Standards and Guidelines for Species Models California Wildlife Habitat Relationships System

California Department of Fish and Wildlife
California Interagency Wildlife Task Group

July 2014

Preface

This document is the third version of its type for the California Wildlife Habitat Relationships (CWHR) System. The original was an October 1982 report entitled "California Wildlife and Fish Habitat Relationships (WFHR) System: Products and Standards for Wildlife." The 1982 version was updated in a December 2000 document entitled “Standards and Guidelines for CWHR Species Models” to reflect changes in the system platform from a mainframe to a personal computer, the advent of Geographic Information Systems (GIS), and some changes in data classification (location categories, for example).

There are similar reasons for updating these standards at this time. Some location categories are no longer being supported, both because they are underutilized and because increasingly system users go directly to GIS data to obtain location information. Additionally, GIS range mapping protocols have been revised.

A single species model in CWHR is still considered to have three components, which must be updated simultaneously - the life history account, the database model queried within the user application (habitat suitability ratings, season in habitat predictions, element importance ratings, season in location predictions), and the GIS coverage representing distribution by season throughout the state. Standards for these components form the three major sections of this document.

Since the inception of CWHR, this document has been invaluable to its developers, identifying all system components and providing standard definitions for all terms. It has been the document provided to experts developing model ratings for all new species added since the system was introduced.

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Life History Account

LIFE HISTORY ACCOUNT

The Life History Account documents the distribution, habitat use and life history of the species in a brief narrative. It is intended to provide the user with an introduction to the species and an information basis for range maps, habitat relationships and habitat ratings. The account is intended to be intermediate between the information in a typical field guide and that in a detailed literature review. The format and definitions are as follows.

Species ID	**Common Name**	**Scientific Name**
Family	**Order**	**Class**

Use taxonomy and nomenclature from the most recent version of the CWHR complete species list.

Written by:
Reviewed by:
Edited by:
Updated by:

DISTRIBUTION, ABUNDANCE, AND SEASONALITY

In support of the accompanying range map, document the general distribution of the species. Cite specific information on the range, major habitats used, relative abundance, seasonal occurrence, and origin (native or exotic) in California. When possible, refer to standard geographic features as they are identified in the USDA Ecological Subregions of the United States and describe elevation to the nearest 100 feet. Report as meters rounded to10ths with feet in parentheses.

SPECIFIC HABITAT REQUIREMENTS

Feeding: Document the foraging strategy and major food items used seasonally and by distinct life stages of the species.

Cover: Document the major cover needs and describe the habitat resources used seasonally and by distinct life stages of the species.

Reproduction: Document the specific habitat needs for key events in the annual reproductive cycle: e.g. courtship, breeding, nesting, parturition, fledging, and lactation. Emphasize spatial and temporal habitat requirements for reproduction rather than specific mating behaviors.

Water: Document the water needs, qualitatively and quantitatively. Wherever possible, emphasize spatial requirements such as distance to water and temporal requirements such as seasonal availability.

Pattern: Document the mix and interspersion of habitat conditions required by the species; distinguish seasonally if appropriate.

SPECIES LIFE HISTORY

Activity Patterns: Document daily and seasonal activity patterns that might be important to management: e.g. nocturnal, hibernates, aestivates.

Seasonal Movements/ Migration: Document the nature of seasonal movements and identify associated special habitat needs.

Home Range: Document the variation in home range sizes and shapes. Include density values here. Report homing experiments as such.

Territory: Document the extent to which territories are defended and the nature of those territories.

Reproduction: Document the significant dates in the reproductive process, the reproductive potential of the species, and the nature of reproductive units: e.g. solitary breeding pairs, colonies.

Niche: Document the species relationships with predators, competitors, disease, parasites, and weather, and its ecological role.

REFERENCES

Cite all references, whether literature or personal communications, in standard Journal of Wildlife Management format.

Editor's Notes:

Use the "active" voice wherever possible.
Quantify habitat requirements wherever possible.
For updates, start literature searches with cited authors from original account. Add to, rather than replace, citations.
When using secondary sources to cite original research, cite both sources. (e.g. Smith, 1992 as cited in Jones, 1994)
Cite yourself in the third person.

Database Model

MODEL ASSUMPTIONS

The CWHR System rests on a set of general assumptions. In addition, there are a number of specific assumptions which model raters must all adhere to when assigning suitability values to habitats and importance levels to elements for any given species. General and specific system assumptions are listed below.

GENERAL ASSUMPTIONS

1. Wildlife species occurrence and abundance are strongly influenced by habitat conditions.

2. Wildlife habitat can be described by a set of environmental characteristics.

3. Relative suitability values (ie., HIGH, MODERATE, LOW, UNSUITABLE) of habitats and the relative importance of special habitat elements may be determined for each species.

4. Habitat suitability value is uniform for a species throughout its range in California for the specified habitat.

SPECIFIC ASSUMPTIONS

1. Habitat ratings reflect values only for that species.

2. Habitats for species that require juxtaposition of two or more habitats are individually rated as if the other habitats are available in the proper mix.

3. Ratings assume that all special habitat elements are present in adequate amounts if they are typical components of the habitat.

4. Ratings assume that adequate habitat amounts and patch sizes exist.

HABITAT CLASSIFICATION SCHEME USED IN THE MODELS

The habitat classification scheme used in the models is described in the publication "A Guide to Wildlife Habitats of California" (Mayer and Laudenslayer, 1988). This guide, along with all updates since 1988, is published at http://www.dfg.ca.gov/biogeodata/cwhr/wildlife_habitats.asp. Primary updates include descriptions of eight agricultural habitat types to replace the original Cropland and Orchard\Vineyard types (1999); revised classification rules (2005); and, the addition of four new vegetation and land use crosswalks (1998-2008).

THE CONNECTION BETWEEN HABITATS AND SPECIAL HABITAT ELEMENTS

One of the specific model assumptions is that all special habitat elements are present in adequate amounts if they are typical components of the habitat. Model raters and model users often ask for explicitness on which special elements they may assume are typical in any given habitat. The standards set below were developed in 1994 by Irene Timossi, Barrett Garrison, and Marshall White and should be used for all new models. The current models have also been evaluated to ensure that they follow this logic. Thus, users may be confident in the following standard assumptions regarding elements.

ELEMENT ASSUMPTIONS

1. If a habitat can be found next to another habitat that contains an element, that element is assumed to be present. For example, large logs in various states of decay may be assumed present in the shore zone of marine habitat because of the adjacency of other habitats.

2. An element is assumed to be present unless it is never present, either in the habitat being evaluated or any other habitat that might occur nearby.

As a result of these assumptions, most habitats possess virtually all of the elements. The exceptions are listed below.

