

# APPENDIX B

## Habitat Suitability Index

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### INTRODUCTION

Preparation of the Stephens' kangaroo rat Habitat Management Plan (SKR HMP) included identifying long-term live-trapping grids and habitat management units. As part of the database development to facilitate this process, a simple Habitat Suitability Index (HSI) model was created. The HSI combines habitat suitability factors that should be helpful in predicting occupied habitat or creating occupiable areas with appropriate management. The HSI model is not meant to be definitive of suitable habitat, but rather provides a tool for the relative ranking of areas within the Lake Mathews and Steele Peak Reserves for the purpose of establishing trapping grids and management units that capture the environmental gradient within the Reserves used by the SKR.

### HABITAT SUITABILITY FACTORS

Based on well established habitat affinities for the SKR, three main habitat suitability factors were used in the HSI model:

1. Vegetation communities
2. Soils
3. Slope

As described *Section 2.6* of the SKR HMP, the SKR is found almost exclusively in open grasslands or sparse shrublands with vegetative cover of less than 50 percent during the summer (e.g., Bleich 1973; Bleich and Schwartz 1974; Grinnell 1933; Lackey 1967; O'Farrell 1990; Thomas 1973). Generally, the SKR prefers habitats dominated by annual native and non-native forbs (e.g., *Erodium* spp.) that disarticulate after the growing season and leave substantial areas of bare ground for much of the year. The SKR and all kangaroo rats (genus *Dipodomys*) are bipedal and adapted to moving quickly through sparse habitats that are characteristic of deserts and semi-deserts. Dense cover of grasses (native and non-native) and shrubs inhibits the ability of kangaroo rats to locomote metabolically efficiently (i.e., bipedally vs. quadrupedally); dense covers and/or shrub habitats are more suitable for quadrupeds. Also, in dense grasslands, thick thatch may build up over time, further precluding kangaroo rats even in the non-growing season.

Soil type also is an important habitat factor for the SKR (O'Farrell and Uptain 1989; Price and Endo 1989). As a fossorial (burrowing) animal, the SKR typically is found in sandy and sandy loam soils with a low clay or gravel content, although there are exceptions where they can utilize the already excavated burrows of Botta's pocket gopher (*Thomomys bottae*) and California ground squirrel (*Spermophilus beecheyi*). Also, Price and Endo (1989) suggest that sandy soils may be necessary for sand bathing, which keeps oils from building up in their fur. Sand bathing

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also may serve an important social communication function in kangaroo rats (Randall 1993). As noted by others (e.g., Brown and Harney 1993), kangaroo rats tend to avoid rocky soils. SKRs may be found on rocky soils, but population densities generally are much lower and probably are limited by soil conditions that inhibit burrowing. *Section 4.3.1.2* of the SKR HMP notes that while the SKR occurs throughout the Lake Mathews Reserve in less suitable soils (e.g., Lodo and Temescal rocky loams, which account for the majority of the soils in the Reserve), the population densities that can be achieved even in highly productive years in the less suitable soils probably is limited. For this reason, management of populations on less suitable soils is a lower management priority. On the other hand, such areas probably do not require as much management because the shallow, rocky soils are less vulnerable to invasions by annual grasses. Temescal rocky loam, which is the dominant soil in the Lake Mathews Reserve (1,947 acres), particularly in the southern parcels, developed predominantly from latite-porphyry or gabbro and has low natural fertility. Minnich and Dezzani (1998) suggest that coastal sage scrub on gabbro basalts is less susceptible to invasion by annual grasses. Lodo rocky loam, which at 1,066 acres, is the second most common soil in the Lake Mathews Reserve has very low natural fertility. The Lodo series is also the dominant soil type on the Steele Peak Reserve.

Slope also is a factor in SKR occupation; the SKR tends to use flatter slopes (*i.e.*, < 30 percent), but, as with less suitable soils, may be found on steeper slopes in low or trace densities (*i.e.*, < 5 individual per hectare). Furthermore, the SKR may use steeper slopes for foraging, but not for burrows (Behrends, pers. obs.). In general, the highest abundances of SKRs occur on gentle slopes less than 15 percent, and for the purposes of rating habitat quality, slopes < 15 percent are rated higher.

#### CREATION OF HSI MODEL

The three factors discussed above – soils, slope, and vegetation communities - occurring in the Lake Mathews and Steele Peak reserves were ranked for their suitability as SKR habitat in the HSI model on the following scale of 1 through 4:

1	=	Very Low Suitability
2	=	Low Suitability
3	=	Medium Suitability
4	=	High Suitability

Soils and slope are based the existing soils maps for the Lake Mathews and Steele Peak reserves show in *Figures 7* and *9*, respectively of the SKR HMP (source: USDA NRCS SSURGO). Soils series are described in terms of soils type (e.g., loam, clay, etc.) and slope (e.g., 25-50 percent slopes). Assigning the soils and slopes to the different categories is based on O'Farrell and

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Uptain (1989), Price and Endo (1989) and the field experience of one of the authors of the SKR HMP (Phil Behrends) based on many years of field experience with the SKR. The CNPS (2005) vegetation community map was used for ranking vegetation communities, which includes both the vegetation alliance/community attribute, but also a density attribute.

