U.S. Fish and Wildlife Service, Region 1

DRAFT

RECOVERY PLAN

FOR THE

STEPHEN'S KANGAROO RAT

APRIL, 1997

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island Territories under U.S. administration.

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List of Shortened Forms Used in This Document

Bureau of Land Management - - Bureau of Land Management, U.S. Department of Interior
Department of Fish and Game - - California Department of Fish and Game
State Parks - - California Department of Parks and Recreation
Endangered Species Act - - Endangered Species Act of 1973, as Amended
Habitat Conservation Plan - - Riverside County Habitat Conservation Agency's Stephens' Kangaroo Rat Habitat Conservation Plan
Marine Corps Base, Camp Pendleton - - U.S. Marine Corps Base, Camp Pendleton
Naval Weapons Center, Fallbrook - - U.S. Naval Weapons Center, Fallbrook Annex
Fish and Wildlife Service - - U.S. Fish and Wildlife Service, U.S. Department of Interior

DISCLAIMER

Recovery plans delineate actions that are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available, subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approvals of any individuals or agencies (involved in the plan formulation), other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director as approved. Approved recovery plans are subject to modification as directed by new findings, changes in species status, and the completion of recovery tasks.

Executive Summary

Current Species Status: The Stephens' kangaroo rat (*Dipodomys stephensi*) is a small nocturnal mammal within a family of rodents (Heteromyidae) more closely related to squirrels than mice or rats. The Stephens' kangaroo rat was listed as a threatened species by California Department of Fish and Game in 1971 due to extensive loss and fragmentation of habitat throughout Riverside and San Diego counties. The species was listed as endangered by the U.S. Fish and Wildlife Service in 1988. Populations of the Stephens' kangaroo rat occur in three geographically distinct regions of southern California. These regions are western Riverside County, western San Diego County, and central San Diego County. The Riverside County Habitat Conservation Agency has completed a Habitat Conservation Plan for the implementation of a reserve network within a portion of this species' range. In May of 1996, the Fish and Wildlife Service issued an incidental take permit for the Stephens' kangaroo rat to the Riverside County Habitat Conservation Agency under the Habitat Conservation Plan.

Habitat Requirements and Limiting Factors: The Stephens' kangaroo rat is native to open grasslands and sparse coastal sage scrub. Typical habitat consists of native and non-native annual herbs (e.g., gold fields (*Lasthenia* sp.) and filaree (*Erodium cicutarium*)), and native and non-native grasses (e.g., foxtail fescue (*Vulpea megalura*) and foxtail chess (Bromus rubens)). The Stephens' kangaroo rat is also found in sparse coastal sage scrub habitat (e.g., cover usually less than 30 percent) where perennial species such as encelia (*Encelia farinosa*), coastal sagebrush (*Artemisia californica*), and California buckwheat (*Eriogonum fasciculatum*), occur. Certain non-native grasses can exclude this species from otherwise suitable habitat (e.g., *Bromus diandrus*). The Stephens' kangaroo rat is found from approximately 55 to 1,250 meters (180 to 4,100 feet) above sea level and typically occurs on relatively flat or gently sloping ground.

Recovery Priority: 2C

Recovery Objective: Delisting.

Recovery Criteria: The minimum criteria for reclassification to threatened status are:

1) establishment of four reserves, which encompass at least 6,070 hectares (15,000 acres) of occupied habitat and are permanently protected, funded, and managed, and are located in western Riverside County (inside or outside the Habitat Conservation Plan planning area), and

2) establishment of one ecosystem based reserve in either western or central San Diego County that is permanently protected, funded, and managed.

The minimum criteria for delisting are the establishment of:

1) a minimum of five reserves in western Riverside County, of which one is ecosystem based, and that encompass at least 6,675 hectares (16,500 acres) of occupied habitat that is permanently protected, funded, and managed, and

2) two ecosystem based reserves in San Diego County. One reserve needs to be established in the Western Conservation Planning Area and one reserve needs to be established in the Central Conservation Planning Area. These reserves must be permanently protected, funded, and managed.