CWHR Habitat	**Dominant Species or Dominant Associates**	**Elements Assumed Absent** (CWHR users do not have to delete these elements during queries.)
Tree-Dominated Habitats (27 types)		
Aspen (ASP)	Willow, Alder, Black Cottonwood	kelp, salt ponds, tidepools

CWHR Habitat	Dominant Species or Dominant Associates	Elements Assumed Absent (CWHR users do not have to delete these elements during queries.)
Blue Oak Woodland (BOW)	Interior Live Oak, Valley Oak, Juniper	kelp; salt ponds; sand dunes; tidepools; trees, fir
Blue Oak-Foothill Pine (BOP)	Interior Live Oak, Valley Oak, California Buckeye	kelp; salt ponds; sand dunes; tidepools; trees, fir
Closed-Cone Pine-Cypress (CPC)	Tecate, Cuyamaca, Foothill Pine	none
Coastal Oak Woodland (C0W)	White Oak, California Black Oak, Engelmann Oak	none
Eucalyptus (EUC)	Blue Gum, Red Gum	none
Desert Riparian (DRI)	Tamarisk, Velvet Ash, Mesquite	kelp; tidepools; trees, fir
Douglas-Fir (DFR)	Live Oaks, Tanoak, Ponderosa Pine	none
Eastside Pine (EPN)	Ponderosa Pine, Jeffrey Pine, White Fir	kelp, salt ponds, sand dunes, tidepools
Jeffrey Pine (JPN)	Ponderosa Pine, Coulter Pine, Sugar Pine	kelp, salt ponds, sand dunes, tidepools
Joshua Tree (JST)	Juniper, Singleleaf Pinyon, Mojave Yucca	kelp; log, large rotten; log, large sound; log, large hollow; snag, large rotten; snag, large sound; tidepools
Juniper (JUN)	White Fir, Jeffrey Pine, Ponderosa Pine	kelp, tidepools
Klamath Mixed-Conifer (KMC)	White Fir, Douglas-Fir, Ponderosa Pine	kelp, salt ponds, tidepools
Lodgepole Pine (LPN)	Aspen, Mountain Hemlock, Red Fir	kelp, salt ponds, sand dunes, tidepools
Montane Hardwood (MHW)	Canyon Live Oak, Douglas Fir, Knobcone Pine	kelp, salt ponds, tidepools

CWHR Habitat	Dominant Species or Dominant Associates	Elements Assumed Absent (CWHR users do not have to delete these elements during queries.)
Montane Hardwood-Conifer (MHC)	Ponderosa Pine, Douglas Fir, Incense Cedar	kelp, salt ponds, tidepools
Montane Riparian (MRI)	Black Cottonwood, White Alder, Bigleaf Maple	kelp, salt ponds, tidepools
Palm Oasis (POS)	Coyote Willow, Velvet Ash, Sycamore	acorns; cones; kelp; tidepools; trees, fir
Pinyon-Juniper (PJN)	Oaks, Mojave Yucca, Ponderosa Pine	kelp, tidepools
Ponderosa Pine (PPN)	White Fir, Incense Cedar, Coulter Pine	kelp, salt ponds, tidepools
Red Fir (RFR)	Noble Fir, White Fir, Lodgepole Pine	kelp, salt ponds, sand dunes, tidepools
Redwood (RDW)	Sitka Spruce, Grand Fir, Douglas Fir	none
Sierran Mixed-Conifer (SMC)	White Fir, Douglas Fir, Ponderosa Pine	kelp, salt ponds, tidepools
Subalpine Conifer (SCN)	Engelmann Spruce, Subalpine Fir, Mountain Hemlock	kelp, salt ponds, sand dunes, tidepools
Valley-Foothill Riparian (VRI)	Cottonwood, Sycamore, Valley Oak	kelp; trees, fir
Valley Oak Woodland (VOW)	Sycamore, Black Walnut, Foothill Pine	kelp; sand dunes; tidepools; trees, fir
White Fir (WFR)	Live Oak, Jeffrey Pine, Sugar Pine	kelp, salt ponds, tidepools
Shrub-Dominated Habitats (12 types)		
Alkali Desert Scrub (ASC)	Saltbush, Sagebrush, Creasotebush	kelp, tidepools
Alpine Dwarf-Shrub (ADS)	Creambush Oceanspray, Greene Goldenweed, Mountain White Heather	kelp, tidepools

CWHR Habitat	Dominant Species or Dominant Associates	Elements Assumed Absent (CWHR users do not have to delete these elements during queries.)
Bitterbrush (BBR)	Big Sagebrush, Rabbitbrush, Mormon Tea	kelp, tidepools
Chamise-Redshank Chaparral (CRC)	Toyon, Ceanothus, Sugar Sumac	kelp, tidepools
Coastal Scrub (CSC)	Lupine, Coyotebush, Sagebrush	none
Desert Scrub (DSC)	Creasotebush, Catclaw Acacia, Desert Agave	kelp, tidepools
Desert Succulent Shrub (DSS)	Octillo, Mojave Yucca, Desert Agave	acorns; kelp; tidepools; trees, fir; trees, pine
Desert Wash (DSW)	Paloverde, Desert Ironwood, Mesquite	kelp; log, large rotten; log, large sound; log, large hollow; snag, large rotten; snag, large sound; tidepools; trees, fir
Low Sage (LSG)	Rabbitbrush, Bitterbrush, Winter Fat	kelp, tidepools
Mixed Chaparral (MCH)	Oaks, Ceanothus, Manzanita	kelp, tidepools
Montane Chaparral (MCP)	Ceanothus, Manzanita, Bitter Cherry	kelp, salt ponds, sand dunes, tidepools
Sagebrush (SGB)	Rabbitbrush, Sagebrush, Gooseberry	kelp, tidepools
Herbaceous-Dominated Habitats (6 types)		
Annual Grassland (AGS)	Wild Oats, Soft Chess, Brome	none
Freshwater Emergent Wetland (FEW)	Big Leaf Sedge, Bulrush, Redroot Nut Grass	none
Saline Emergent Wetland (SEW)	Cordgrass, Pickleweed, Bulrush	trees, fir

CWHR Habitat	Dominant Species or Dominant Associates	Elements Assumed Absent (CWHR users do not have to delete these elements during queries.)
Pasture (PAS)	Bermuda Grass, Ryegrass, Tall Fescue	none
Perennial Grassland (PGS)	California Oatgrass, Hairgrass, Sweet Vernalgrass	none
Wet Meadow (WTM)	Thingrass, Sedge, Spikerush	kelp, tidepools
Agricultural and Developed Habitats (9 types)		
Dryland Grain Crops (DGR)	Cereal Rye, Barley, Wheat	none
Deciduous Orchard (DOR)	Almonds, Walnuts, Peaches	none
Evergreen Orchard (EOR)	Oranges, Avocados, Lemons	none
Irrigated Hayfield (IRH)	Alfalfa, Hay	none
Irrigated Grain and Seed Crops (IGR)	Corn, Dry Beans, Safflower	none
Irrigated Row and Field Crops (IRF)	Tomatoes, Cotton, Lettuce	none
Rice (RIC)	Rice	none
Urban (URB)	Grass Lawns, Trees, Hedges	none
Vineyard (VIN)	Grapes, Kiwi Fruit, Boysenberries	none
Aquatic Habitats (4 types)		
Estuarine (EST)	Plankton, Algae, Eel Grass	none
Lacustrine (LAC)	Plankton, Duckweed, Water Willies	none

