Department of Fish and Game for their assistance in typing, editing, and producing this report.

WESTERN SKINK (*Eumeces skiltonianus*)

HABITAT USE INFORMATION

General

The western skink (*Eumeces skiltonianus*) is a common but secretive species whose range extends throughout Washington, Oregon, Nevada, Utah, Wyoming and into western Montana and northern Arizona (Stebbins 1985). It is widespread in northern California but restricted to the coast in central and southern California. Found in a variety of habitats, this lizard is most common in early successional stages or open areas of late successional stages. Heavy brush and densely forested areas are generally avoided (Tanner 1957). Western skinks are found from sea level to at least 2,130 m (7,000 ft) (Zeiner et al. 1988). This diurnal reptile is active during the warm seasons (Tanner 1957).

Food

Western skinks eat a variety of invertebrates including insects, spiders, and sow bugs (Stebbins 1985). Taylor (1936) found crickets, beetles, moths, grasshoppers, and other arthropods in the stomachs of skinks. Skinks forage actively through leaf litter and dense vegetation and occasionally dig in loose soil. Tanner (1957) reported insect eggs, adult and larval beetles, caterpillars, moths, grasshoppers, crickets, insect larvae, ants, spiders, centipedes, and sow bugs among the food items of the western skink. Prey is sometimes stalked and cannibalism has been reported (Zweifel 1952).

Water

The literature on western skinks does not include any discussion of water requirements. Individuals seem to prefer somewhat moist microhabitats and the soil of nest chambers is invariably moist. Standing water is not known to be required (Zeiner et al. 1988).

Cover

Western skinks frequent grassland, broken chaparral, pinyon-juniper *(Pinus-Juniperus*) and juniper-sage (*Artemisia* spp.) woodland, and open pine-oak (*Pinus-Quercus* spp.) and pine forests. They seem to prefer rocky habitats near streams where there is abundant herbaceous cover, but they may also be found in dry locations (Stebbins 1985). Western skinks are most common in early successional stages or in open areas in late successional forested habitats where they are sometimes found in concentrated colonies (Tanner 1957).

Western skinks can be found inside rotten logs and under logs, bark, rocks, and other surface objects. They are good burrowers and sometimes construct burrows several times their own body length (Stebbins 1985).

Reproduction

Western skink females construct nest chambers that are several centimeters deep in loose moist soil. Typically these chambers are located under surface objects, especially flat stones, and sometimes in or near rock outcrops (Tanner 1957).

The reproductive season for western skinks varies geographically and from year to year depending on local conditions. Mating probably occurs in the spring soon after emergence from the period of winter inactivity. Taylor (1957) found that the mating season in Utah occurred through May and into the first part of June, and egg laying occurred in the first two weeks in July. Stebbins (1954) found that western skinks near Berkeley, California laid eggs primarily in June and July with hatching occurring in July and August. Clutch size ranges from 2-6 eggs (Tanner 1957; Punzo 1982). Females remain with the eggs during incubation (Tanner 1943, 1957).

Interspersion and Composition

There have been no studies documenting the home range size of western skinks. Fitch and von Achen (1977) found that in Kansas the females of a related species *E. fasciatus* had extremely small home ranges of 0.005 ha (0.01 ac) while guarding eggs. During the rest of the year, females had home ranges averaging 0.09 ha (0.2 ac), which is similar to males. Home ranges apparently are not fixed, and are subject to constant revision depending on environmental conditions; complete home range relocation is not uncommon (Fitch and von Achen 1977).

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. 1988) contains habitat ratings for each habitat type predicted to be occupied by western skinks throughout California.

Season .

This model is designed as a year-round model for the western skink.

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 western skinks occupy. These ratings can be used in conjunction with the ARC/INFO map to model wildlife habitat suitability.

Minimum habitat area .

Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before a species will occupy an area. Specific information on minimum areas required for western skinks was not found in the literature. Our model assumed two home ranges as the minimum area required to support a western skink population for at least 12 months.

Verification level .