Soils and vegetation communities ranked as “Very Low Suitability” almost always do not support the SKR, although there are rare exceptions. Soils and vegetation communities ranked as “Low Suitability” typically do not support the SKR, but occasionally the species may occur, but usually only in trace densities (< 1 SKR/hectare). Soils and vegetation communities ranked as “Medium Suitability” more commonly support the SKR, but occupancy and populations densities may vary from season-to-season or year-to-year in relation to stochastic events (e.g., precipitation cycles, vegetation succession, wildfire, and other disturbances) and/or demographic factors. Soils and vegetation communities ranked as “High Suitability” typically support the SKR on the most consistent basis and at the highest population densities. Absence of the SKR from these areas only would be expected where local populations have been extirpated due to some other environmental pressure; e.g., a small isolated habitat patch subject to high predation levels, or high precipitation and increased vegetation cover density has displaced animals.

As described above, the SKR typically uses friable soils on relatively level terrain; i.e., sandy and sandy loam soils with little clay and gravel content on slopes less than 30 percent (although exceptions to both criteria do occur). *Table 1* shows the Habitat Suitability rankings for soils. Clays and Gullied Land were assigned Very Low Suitability. Generally rocky or cobbly soils and/or soils on steeper, eroded slopes (> 25 percent) and Terrace Escarpments (typically 30-70 percent slopes) were assigned Low Suitability. Loamy soils and sandy loam soils on somewhat steep slopes (e.g., 15-35 percent) were assigned Medium Suitability. Sandy soils and sandy loams on gentle slopes (< 15 percent) were assigned High Suitability.

**TABLE 1**  
**Habitat Suitability Rankings of Soils Occurring**  
**in the Lake Mathews and Steele Peak Reserves**

Soil Code	Soil Series <sup>1</sup>	Habitat Suitability Rank
BfD	Bosanko clay, 8 to 15 percent slopes	1
BuD2	Buren fine sandy loam, 8 to 15 percent slopes, eroded	4
BxC2	Buren loam, deep, 2 to 8 percent slopes, eroded	3
CaC2	Cajalco fine sandy loam, 2 to 8 percent slopes, eroded	4
CaD2	Cajalco fine sandy loam, 8 to 15 percent slopes, eroded	4
CaF2	Cajalco fine sandy loam, 15 to 35 percent slopes, eroded	3

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**TABLE 1  
Habitat Suitability Rankings of Soils Occurring  
in the Lake Mathews and Steele Peak Reserves**

Soil Code	Soil Series <sup>1</sup>	Habitat Suitability Rank
ChC	Cieneba sandy loam, 5 to 8 percent slopes	4
ChD2	Cieneba sandy loam, 8 to 15 percent slopes, eroded	4
CkF2	Cieneba rocky sandy loam, 15 to 50 percent slopes, eroded	2
EcC2	Escondido fine sandy loam, 2 to 8 percent slopes, eroded	4
EcD2	Escondido fine sandy loam, 8 to 15 percent slopes, eroded	4
EcE2	Escondido fine sandy loam, 15 to 25 percent slopes, eroded	3
EfF2	Escondido rocky fine sandy loam, 8 to 50 percent slopes, eroded	2
FaD2	Fallbrook sandy loam, 8 to 15 percent slopes, eroded	4
GzG	Gullied land	1
HcC	Hanford coarse sandy loam, 2 to 8 percent slopes	4
HuC2	Honcut loam, 2 to 8 percent slopes, eroded	3
LaC	Las Posas loam, 2 to 8 percent slopes	3
LcD2	Las Posas stony loam, 8 to 15 percent slopes, eroded	2
LoF2	Lodo gravelly loam, 15 to 50 percent slopes, eroded	3
LpF2	Lodo rocky loam, 25 to 50 percent slopes, eroded	2
MmC2	Monserate sandy loam, 5 to 8 percent slopes, eroded	4
MmE3	Monserate sandy loam, 15 to 25 percent slopes, severely eroded	3
PID	Placentia fine sandy loam, 5 to 15 percent slopes	4
PrD	Porterville cobbly clay, 2 to 15 percent slopes	1
SmE2	San Timoteo loam, 8 to 25 percent slopes, eroded	3
TaF2	Temescal loam, 15 to 50 percent slopes, eroded	2
TbF2	Temescal rocky loam, 15 to 50 percent slopes, eroded	2
TeG	Terrace escarpments	2
VsC	Vista coarse sandy loam, 2 to 8 percent slopes	4
VsD2	Vista coarse sandy loam, 8 to 15 percent slopes, eroded	4
YbC	Yokohl loam, 2 to 8 percent slopes	3
YbD2	Yokohl loam, 8 to 15 percent slopes, eroded	3
YkE2	Yokohl cobbly loam, 2 to 25 percent slopes, eroded	2
YrD2	Ysidora very fine sandy loam, 2 to 15 percent slopes, eroded	4
YsE2	Ysidora gravelly very fine sandy loam, 8 to 25 percent slopes, eroded	3