CWHR Habitat	Dominant Species or Dominant Associates	Elements Assumed Absent (CWHR users do not have to delete these elements during queries.)
Marine (MAR)	Plankton, Algae, Kelp	Stage 1 (pelagic) – acorns, amphibians, aquatics, bogs, brush pile, buildings, burrow, campground, cave, cliff, cones, duff, dump, eggs, fences, fern, flowers, forbs, fruits, fungi, grain, graminoids and grass interfaces, insects, lakes, layers, lichens, lithic, litter, mammals – medium and small, moss, mud flats, nectar, nest box, nest island, nuts, pack stations, ponds, riparian, rivers, rock, roots, salt ponds, sand dune, sap, seeds, shrubs and shrub interfaces, soils, springs, steep slopes, streams, stumps, talus, transmission lines, tree leaves, trees and tree interfaces, vernal pools, water – fast, slow and man created, water/agriculture
		Stages 2-4 (subtidal, intertidal, shore, respectively) – none
Riverine (RIV)	Water Moss, Algae, Duckweed	none
Non-Vegetated Habitats (1 type)		
Barren (BAR)	Rock, Pavement, Sand	none

STANDARD DEFINITIONS FOR SPECIES DATABASE MODEL

Model raters should use these definitions when completing or updating the Template for Species Database Model that follows.

TAXONOMY:

Common Name:
Scientific Name:
Class:
Family:
Order:

Use taxonomy and nomenclature from the most recent version of the CWHR complete species list.

IDENTIFICATION:

CWHR ID Code: 4-digit alpha-numeric code assigned to the species.

AOU#: ID from most recently published list of the American Ornithologists Union; birds only.

TNC ID Code: ID from The Nature Conservancy; natives only.

If no code exists, leave blank.

LIFE HISTORY ATTRIBUTES:

Daily Activity: Indicates the time periods when the species is active (not just most active) foraging, traveling, etc. Animals that are most active at dawn and dusk but are also active throughout the day and night (e.g., deer) are circadian, not crepuscular.

Circadian (C): Active during all parts of 24-hour period.

Diurnal (D): Active only during daylight.

Nocturnal (N): Active only during darkness.

Crepuscular (P): Active only at dawn and dusk

Seasonal Activity: Hibernate and aestivate are used in the broadest sense of the terms (i.e., include facultative hibernators such as raccoons and bears).

Yearlong (Y):	Active during all months.
Hibernate (H):	Inactive during winter.
Aestivate (A):	Inactive during summer.

Migration: This identifies random or periodic movements to different habitats.

Unpredictable movements (U):	Individuals perform irregular, unpredictable movements.
	Regular seasonal migrations generally limited to less than 100 miles travel distance; generally implies within-state migrations as the norm.
	Regular seasonal migrations generally longer than 100 miles travel distance; generally implies interstate migrations as the norm.
Non-migratory (-):	Do not engage in predictable movements away from normal home range during the year. Dispersal of juveniles is not considered a migration.

SPECIAL STATUS:

All of the following are tracked:

- Federal Endangered (California Natural Diversity Database or CNDDB.)
- Federal Threatened (CNDDB)
- California Endangered (CNDDB)
- California Threatened (CNDDB)
- California Fully-Protected (Fish and Game Code 3511 birds; 4700 mammals; 5050 reptiles and amphibians)
- California Protected (Title 14 CCR 41 amphibians; 42 reptiles; Fish and Game Code 4500 marine mammals)

California Species of Special Concern (CNDDB)
Federally-Proposed Endangered (CNDDB)
Federally-Proposed Threatened (CNDDB)
Federal Candidate (CNDDB)
BLM Sensitive (BLM designation)
USFS Sensitive (USFS designation)
CDF Sensitive (California Board of Forestry designation)
Harvest (Fish and Game Code 3500 birds; 3950 mammals)

Model raters may leave this blank for CWHR staff to complete.

SUBSPECIES: **STATUS:**

Note any special status subspecies, using the categories listed above.
Model raters may leave this blank for CWHR staff to complete.

LOCATION and SEASON IN LOCATION:

Model raters should at minimum delineate seasonal distributions on a 1:1,000,000 scale map using the guidelines for map review contained in this document. CWHR staff will digitize this into a GIS coverage to derive the appropriate location predictions and season-in-location predictions for the database models.

The following location categories are tracked:

Counties
USDA Ecological Subregions of the United States (1994, last updated 2010)
California Interagency Watershed Map of 1999 (updated May 2004, Calwater 2.2.1)
USFS National Forests

Season in location is defined as follows:

Yearlong (present all seasons)
Summer Range (summer only; spring-summer, summer-fall, spring-fall)
Winter Range (winter only, fall-winter, winter-spring, fall-spring)
Migration-Only Range (fall only, spring only, fall and spring; this is not mapped.)

Spring: March 1 to May 31
Summer: June 1 to July 31

Fall: August 1 to November 30
Winter: December 1 to February 28

HABITAT SUITABILITY and SEASON IN HABITAT:

Habitats, size/age classes, and canopy closure classes are fully-described in "A Guide to Wildlife Habitats of California" (Mayer and Laudenslayer, 1988) and a more recent supplement describing agricultural types added since publication. There are a total of 59 habitats in the CWHR System with up to 17 combinations of size/age class and canopy closure class per habitat.

Habitat suitability ratings are defined for each of three life requisites – reproduction, cover and feeding – for each size/age and canopy closure class in each habitat. Ratings are defined as follows:

High (H):	Meet the life history need in support of a relatively high population density (as implied by probability of occurrence).
Medium (M):	Meet the life history need in support of a relatively moderate population density (as implied by probability of occurrence).
Low(N):	Meet the life history need in support of a relatively low population density (as implied by probability of occurrence).
Not Used (–):	The species is not expected to occur in the habitat.

Note that high, moderate and low densities are relative to the individual species being evaluated.. Some species occur at low population densities and are rare even in optimum habitats. Conversely, some species can occur at high population densities in poor quality habitats, if those habitats are functioning as "sinks" or overflow areas adjacent to high quality habitats.