The spatial model presented here has not been field tested. The CWHR suitability values used are based on a combination of published literature 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, elevation is used to further constrain suitability. Further spatial modeling was not performed on this species. Our habitat maps had no patches smaller than 2 ha (5 ac). Many western skink 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 within the correct elevational range, 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 because of its 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 geometric mean value of the three suitability values was used to determine the base value of each grid cell for this analysis.

Elevation .

Western skinks are found at elevations below 2,134 m (7,000 ft).

Species' distribution .

The study area must be manually compared to the range maps in the CWHR Species Notes (Zeiner et al. 1988) 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 becomes 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 the 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 outside the elevational range of the western skink. If the grid cell is at an elevation greater than 2,134 m (7,000 ft) it receives a suitability value of zero. All other grid cells retain their original values. Since the home range size of the western skink (900 m^2) is much smaller than the size of our habitat patches 2.02 ha (20,235 m^2), 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 for an accurate assessment of how much area is available to this species.

SOURCES OF OTHER MODELS

No other habitat models for the western skink were found.

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Zweifel, R.G. 1952. Notes on the lizards of the Coronados Islands, Baja California, Mexico. Herpetologica 8:9-11.

APPENDIX 1: Western Skink Macro

```
/*          WESTERN SKINK

/* wskmodel.aml - This macro creates an HSI coverage for the
/*               Western Skink.

/* 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...

/*   Homerange: the size of the species' homerange in sq.m.

/*   High:  The value in the WHR grid which indicates high quality habitat.

/*   Medium:  The value in the WHR grid which indicates medium quality habitat.

/*   Low:  The value in the WHR grid which indicates low quality habitat.

/*   None:  The value in the WHR grid which indicates habitat of no value.

/*   MaxElev: The maximum elevation at which the species occurs.

/*   SpecCode: The WHR code for the species.

/*   AcreCalc:  The number needed to convert square units (feet or meters) to acres.

&setvar SpecCode = R036

&if %.Measure% = Meters &then
  &do
    &setvar Homerange  = 809
    &setvar MaxElev    = 2134
    &setvar AcreCalc   = 4047
  &end
&else
  &if %.Measure% = Feet &then
    &do
      &setvar Homerange  = 8712
      &setvar MaxElev    = 7002
      &setvar AcreCalc   = 43560
```

```
   &end
  &else
   &do
    &type Measurement type incorrect, check spelling.
    &type Only Meters and Feet are correct.
    &goto &BADEND
   &end

&setvar High          = 3
&setvar Medium        = 2
&setvar Low           = 1
&setvar None          = 0


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

/*  .WHRgrid (WHR grid name): the name of the grid containing all
/*   the WHR information.

/*  .Elevation (Elevation grid):  the name of the grid containing
/*   the elevation information.

/*  .Bound (Boundary grid name): the grid containing only the
/*   boundary of the coverage. All cells inside the boundary
/*   have a value of 1. All cells outside the boundary must
/*   have a value < 1.

/*  .ID (Identifier): 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).

/*  .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.

/*   .Measure:  the units the coverage is measured in (feet or meters).


&type (2)  Get geometric means at correct elevation...

/*    Create a Geometric Means grid (%.ID%Geom) for the species by
/*    copying these values from the WHR grid that are at the correct
/*    elevation (< 2134 m).

if (%.Elevation%  <= %MaxElev%)
  %.ID%Elev = %.WHRgrid%.%SpecCode%_g
endif

%.ID%valzero = con(isnull(%.ID%Elev),0,%.ID%Elev)

if (%.Bound% == 1)
  %.ID%hsi = %.ID%valzero
endif

/*
&type (2)  Quitting from GRID and adding the acres field.....

/*     Quit from GRID (Q), then run additem to add an acre item to
/*     the HSI grid vat file (%ID%HSI.vat). Reindex on value when done.
```

```
Q
additem %.ID%HSI.vat %.ID%HSI.vat acres 10 10 I
indexitem %.ID%HSI.vat value

/*

&type (3)  Calculating acres.....

/*    Use INFO to calculate the acreage field: Multiply the number
/*    of cells by the cell size squared and divide by the number of
/*    square meters per acre (4047). Reindex on value when done.

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

&END

indexitem %.ID%HSI.vat value

&label BADEND

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

&return
```