The acreage and reserve system requirements in Riverside and San Diego Counties are set to achieve a cushion of protection and redundancy against catastrophic events, capture the genetic diversity of the species, and ensure the maintenance of the species through the maintenance of its biological community in at least three ecosystem based reserves.

Actions Needed:

1) Establish reserves and implement management plans.

2) Establish environmental education programs.

3) Initiate research necessary to monitor and guide recovery efforts.

Total Estimated Cost of Recovery: The cost of recovery actions through 2001 is estimated to be $1.2 million plus additional costs that have yet to be determined, for establishing additional conservation units.

DRAFT

Recovery Plan

for the

STEPHENS' KANGAROO RAT

(Dipodomys stephensi)

Prepared by

Region 1
U.S. Fish and Wildlife Service
Portland, Oregon

Approved: XXXX
Regional Director, U.S. Fish and Wildlife Service

Date: _____

I. INTRODUCTION

The purpose of this recovery plan is to establish interim and long-term goals and objectives, describe site-specific management actions to achieve these goals, and establish a schedule and estimate the costs required to reclassify as threatened and ultimately delist the Stephens' kangaroo rat (*Dipodomys stephensi*). This recovery plan provides guidelines and recommendations to be used in developing and assessing conservation and management activities proposed for the species.

Brief Overview

The Stephens' kangaroo rat was listed as a threatened species under the California Endangered Species Act by the California Department of Fish and Game in 1971 in response to evidence of declines in the extent of habitat throughout its range in Riverside and San Diego counties in southern California. The species was listed as an endangered species on September 30, 1988, by the U.S. Fish and Wildlife Service (53 Federal Register 190) for reasons fully described below. The Stephens' kangaroo rat has a recovery priority of 2C indicating that it is a full species facing a high degree of threat but having a high potential for recovery if appropriately managed. The "C" indicates that recovery of this species is or may be in conflict with construction or other forms of economic activity.

Taxonomy and Description

The Stephens' kangaroo rat is 1 of 19 species of kangaroo rats (genus *Dipodomys*) that comprise a distinct group of rodents belonging to the family Heteromyidae. This family is related to squirrels rather than rats and mice, and thus belongs to the superfamily Sciuroidae. The family Heteromyidae occurs only in the New World, and the genus *Dipodomys* occurs only in the warmer, more arid portions of the North American continent (Grinnell 1922). All species in the genus *Dipodomys* are similar, even down to small details of external structure (Grinnell 1922). Characteristics common to all kangaroo rats include external cheek pouches, large hind legs, relatively small front legs, long tails, and large heads.

The Stephens' kangaroo rat is a medium-sized member of the family and was first described by Merriam (1907) as *Perodipus stephensi*. The genus was changed to *Dipodomys* by Grinnell (1921) who considered all kangaroo rat species to be members of this genus. The taxonomic status of Stephens' kangaroo rat has been questioned in the past (Hall and Kelson 1959). However, the works of Lackey (1967a) on cranial measurements, Best and Schnell (1974) on bacular variation (i.e., shape of bone found in the penis), and Stock (1974) on chromosome evolution have upheld Merriam's (1907) description of Stephens' kangaroo rat as a separate and distinct species. Lackey (1967a) concluded that the Bonsall relict kangaroo rat (*Dipodomys cascus*) described by Huey (1962) was synonymous with the Stephens' kangaroo rat.

The Stephens' kangaroo rat has a dusky cinnamon buff overfur, pure white underfur, and lateral white tail band. The tail is crested and bicolored. The average adult weight is approximately 70 grams (2 ounces) and total adult body-plus-tail length ranges between 23 and 30 centimeters (9 and 12 inches). The tail is 1.45 times the length of head and body. The length of the hind foot is between 3.8 and 4.3 centimeters (1.5 and 1.7 inches), and length of ear (from notch) is between 1.3 and 1.5 centimeters (0.5 and 0.6 inches) (Bleich 1977).