Season in Habitat is defined using the following categories:

Yearlong (present all seasons)
Summer Range (summer only; spring-summer, summer-fall, spring-fall)
Winter Range (winter only, fall-winter, winter-spring, fall-spring)
Migration-Only Range (fall only, spring only, fall and spring)

Spring: March 1 to May 31
Summer: June 1 to July 31
Fall: August 1 to November 30
Winter: December 1 to February 28

SPECIFIC HABITAT ELEMENTS:

Element categories and definitions are found in "A Guide to Wildlife Habitats of California" (Mayer and Laudenslayer, 1988). A single element has been added since publication and is defined below. A few elements and element categories have been renamed for clarity. There are a total of 124 elements in the CWHR System.

Mine: An excavated underground chamber that is open to the surface where minerals and ore are extracted.

Element ratings are defined for each of three life requisites – reproduction, cover and feeding. Note that a feeding rating may be applied to a non-diet element if it is an essential substrate for a diet item (e.g. mudflats for invertebrates eaten by certain shorebirds or trees with loose bark for insects gleaned by creepers). Model raters should remember to include all elements identified in the species life history account. Ratings are defined as follows:

Essential (E):	The element must be present within the home range of the species if the species is to be present. By definition, no human-made elements should fit this category. If another element is equally valuable in meeting a life requisite, the rating given to an element should be "Secondarily Essential".
Secondarily Essential (S):	An element which must be present within the home range of the species unless it is compensated by the presence of other secondarily essential elements. By definition, every element with this rating should have at least one "companion" element which also has an "S" rating. No species should be left with only one "S"- rated element.
Preferred (P):	The element is used by the species to a greater degree than its abundance, and the presence of the element enhances habitat value for the species, but the element is not essential for species presence. Elements only incidentally used by a species should be left blank.
Not Rated (–):	The species may use the element, but the presence of the element does not enhance habitat value for the species.

TEMPLATE FOR SPECIES DATABASE MODEL

TAXONOMY:

Common Name:
Scientific Name:
Class:
Family:
Order:

IDENTIFICATION:

CWHR ID Code:

AOU#:

TNC ID Code:

LIFE HISTORY ATTRIBUTES:

Daily Activity:

Seasonal Activity:

Migration:

SPECIAL STATUS:

Model raters may leave this blank for CWHR staff to complete.

SUBSPECIES: **STATUS:**

Model raters may leave this blank for CWHR staff to complete.

LOCATION and SEASON IN LOCATION:

Model raters should at minimum delineate seasonal distributions on a 1:1,000,000 scale map using the guidelines for map review contained in this document. CWHR staff will digitize this into a GIS coverage to derive the appropriate location predictions and season-in-location predictions for the database models.

HABITAT SUITABILITY and SEASON IN HABITAT:

Habitat Type	Season In Habitat	Size/Age Class	Canopy Class	Importance to... R	C	F

Attach additional sheets as necessary.

SPECIFIC HABITAT ELEMENTS:

Vegetative Diet Elements	R	C	F
Fungi			
Lichens			
Moss			
Kelp			
Algae			
Graminoids			
Forbs			
Shrubs			
Tree Leaves			
Sap			
Roots			
Seeds			
Acorns			
Grain			
Berries			
Fruits			
Nuts			
Cones			
Flowers			
Nectar			

Animal Diet Elements	R	C	F
Invertebrates			
Insects, Terrestrial			
Insects, Flying			
Aquatic Invertebrates			
Fish			
Amphibians			
Reptiles			
Birds, Small			
Birds, Medium			
Birds. Large			
Mammals, Small			
Mammals, Medium			
Mammals, Large			
Carrion			
Eggs			

Vegetative Cover Elements	R	C	F
Tree Layer			
Shrub Layer			
Herbaceous Layer			
Trees, Hardwood			
Trees, Pine			
Trees, Fir			
Trees, Live With Broken Top			
Trees With Loose Bark			
Trees With Cavities			
Riparian Inclusion			
Aquatics, Submerged			
Aquatics, Emergent			

Dead or Decadent Vegetation Elements	R	C	F
Snag, Small Sound			
Snag, Small Rotten			
Snag, Medium Sound			
Snag, Medium Rotten			
Snag, Large Sound			
Snag, Large Rotten			
Stump, Sound			
Stump, Rotten			

Duff			
Litter			
Slash, Small			
Slash, Large Sound			
Slash, Large Rotten			
Slash, Large Hollow			
Log, Medium Sound			
Log, Medium Rotten			
Log, Medium Hollow			
Log, Large Sound			
Log, Large Rotten			
Log, Large Hollow			
Habitat Edge Elements	**R**	**C**	**F**
Tree/Shrub			
Tree/Grass			
Tree/Water			
Tree/Agriculture			
Shrub/Grass			
Shrub/Water			
Shrub/Agriculture			
Grass/Agriculture			
Water/Agriculture			
Physical Elements	**R**	**C**	**F**
Soil, Friable			
Soil, Organic			
Soil, Gravely			
Soil, Sandy			
Soil, Aerated			
Soil, Saline			
Barren			

Bank			
Sand Dune			
Burrow			
Cave			
Cliff			
Lithic			
Rock			
Talus			
Steep Slope			
Aquatic Elements	**R**	**C**	**F**
Water			
Vernal Pools			
Ponds			
Lakes			
Streams, Intermittent			
Streams, Permanent			
Rivers			
Mud Flats			
Springs			
Mineral Springs			
Bogs			
Hot Springs			
Tidepools			
Water, Slow			
Water, Fast			
Human Elements	**R**	**C**	**F**
Nest Island			
Nest Box			
Nest Platform			

Transmission Lines			
Buildings			
Fences			
Brush Pile			
Campgrounds			
Pack Station			
Water (Artificial Catchment)			
Dump			
Wharf			
Jetty			
Salt Ponds			
Mine			

SUMMARY OF INFORMATION IN MAJOR DATA TABLES

The data for each species database model is stored in five major data tables which link on a common field – the CWHR species id code – during queries of the system software. Information on habitats is stored in three major data tables. The tables are summarized below. Data dictionaries for all of these tables follow.