Source: USDA NRCS SSURGO

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Table 2 shows the Habitat Suitability rankings for vegetation communities. The Habitat Suitability ranking is based on a combination of the vegetation community type and the density rating for the particular mapping unit. The “N” under SKR Suitability indicates that the vegetation community typically does not support the SKR, such as riparian and sycamore and coast live oak woodland communities. Although the SKR is considered to be a grassland species, all shrubland communities were assigned “P” for potential habitat because where there are openings or disturbances within shrubland patches, or the community is sparsely distributed (such as after wildfire or extended drought), SKR occupation may occur, often in a dynamic fashion related to successional factors in the community (e.g., in relation to wildfire, grazing or other disturbances of vegetation, and precipitation cycles). For potential habitat, the HSI ranking was then related to the following density values assigned to the community by CNPS (2005):

1	=	Greater than 60%
2	=	40-60%
3	=	25-40%
4	=	10-25%
5	=	2-10%

As noted above the SKR typically occupies habitat with less than 50 percent vegetation cover, although it may be found in areas with more than 50 percent cover, especially grasslands and forblands during the spring growing season, but also in some shrublands (USFWS 1997). Typically coastal sage scrub communities are more likely to support SKR than chaparral communities because, in the absence of direct disturbance, they tend to be more open. Generally chaparral communities with densities of “1” or “2” were assigned Low Suitability and densities with “3” or higher were assigned Medium Suitability. Coastal sage scrub-chaparral communities with densities of “1” were assigned Low Suitability and densities of “2-5” were assigned Medium Suitability. Coastal sage scrub communities with densities of “1” were assigned Low Suitability, densities of “2-3” were assigned Medium Suitability, and densities of “4-5” were assigned High Suitability. Annual grassland communities were assigned High Suitability regardless of density because of seasonal and year-to-year variation in densities. Refinement of what grasslands are likely or unlikely to be highly suitable habitat for the SKR over the long-term would require more detailed field surveys to verify site conditions because some annual grassland areas remain too densely vegetated over the seasons and years to reliably support the SKR without active management.

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**TABLE 2  
Habitat Rankings of Vegetation Communities in Reserves**

Vegetation Community Alliance Mapping Unit Name <sup>1</sup>	Habitat Suitability Rank	SKR Suitability	Cover Density
Coast Live Oak – Sycamore Riparian	1	N	1
Coast Live Oak – Sycamore Riparian	2	N	2
California Juniper - Coastal Sage Scrub	3	P	4
California Juniper - Coastal Sage Scrub	3	P	5
Willow	1	N	1
Willow	2	N	2
Willow	2	N	3
Willow	2	N	4
Chamise - Coastal Sage Scrub Disturbance	2	P	1
Chamise - Coastal Sage Scrub Disturbance	3	P	2
Chamise - Coastal Sage Scrub Disturbance	3	P	3
Chamise - Coastal Sage Scrub Disturbance	3	P	4
Chamise - Coastal Sage Scrub Disturbance	3	P	5
Laurel Sumac - California Buckwheat – Black Sage - White Sage - California Sagebrush	3	P	4
Mexican Elderberry – Mulefat	2	N	4
Mexican Elderberry – Mulefat	2	N	5
California Sagebrush - California Buckwheat - Annual Grass-Herb	3	P	2
California Sagebrush - California Buckwheat - Annual Grass-Herb	3	P	3
California Sagebrush - California Buckwheat - Annual Grass-Herb	4	P	4
California Sagebrush - California Buckwheat - Annual Grass-Herb	4	P	5
Brittlebush - California Buckwheat	3	P	3
Brittlebush - California Buckwheat	4	P	4
Brittlebush - California Buckwheat	4	P	5
Coast Live Oak	2	N	2
Coast Live Oak / Annual Grass-Herb Association	2	N	3
Coast Live Oak / Annual Grass-Herb Association	2	N	5
California Juniper / Annual Grass-Herb Association	4	P	5
California Juniper - California Buckwheat - California Sagebrush Association	4	P	4
California Juniper - California Buckwheat - California Sagebrush Association	4	P	5
Mixed Tree and Shrub Willow Super Alliance	1	N	1
Red Willow	1	N	1
California Sycamore	1	N	1
California Sycamore	2	N	2
California Sycamore	2	N	3
California Sycamore	2	N	4
Sugar Bush Alliance	4	P	4
Chamise Pure Association	2	P	1
Chamise - California Buckwheat Association	2	P	2