Paleontology and Origins

The fossil record of the family Heteromyidae is fragmentary. It appears that all living species of the genus *Dipodomys* have arisen since the early Pleistocene from an ancestral lineage that includes the genus *Prodipodomys* (Stock 1974). Specimens of a *Dipodomys* species similar to Stephens' kangaroo rat were reported from the Pleistocene deposits of Costeua Pit, Orange County (Bleich 1977). At least by early to middle Pleistocene, the presumed ancestors of the *Heermanni* complex penetrated the Colorado and Mojave deserts and later spread throughout the Great Basin, California, and Baja California, Mexico. This ancestral form is best represented by the physical and chromosomal characteristics of the Stephens' kangaroo rat and San Quintin kangaroo rat (*Dipodomys gravipes*) (Stock 1974). Stock (1974) suggests that the Stephens' kangaroo rat was isolated

in the San Jacinto and San Bernardino Valleys by the last major mountain building activity in the middle Pleistocene.

Based on chromosome analysis, Stock (1974) hypothesized that kangaroo rats may have first evolved in the semiarid grasslands of northern Mexico and the central United States, and first developed evolutionary trends toward traveling on two feet in response to open, semiarid grassland situations rather than in response to true desert conditions.

Genetics

Although there are some discrepancies between the findings of Stock (1974) and Futcher (1974), both authors agreed that the Stephens' kangaroo rat has a chromosome number of 70. Only one other kangaroo rat, the San Quintin kangaroo rat, has a chromosome number of 70. The chromosome number of kangaroo rats range from 52 [Merriam's kangaroo rat (*Dipodomys merriami*)] to 74 [Ord's kangaroo rat (*Dipodomys ordii compactus*)] (Stock 1974). The Pacific kangaroo rat (*Dipodomys agilis*) has a chromosome number of 62 (Stock 1974).

Using gel electrophoresis of blood proteins to describe genetic characteristics, Stephens' kangaroo rat populations at nine locations in Riverside County were found to be very similar in terms of genetic makeup (McClenaghan and Truesdale 1991). McClenaghan and Truesdale (1991) observed low levels of genetic variability within and between populations of Stephens' kangaroo rat. McClenaghan (1994) also found Stephens' kangaroo rat on Marine Corps Base, Camp Pendleton, San Diego County, to be genetically similar to the populations in Riverside County.

More recently, however, preliminary analysis of mitochondrial deoxyribonucleic acid (DNA) from hair follicle samples of approximately 40 individuals (Tony Metcalf, pers. Comm., 1995) reveals much greater genetic diversity in the species than was reported by McClenaghan and Truesdale (1991), who used less sensitive electrophoretic analysis. The preliminary results of this research suggest that

Stephens' kangaroo rat populations are generally structured with basal (older) genetic characteristics in the northernmost population localities (Norco, Sycamore Canyon-March Air Force Base, Lake Perris-San Jacinto, and Badlands) and derived (younger) genetic characteristics in the central and southern portion of the range (Lake Mathews-Estelle Mountain, Motte Rimrock, Steele Peak, Cottonwood Hills, Lake Skinner-Domenigoni Valley, and Marine Corps Base, Camp Pendleton (Figure 1). The San Jacinto population appears to have the least amount of derived genetic characteristics with the populations in the other northern localities having a mixture of both basal and derived characteristics. The genetic relationships of populations of Stephens' kangaroo rat are the subject of ongoing research at the University of California, Riverside (Tony Metcalf, pers. comm., 1995). Further analysis of the data are expected to clarify the relationships.

Natural History

The life history strategy of the Stephens' kangaroo rat has two important features. The species makes use of sparse habitat that does not appear as favorable to other *Dipodomys* in its range, and it is able to rapidly colonize areas of habitat modified by natural factors, such as fire, drought, and habitat scouring in upper floodplains. This species, under certain conditions, can also colonize habitat that has been modified by anthropogenic factors, including fire, grazing, and clearing for roads, agriculture, and other land uses.