DATABASE TABLE	INFORMATION
SPECIES.DBF	CWHR id code, other id codes, taxonomy, legal status
SUBS.DBF	CWHR id code, subspecific name, legal status
LOCATION.DBF	CWHR id code, season in location by location category (e.g. county)
HABITAT.DBF	CWHR id code; habitat suitability ratings for reproduction, feeding and cover by habitat and stage; season in habitat
ELEMENT.DBF	CWHR id code; element suitability ratings for reproduction, feeding and cover for each element by element category (e.g. diet elements)
COHABS.DBF	Habitats known to occur in each county
HABCROSS.DBF	Dominant plant species, descriptions and map images of each habitat
XWALK.DBF	Crosswalks of CWHR habitats with with several vegetation classification systems

DATA DICTIONARIES

SPECIES.DBF

ROW #	NAME	TYPE	W	DESCRIPTION
1	ID	Character	4	Unique four-character alpha-numeric code used to identify a species
2	NAME	Character	35	Common name
3	SCI_NAME	Character	40	Scientific name
4	FAMILY	Character	20	Family
5	ORDER	Character	20	Order
6	CLASS	Character	20	Class
7	TNC_ID	Character	12	The Nature Conservancy ID # (native species only)
8	AOU_ID	Character	6	American Ornithologists Union ID # (birds only)
9	MODEL	Logical	1	"X" indicates the species is modeled in CWHR; a way of sorting the modeled species from the complete terrestrial vertebrate species list for California
10	LHA	Memo	10	Species life history account in text format
11	DAILY_ACT	Character	1	Letter code used to indicate the daily activity pattern of the species: C=circadian, N=noctural, D=diurnal, P=crepuscular
12	SEAS_ACT	Character	1	Letter code used to indicate the seasonal activity pattern of the species: Y=yearlong, H=hibernate, A=aestivate
13	MIGRATION	Character	1	Letter code used to indicate the migration pattern of the species: U=unpredictable movements L=local migrator D=distant migrator blank=non-migratory
14	FED_END	Character	1	Row numbers 14-26: "X" indicates the species is listed with that status
15	FED_THR	Character	1	""
16	CAL_END	Character	1	""

17	CAL_THR	Character	1	“”
18	CAL_FU_PRO	Character	1	“”
19	CAL_PRO	Character	1	“”
20	CAL_SSC	Character	1	“”
21	FED_PR_END	Character	1	“”
22	FED_PR_THR	Character	1	“”
23	FED_CAN	Character	1	“”
24	BLM_SEN	Character	1	“”
25	FS_SEN	Character	1	“”
26	CDF_SEN	Character	1	“”
27	HARVEST	Character	1	“”
28	INTRO	Character	6	“NATIVE” or “INTROD” used to indicate whether a species is native or introduced to California; used when compiling the complete list of terrestrial vertebrates for the state
29	ELEMREQ	Character	1	***
30	QGROUP	Character	5	Used for identifying subgroups of species within a query when users have this option: AAN = Amphibians, Anurans APL = Amphibians, Plethodonts BPA = Birds, Passerines BRA = Birds, Raptors BSH = Birds, Shore Birds MBA = Mammals, Bats MCA = Mammals, Carnivores MMA = Mammals, Marine MRO = Mammals, Rodents RCO = Reptiles, Colubrids RIG = Reptiles, Iguanids RVI = Reptiles, Viperids
31	USER_C	Character	2	Used for identifying user selections during queries
32	TAXA_SORT	Numeric	5	Hierarchical numbering scheme for sorting taxonomically.

33	CHANGETYPE	Character	1	Code used to indicate the type of change made to a record: A=addition, D=deletion, M=modification
34	REASONCODE	Numeric	2	Code used to indicate the reason for a change made to a record (See DATA CHANGE DOCUMENTATION below.)
35	SOURCE	Character	10	Abbreviation for author or source document; source.dbf is lookup table
36	DATE	Date	8	Date on which an actual change was made to the database table
37	INITIAL	Character	2	First and last initials of the person who actually made the change

SUBS.DBF

ROW #	NAME	TYPE	W	DESCRIPTION
1	ID	Character	4	Unique four-character alpha-numeric code used to identify a species; may be duplicated in this table
2	SUBSP_NAME	Character	35	Subspecific scientific name
3	FED_END	Character	1	Row numbers 3-15: "X" indicates the subspecies is listed with that status
4	FED_THR	Character	1	""
5	CAL_END	Character	1	""
6	CAL_THR	Character	1	""
7	CAL_FU_PRO	Character	1	""
8	CAL_PRO	Character	1	""
9	CAL_SSC	Character	1	""
10	FED_PR_END	Character	1	""
11	FED_PR_THR	Character	1	""
12	FED_CAN	Character	1	""
13	BLM_SEN	Character	1	""
14	FS_SEN	Character	1	""

15	CDF_SEN	Character	1	“”
16	HARVEST	Character	1	“”
17	CHANGETYPE	Character	1	Code used to indicate the type of change made to a record: A=addition, D=deletion, M=modification
18	REASONCODE	Numeric	2	Code used to indicate the reason for a change made to a record (See DATA CHANGE DOCUMENTATION below.)
19	SOURCE	Character	10	Abbreviation for author or source document; source.dbf is lookup table
20	DATE	Date	8	Date on which an actual change was made to the database table
21	INITIAL	Character	2	First and last initials of the person who actually made the change

LOCATION.DBF

ROW #	NAME	TYPE	W	DESCRIPTION
1	ID	Character	4	Unique four-character alpha-numeric code used to identify a species.
2	CATEGORY	Character	2	Numeric code for location category; locnames.dbf is lookup table
3	LOC_CODE	Character	5	Five-character-maximum code for location. Where possible, location categories are encoded within this. DFG Regions end with a numeric digit, BLM Field Offices with FO, Hydrologic Regions with HR, National Forests with NF, Latilong Blocks with LL, USDA Ecoregions with ER, and CERES Bioregions with BR. The three character county codes are standard for DFG statewide GIS data sets. Locnames.dbf is look-up table.
4	LOC_SEAS	Character	2	Code for exclusive season-in-location category: Y=yearlong species, W=winter visitor, S=summer visitor or breeder, M=migrant

HABITAT.DBF

ROW #	NAME	TYPE	W	EXPLANATION
1	ID	Character	4	Unique four-character alpha-numeric code used to identify a species
2	HAB_CODE	Character	3	Unique three-character alpha code used to identify a habitat; habcodes.dbf is lookup table
3	HAB_SIZE	Character	1	Code for size class (tree and shrub habitats), height class (herb habitats) or zone (aquatic habitats)
4	HAB_CC	Character	1	Code for canopy closure class (tree, shrub, and herb habitats) or substrate (aquatic habitats)
5	HAB_SEASON	Character	2	Code for exclusive season-in-habitat category: Y=yearlong species, W=winter visitor, S=summer visitor or breeder, M=migrant.
6	REPRO	Character	1	Code for habitat suitability for reproduction: H=high, M=medium, L=low, blank=not suitable
7	COVER	Character	1	Code for habitat suitability for cover: H=high, M=medium, L=low, blank=not suitable
8	FEEDING	Character	1	Code for habitat suitability for feeding: H=high, M=medium, L=low, blank=not suitable
9	INDEX	Character	1	***
10	HAB_SEQ	Character	2	Used for ordering habitats 1-59.
11	CC_SEQ	Character	1	***
12	SELECT	Character	1	Field for selecting individual records.
13	CHANGETYPE	Character	1	Code used to indicate the type of change made to a record: A=addition, D=deletion, M=modification