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**TABLE 2  
Habitat Rankings of Vegetation Communities in Reserves**

Vegetation Community Alliance Mapping Unit Name <sup>1</sup>	Habitat Suitability Rank	SKR Suitability	Cover Density
Chamise - Hoaryleaf Ceanothus - Black Sage Association	2	P	1
Chamise - Hoaryleaf Ceanothus - Black Sage Association	2	P	2
Chamise - Hoaryleaf Ceanothus - Black Sage Association	2	P	3
Chamise - Hoaryleaf Ceanothus - Black Sage Association	2	P	3
Chamise - Hoaryleaf Ceanothus - Black Sage Association	3	P	4
Chamise - Hoaryleaf Ceanothus - Sugar Bush Association	2	P	1
Mulefat	2	P	3
Mulefat	2	P	4
California Sagebrush - California Buckwheat	3	P	2
California Sagebrush - California Buckwheat	3	P	3
California Buckwheat	4	P	4
California Buckwheat	4	P	5
Brittlebush Alliance	4	P	4
California Sagebrush - White Sage	3	P	2
Brittlebush - California Sagebrush Association	3	P	2
Brittlebush - California Sagebrush Association	3	P	3
Brittlebush - California Sagebrush Association	4	P	4
Brittlebush - California Sagebrush Association	4	P	5
California Buckwheat - Brittlebush Association	3	P	3
California Buckwheat - Brittlebush Association	4	P	4
California Buckwheat - Brittlebush Association	4	P	5
California Sagebrush - Laurel Sumac Association	3	P	2
California Sagebrush - Laurel Sumac Association	3	P	3
California Sagebrush - Laurel Sumac Association	4	P	4
California Annual Grassland	4	P	1
California Annual Grassland	4	P	2

<sup>1</sup> CNPS. 2005. Vegetation Alliances of Western Riverside County, California.

The Habitat Suitability rankings for the soils and vegetation communities were then summed to generate an HSI score for the vegetation/soils polygon combinations as follows:

Score	Ranking
2	Very Low Suitability
3-4	Low Suitability
5-6	Medium Suitability
7-8	High Suitability

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It is important to understand that the rankings provided in *Tables 1* and *2* are only general and are only intended to identify habitat management units and a potential set of trapping grids. Because the SKR is an opportunistic, colonizing species, it is possible, and even likely, that it occurs in areas ranked as having Very Low or Low Suitability, such as where SKR use ground squirrel or gopher burrows in clayey soils, on steeper slopes (especially in areas adjacent High Suitability areas), and in areas where the vegetation communities have been mapped as having a dense cover, but at any given time are suitable for the SKR due to changing field conditions due to disturbances such as wildfire, grazing, extended drought and mechanical clearing.

### RESULTS

The results of the HSI modeling for the Lake Mathews and Steele Peak Reserves are shown in *Figure A-1* and summarized in *Table 3*.

**TABLE 3  
Habitat Suitability Index Summary**

HSI Rank	Lake Mathews		Steele Peak	
	Acres	Percent	Acres	Percent
High	197.1	4%	51.8	62%
Medium	2932.0	64%	150.8	38%
Low	499.4	11%	1.1	<1%
Very Low	918.7	20%	0.0	0%
<b>Total</b>	<b>4,547.2</b>		<b>203.7</b>	

The large majority of both the Lake Mathews and Steele Peak Reserve is ranked as having Medium Suitability.

The southerly parcels of the Lake Mathews Reserve (LM6-11) are comprised of Medium or Low Suitability, with Low areas typically associated with riparian areas, steep ravines and chaparral vegetation. The SKR likely is distributed throughout these parcels, but primarily in more level terrain such as ridgelines, hilltops and saddles and along dirt roads. The northern parcels (LM1-5) support all rankings, with Medium and Very Low rankings accounting for the majority of the area. The Very Low ranking accounts for almost 919 acres, and reflects the CNPS mapping of the old citrus groves as agricultural land. With the clearing of these areas, the vegetation now is primarily annual grassland and the ranking probably should be at least Low or Medium, depending on soils and slopes. The SKR HMP treats some of these areas as having good

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management potential, although other areas such as unit LM1-J are dominated by Porterville cobbly clay soils, which are considered marginal for the SKR.

For the Steele Peak Reserve, much of the hillier terrain in the northern parcel and the western portion of the southern parcel are comprised on Medium Suitability, with the areas of grassland underlain by annual grassland on more gentle slopes is mapped as High Suitability. These mapped areas correspond well with the occupied habitat distribution, with Medium Suitability areas being mostly trace density and the High Suitability areas as low density.