As with other small rodent species, the Stephens' kangaroo rat has a relatively short generation time, short life expectancy, early age at first reproduction, ability to produce more than one litter per year when conditions are favorable, and an ability to disperse. All of these factors allow populations of this species to increase or decrease relatively rapidly in response to the amount and quality of habitat available.

The core of the species' range is western Riverside County, a relatively dry inland valley in the rain shadow of the Santa Ana Mountains. Mean annual rainfall is

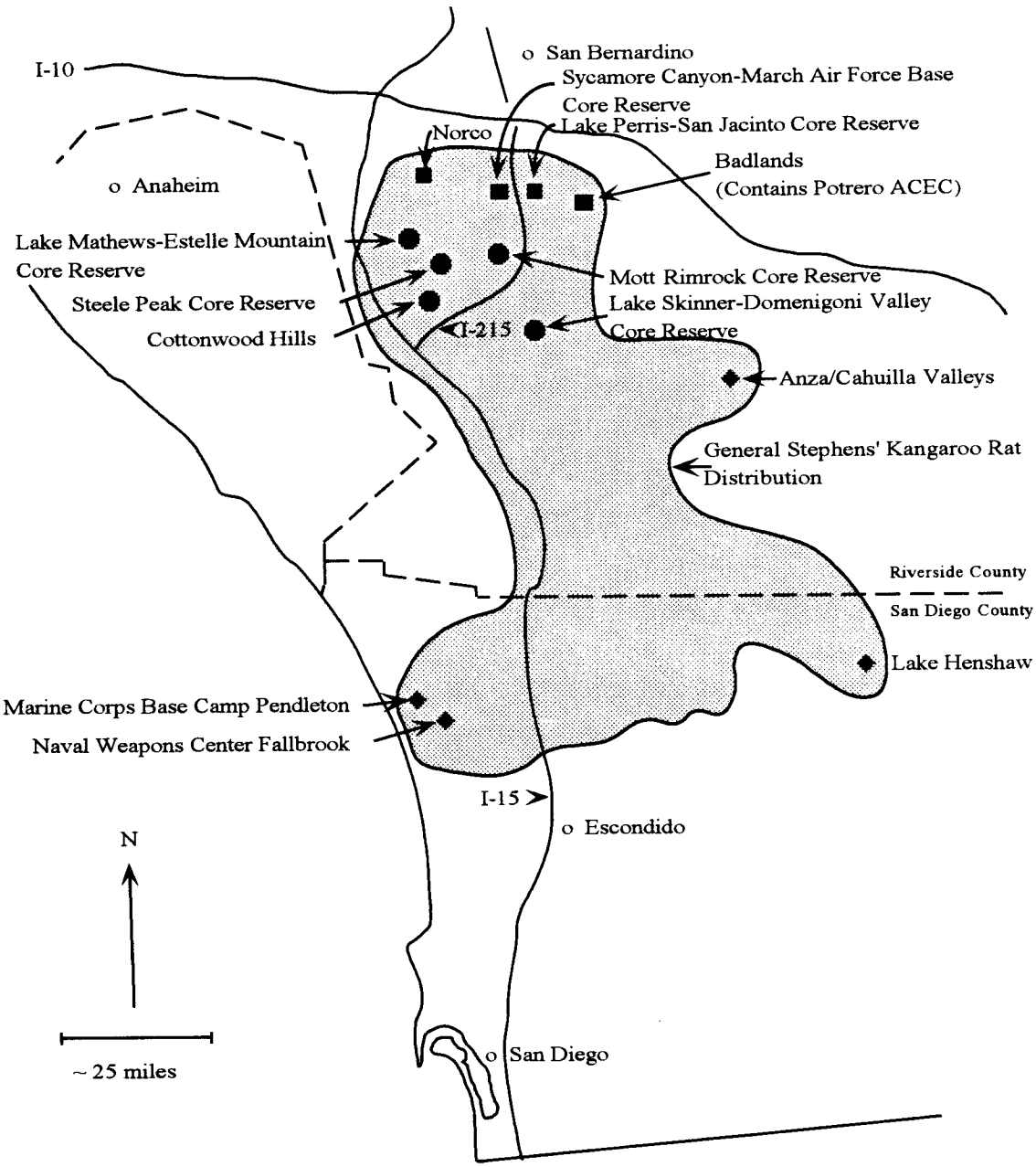

Figure 1. Genetic variation of the Stephens' kangaroo rat.