14	HABSUITCODE	Numeric	2	Dave Sterner's (1995) codes for changes to habitat suitability ratings based on validation study findings (See DATA CHANGE DOCUMENTATION below.)
15	REASONCODE	Numeric	2	Code used to indicate the reason for a change made to a record (See DATA CHANGE DOCUMENTATION below.)
16	SOURCE	Character	10	Abbreviation for author or source document; source.dbf is lookup table
17	DATE	Date	8	Date on which an actual change was made to the database table
18	INITIAL	Character	2	First and last initials of the person who actually made the change
19	COMMENTS	Character	50	Comments by the person making the change

ELEMENT.DBF

ROW #	NAME	TYPE	W	EXPLANATION
1	ID	Character	4	Unique four-character alpha-numeric code used to identify a species
2	CATEGORY	Character	2	Numeric code for element category; elecodes.dbf is lookup table
3	ELEM_CODE	Character	10	Ten-character-maximum code for element; elecodes.dbf is lookup table
4	SELECT	Character	1	Field for selecting individual records
6	DECAY	Character	1	Code which applies to dead or decadent vegetation elements and certain vegetation residue elements: S=sound, R=rotten, H=hollow
7	REPRO	Character	1	Code for the importance level for reproduction: E=essential, S=secondarily essential, P=preferred
8	COVER	Character	1	Code for the importance level for cover: E=essential, S=secondarily essential, P=preferred

9	FEEDING	Character	1	Code for the importance level for feeding: E=essential, S=secondarily essential, P=preferred
10	CHANGETYPE	Character	1	Code used to indicate the type of change made to a record: A=addition, D=deletion, M=modification
11	REASONCODE	Numeric	2	Code used to indicate the reason for a change made to a record (See DATA CHANGE DOCUMENTATION below.)
12	SOURCE	Character	10	Abbreviation for author or source document; source.dbf is lookup table
13	DATE	Date	8	Date on which an actual change was made to the database table
14	INITIAL	Character	2	First and last initials of the person who actually made the change

COHABS.DBF

1	HAB_CODE	Character	3	Unique three-character alpha code used to identify a habitat
2	HAB_NAME	Character	32	Complete habitat name
3	LOC_NAME	Character	44	Complete location name
4	LOC_CODE	Character	10	Five-character-maximum code for location
5	CHANGETYPE	Character	1	Code used to indicate the type of change made to a record: A=addition, D=deletion, M=modification
6	REASONCODE	Numeric	2	Code used to indicate the reason for a change made to a record (See DATA CHANGE DOCUMENTATION below.)
7	SOURCE	Character	10	Abbreviation for author or source document; source.dbf is lookup table
8	DATE	Date	8	Date on which an actual change was made to the database table
9	INITIAL	Character	2	First and last initials of the person who actually made the change

HABCROSS.DBF

ROW #	NAME	TYPE	W	EXPLANATION
1	HAB_CODE	Character	3	Unique three-character letter code used to identify a habitat
2	HAB_NAME	Character	32	Complete habitat name
3	HAB_MAP	Binary	10	A map depicting the habitat's general distribution in California
4	HAB_TEXT	Memo	10	Complete description of the habitat in memo format
5	WHRSP_1	Character	24	Primary dominant species or associate
6	WHRSP_2	Character	24	Second-most dominant species or associate
7	WHRSP_3	Character	24	Third-most dominant species or associate
8	SERAL_TYPE	Numeric	2	Code for unique combination of seral stages (13 possibilities); habstage.dbf is look-up table
9	CHANGETYPE	Character	1	A single character letter code used to indicate the type of change made to a record. A=addition, D=deletion, M=modification.
10	REASONCODE	Numeric	2	Numeric code used to indicate the reason for a change made to a record (See DATA CHANGE DOCUMENTATION below.)
11	SOURCE	Character	10	Abbreviation for author or source document; source.dbf is lookup table
12	DATE	Date	8	Date on which an actual change was made to the database table, beginning with changes for Version 7.0. All changes for Version 6.0 were given a default date of 11/30/97.
13	INITIAL	Character	2	First and last initials of the person who actually made the changes

XWALK.DBF

ROW #	NAME	TYPE	W	EXPLANATION
1	HAB_CODE	Character	5	Unique three-character letter code used to identify a habitat
2	CROSS	Character	3	Unique code for vegetation crosswalk: CAL= CalVeg CHH= Cheatham and Haller HOL= Holland MCV= Manual of California Vegetation UNE= UNESCO
3	CROSS_TYPE	Character	70	Full name for equivalent vegetation type in the crosswalked scheme
4	CHANGETYPE	Character	1	Code used to indicate the type of change made to a record. A=addition, D=deletion, M=modification.
5	REASONCODE	Numeric	2	Code used to indicate the reason for a change made to a record (See DATA CHANGE DOCUMENTATION below.)
6	SOURCE	Character	10	Abbreviation for author or source document source.dbf is lookup table
7	DATE	Date	8	Date on which an actual change was made to the database table
8	INITIAL	Character	2	First and last initials of the person who actually made the change

DATA CHANGE DOCUMENTATION FOR CWHR

Documentation fields are included in all of the major data tables in CWHR. These fields include CHANGETYPE, REASONCODE, HABSUITCODE, SOURCE, DATE AND INITIAL. (See DATA DICTIONARIES above for descriptions.) The SOURCE field links with its own lookup table which fully cites the information source for a change. The REASONCODE and HABSUITCODE fields contain codes for what prompts a data change, independent of the information source. The codes found in these fields are described below. Following these descriptions is a form which users may submit for proposing changes to the data, designed to check that users are considering the same assumptions as model developers when suggesting corrections.

HABSUITCODE

This field is found in habitat.dbf and element.dbf and codes changes to habitat suitability ratings based on validation study findings.

01	The study found an omission error or recommended an increase in suitability for this habitat and stage.
02	Increase in habitat suitability was extrapolated to a related (similar) cover category from a finding within the same habitat and same or similar seral stage.
03	Increase in habitat suitability was extrapolated to a different seral stage from a finding within the same habitat and same or similar canopy cover.
04	Prior to this study, CWHR omitted this species from all stages of this habitat. Study authors found this species in at least one habitat stage and, because of the species' range extension into this habitat, presence in additional and possibly dissimilar stages and cover categories was inferred.
05	Ratings in this habitat were extrapolated to another habitat and assumed to provide the same level of suitability to one or more life requisites.
06	The study found a commission error or recommended reduction in suitability for this habitat and stage and the species was removed or suitability was lowered.
07	Decrease in habitat suitability extrapolated to a related (similar) canopy cover category from a finding within the same habitat and same or similar seral stage.
08	Decrease in habitat suitability extrapolated to a different habitat stage from a finding within the same habitat and same or similar canopy cover category.
09	Addition to or modification of suitability rating for seral stage 6 extrapolated from habitat category 5D. The stage 6 has been excluded even though the species has been included in the 4D and 5D categories. This does not appear to be consistent. The density and age categories are similar and, therefore, one would expect the species to be present.
10	Addition to or modification of this habitat stage based on review of general species literature and inconsistency with the model ratings in adjacent stages.

11	The CWHR habitat suitability rating does not appear to take into account special habitat elements which may be present.

REASONCODE

This field is found in all of the major data tables and codes general reasons for data changes.

31	Range map revision	Formal review of CWHR distribution map
33	Expert opinion/ Field observation	Informal field studies; direct communication to CWHR program staff
35	Literature review/ Published information	This is any public written information used to make a change. Changes to habitat suitability levels in habitat.dbf which are extrapolated from published information should also have a value in the habsuitcode field.
41	Taxa split or new species	Published taxonomic change to species.dbf or subs.dbf.
43	Taxa lump	Published taxonomic change to species.dbf or subs.dbf
45	Name change only	Published official name change; affects species.dbf and subs.dbf
47	Special status change	Published special status change; affects species.dbf and subs.dbf
51	New habitat crosswalk	Any change to CWHR crosswalk based on a new vegetation classification system; affects xwalk.dbf
61	New species model	Model addition directed by CWHR program staff; includes modifications and additions due to taxa splits
63	New category of information	Information added because something new is being tracked (eg. added element, new status category)
65	Changes made for consistency with model definitions	Affects mainly element.dbf and the definitions of “Essential”, “Secondarily Essential” and “Preferred”.
71	Changes in CWHR habitat classification	Two agricultural habitats were expanded into eight. Records for cropland and orchard/vineyard were dropped. Ratings were developed for rice and eucalyptus, the final two of the eight to receive ratings.

A Checklist for Proposing Changes to the California Wildlife Habitat Relationships System

Users are encouraged to propose changes to data in the CWHR system which will improve the reliability of the model predictions. Please complete the form below to propose corrections, additions or deletions to information in the CWHR database based upon the output of a query. Thank you for your input.

****

Name:_____Date:_____
Title:_____Agency/Company:_____
Suggested change:
_____
_____
_____
_____

****

Version of CWHR used: _____

Query parameters:

Habitats and stages_____
Habitat suitability levels_____
Elements excluded from query_____
Exclusion level for elements_____

Were habitat parameters field-verified?_____

Did you consider the following model assumptions?

____ Habitat suitability ratings for a species in a habitat are statewide rather than bioregional. Suitability of a given habitat for a given species may vary throughout the state, but only one overall statewide rating is assigned. This is likely to represent the average of a range of suitability values.

____ Habitats for species that require juxtaposition of two or more habitats are individually rated as if the other habitats are available in the proper mix.

____ Ratings are developed assuming all special habitat elements are present in adequate amounts if they are typical components of the habitat.

____ Habitats are rated assuming that adequate habitat amounts and patch size exist.

____ The model does not account for species interactions (e.g. competition, predation) within a habitat.

Did you consider the basic logic governing the query process? (This topic is covered in detail in the CWHR training course.)

____ Species presence/absence for location and habitat are calculated with "and" logic rather than made directly. For example, to determine if the Northern Goshawk is predicted to occur in Blue Oak Woodland habitat in El Dorado County, the program will search first for the species in the habitat and next for the species in the location. If the answer is "yes" to both questions, the species will be predicted to occur there. No prediction is made directly for that species in that habitat in that location.

____ There is no connection between the elements databases and the databases for habitat and locations. Excluding elements considered essential for a given life requisite will drop a species off a list regardless of its presence in a given habitat or location.

What is the source of the proposed change? Please attach documentation.

____ Expert opinion/Field observation. Observation should be documented with field notes including observer name, date, location, and CWHR habitat for suggested commission/omission errors. For proposed changes to habitat suitability levels, CWHR habitat, size and cover class should also be included.

____ Published information/Validation study. Copy of article or pertinent parts with full citation should be attached.

****

If you are proposing an original validation study, please consult with CWHR program staff in the course of designing the study. The following references may also be helpful:

For an example of a well-designed validation study, see Hejl, S.J. and Verner, J. (1988) Evaluating avian-habitat relationships in red fir forests of the Sierra Nevada. 1988 Transactions of the Western Section of the Wildlife Society 24: 121-134.

For a discussion on the problems associated with making changes based on validation study findings, see Sterner, D. (1995) Guidelines for making changes to the CWHR model. Unpublished report. California Department of Fish and Game.

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CWHR Program Use Only

Are changes necessary?_____yes _____no

Justification:_____
_____
_____

Initials_____ Date:_____

****

GIS Coverage of Species Distribution

Range Map Protocol: Creating New and Editing Existing Range Maps

Instructions for Expert Reviewers

California Wildlife Habitat Relationships Program
California Department of Fish and Wildlife

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March 2012

Purpose and Scope

Most of the species range maps created by the Department of Fish and Wildlife (Department) are maintained by the California Wildlife Habitat Relationships (CWHR) Program. However, a portion of these range maps are now outdated, having been created prior to widespread use of Geographic Information Systems (GIS). These older maps were often hand-drawn at scales coarser than the supporting data, and feature boundaries (e.g., coastline, Nevada border, mountain ranges, and valleys) that were inconsistently depicted, reducing the utility of the maps for spatial analysis. In addition, as a result of taxonomic revisions, new species are being defined that require entirely new range maps.

The purpose of the range mapping protocol outlined in this document is to create an accurate, replicable and standardized depiction of a species' range in California. **We define range as the maximum current geographic extent of the species in California and current as the last 20 years. Unlike distribution polygons (that capture only known occurrences), range polygons may include areas not currently occupied by a species and, conversely, may omit areas potentially used by a species.** We are seeking to minimize or eliminate omission error (missing part of a species' range) even if it means increasing commission error (mapping areas not actually occupied by a species).

The protocol outlined below has evolved in response to experience gained by the Department over the past several years. The approach is further based on the use of spatial distribution and occurrence data in a systematic and hierarchical manner to depict species range based on information from a variety of sources and scales (Hollander et al 1994). **The purpose of these instructions is to provide individuals reviewing or generating species range data with an understanding of the occurrence data and initial research behind the draft maps, offer detailed instructions for completion of the process, and promote consistency in range map review and creation.**

Range Mapping Protocol – Common Boundaries

The Department's approach to range mapping relies mainly on the use of standardized polygon boundaries derived from surrogate spatial data. This approach uses existing spatial (GIS) polygons, or portions of these polygons, to describe range boundaries. For most range map revisions, we are currently using the Ecological Subsection level polygons described by the USDA Forest Service as part of the Ecological Subregions of California mapping project (hereafter referred to as Ecoregions) as the primary boundary of choice. We selected this dataset because the polygons are based on both physical and ecological factors that strongly influence species distribution – including elevation, soils, climate, vegetation, geology, slope, and precipitation (Miles and Goudy, 1994). Using USDA Ecoregion boundaries as surrogate range polygon boundaries requires acceptance of the assumption that species distribution is a function of habitat use at varying scales. This technique is appropriate for species that respond to habitat at scales matching the Ecoregions, but may misrepresent our definition of range for others. For some species, it may be appropriate to use a different surrogate boundary dataset (see below). Ecoregion subsections are the preferred mapping units and are to be used as the base range polygons as often as is appropriate for a species.