- ■ Basal Groups
- ● Derived Groups
- ◆ Expected Derived Group (Needs Confirmation)

fewer than 38 centimeters (15 inches) and is variable. The shrub cover of coastal sage scrub habitat in the majority of this area varies from moderate to very sparse and thus provides habitat for the Stephens' kangaroo rat.

The other areas inhabited by the Stephens' kangaroo rat also generally receive fewer than 38 cm (15 inches) of rain per year, although local meteorological data are not available for all localities. It is likely that the species, and more importantly its habitat, responds to more localized rainfall, temperature, and evapotranspiration conditions. The prehistoric vegetation distribution in these areas is difficult to reconstruct because of the long history of human activities (e.g., cattle grazing and other ranching activities, fire).

Historic and Current Distribution

The geographic distribution of the Stephens' kangaroo rat includes the San Jacinto Valley and adjacent areas of western Riverside, southwestern San Bernardino, and northwestern San Diego counties (Figure 2). The entire geographic range of Stephens' kangaroo rat is estimated to be 2,870 square kilometers or 287,000 hectares (1,108 square miles) (USFWS 1987). This is an unusually small range for rodent species in general, and kangaroo rats in particular (Price and Endo 1989). Most of the range occurs in western Riverside County, and extends into northern San Diego County and, perhaps, southwestern San Bernardino County. Although historically present, the Stephens' kangaroo rat may no longer occur in San Bernardino County (J. Gustafson, California Department of Fish and Game, pers. comm., 1992; R. McKernan, San Bernardino County Museum, pers. comm., 1992).

Grinnell (1922) and Hall and Kelson (1959) described the distribution of the Stephens' kangaroo rat as the San Jacinto Valley and surrounding areas of western Riverside County and extreme southern San Bernardino County. When Lackey (1967a) concluded that the Bonsall relict kangaroo rat (*Dipodomys cascus*) described by Huey (1962) was synonymous with the Stephens' kangaroo rat, he extended the range south into the San Luis Rey River valley in northern San