Range Mapping Protocol – Source Data

As well as the Ecoregion subsection boundaries, several standard layers are included on the maps sent to expert reviewers. Among these are: an underlying relief to aid in the visualization of mountain ranges and peaks, major roads and highways, major water features, and county line boundaries. The current CWHR range map (full species only) is also included as another layer of information. **Other data layers can be added to the map upon request, such as elevation lines, rivers, watersheds or urban boundaries.** There are many occurrence datasets that are available for use as source information in the delineation of species range. All applicable data sources are included on the map, and reviewers are encouraged to submit any additional data sets they possess. In some cases photocopied information, such as County Bird Atlas data, is sent separately or attached as a pdf or word document. The following list represents some of the most commonly used data sets:

California Natural Diversity Database (CNDDB) data – Statewide database of observation records for species with special status. Records vary in the certainty of the observation location and come from observers, museum records, or technical reports.

Museum Records – Geographic coordinates from collection sites of specimens in the Museum of Vertebrate Zoology (MVZ) at U.C. Berkeley, and other natural history museums such as California Academy of Sciences and the L.A. County Museum. Also included are digitally networked online collections such as HerpNET.

Biogeographic Information and Observation System (BIOS) data – Includes public occurrence data sets, survey data, critical habitat and species ranges, among other data sets, provided by California Department of Fish and Wildlife, U.S. Forest Service, U.S. Fish and Wildlife Service, Bureau of Land Management, and other agencies and organizations such as The Nature Conservancy.

Breeding Bird Survey (BBS) and Christmas Bird Count (CBC) data – Originally designed as a monitoring tool for bird populations, these data also provide a long-term record of occurrence at the specified route or circle location.

Reserve Surveys – Database of known occurrences for some species on U.C. Natural Reserves, CDFW Ecological Reserves, and other public or non-governmental organization (NGO) lands.

Partners in Flight (CPIF) and Important Bird Areas (IBA) – CPIF data, maintained by the Point Reyes Bird Observatory, represents sites that monitor bird breeding activity across the state. Important Bird Areas are those localities identified by Audubon and its partners as areas containing significant populations of sensitive bird species.

Mesocarnivore Photo Station data – Database established to record furbearer and raptor presence through photographs taken at camera stations, although several species outside these categories were captured on camera as well.

It is up to you, the map reviewer, to decide whether or not a region of the state populated only with historic records (i.e. records more than 20 years old) is no longer part of a species' range or whether the species may still be presumed extant (e.g. lack of current data indicates only a lack of recent surveys). Your name will appear on the final published range map as the expert reviewer.

Range Mapping Protocol – Delineation

1) Begin by selecting standard USDA Ecoregion Subsection polygons wherever possible to delineate the range. Please indicate which Ecoregion subsections should be included in their entirety. You should also note the season of occurrence for the species in that polygon. Mutually exclusive season designations in CWHR include summer, winter, or yearlong (S, W, Y).

2) Indicate any modifications to subsection boundaries necessary to delineate range. If your judgment indicates that a subsection polygon needs to be modified in order to accurately capture species range, indicate both the season of occurrence and the modification. Modifications should follow or be based on a geographic or other natural feature, such as a valley or mountain range, as often as possible. For example, a river that bisects an Ecoregion subsection could be used to indicate the southern boundary of species range in that subsection, or an elevation line could be indicated as the maximum extent of a species range within a subsection (i.e. below 5000 feet in 341Dj, the White Mountains). Other features can be used to guide modifications to Ecoregion subsections such as habitat or vegetation type, highways, county lines or buffered occurrence data points. **The Department maintains a comprehensive library of geographic, hydrologic, biological, and cultural spatial data layers that can be used to modify Ecoregion subsection polygons. You should avoid the use of hand-drawn polygons that are intended to represent features when a surrogate digital coverage exists.** Hand-drawn modifications should be used only when no other alternative is available. Modifications should be indicated as specifically as possible to allow staff to accurately represent the modification in the final range.

3) Indicate any natural or other topographic features as boundaries to delineate range. If your professional judgment indicates that an Ecoregion subsection boundary, even with modification, is not appropriate to accurately capture species range, another feature can be selected. You are responsible for determining the appropriate type of feature to be used. **The Department maintains a comprehensive library of geographic, hydrologic, biological, and cultural spatial data layers which can be used to indicate species range. Again, you should avoid the use of hand-drawn polygons to represent features when a surrogate digital coverage exists.** Frequently used natural features include watersheds (such as USGS Hydrologic Units), lakes, rivers, mountain ranges, and valleys. Landcover type, such as vegetation or urban areas, and geopolitical boundaries like state or federal parks, forests and reserves, can also be used. Buffers around natural or geopolitical features can also be used.

4) If suitable natural or topographic features do not exist that can be used to depict species range, buffered occurrence data points can be used. The appropriate size of the buffer is up to you, but 5 miles is generally used for mammal and bird species, and 2 miles is generally used for amphibians and reptiles. However, it is important to remember that maps are intending to depict species range, not distribution, and may therefore include some areas that are not currently being used by the species in an effort to minimize omission error in the model. **Hand-drawn range boundaries are the least desirable and should be used only as a last resort.**

References

Garrison, B.A. 1997. Protocols for reviewing species distribution maps. *Pages 37-39 in* California Department of Fish and Game and California Interagency Wildlife Task Group. 2000. Standards and Guidelines for CWHR Species Models. Technical Report #31. California Wildlife Habitat Relationships System. Wildlife and Habitat Data Analysis Branch. California Department of Fish and Game. Sacramento, CA.

Hollander, A.D., F.W. Davis, and D.M. Stoms. 1994. Hierarchical representations of species distributions using maps, images, and sighting data. *Pages 71-88 in*: R.I. Miller, ed. Mapping the diversity of nature. Chapman and Hall Publ., New York, NY.

Miles, S.R., and C.B. Goudy. 1994. Ecological subregions of California: section and subsection descriptions. USDA, Forest Service. Sacramento, CA. Rpt. No. R5-EM-TP 005.

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White. 1990. California's wildlife: Volume III, Mammals. Department of Fish and Game, Sacramento, CA.