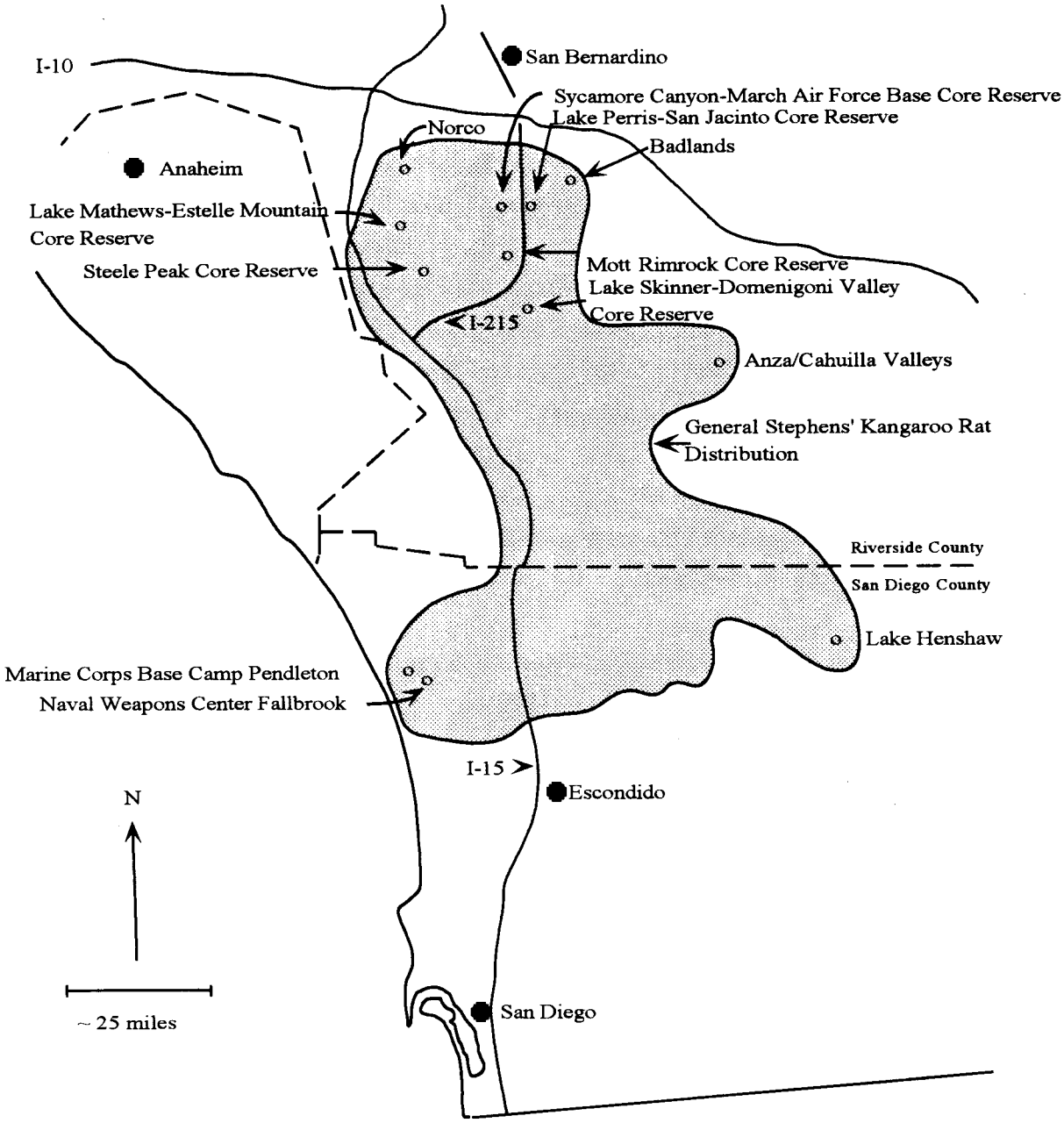

Figure 2. General distribution of the Stephens' kangaroo rat and approximate locations of significant populations. (It is important to note that small fragmented populations of the Stephens' kangaroo rat occur throughout the stippled area.)

Diego County. Bleich and Schwartz (1974) extended the southern portion of the range westward when they found Stephens' kangaroo rat on the Naval Weapons Center, Fallbrook, San Diego County. O'Farrell, Juarez, and Uptain (1986) extended the range eastward in San Diego County after finding Stephens' kangaroo rat east of Lake Henshaw (Warner Ranch). Montgomery (SJM Biological Consulting, pers. comm. 1994) extended the southern boundary of the range 22.5 kilometers (14 miles) east of Escondido (Guejito Ranch). Montgomery (1990) also verified the presence of the Stephens' kangaroo rat in Norco, Riverside County, following their discovery by the Fish and Wildlife Service, which extended the range approximately 3 kilometers (2 miles) north of the northwest portion of the previously known range. More recently, Montgomery (pers. comm., 1994) extended the eastern range of the Stephens' kangaroo rat into the Anza Valley, Riverside County.

Although the size of the known range for the Stephens' kangaroo rat has increased considerably over that given by Grinnell (1922), it does not suggest the species is abundant. All but one of Grinnell's original Stephens' kangaroo rat locations have succumbed to destruction in one way or another. Of those locations of Stephens' kangaroo rat recorded by Lackey (1967a), only two contain active populations. O'Farrell and Uptain (1989) conducted a study to provide an overview of Stephens' kangaroo rat distribution and an assessment of local abundance for each population throughout the range, except for Marine Corps Base, Camp Pendleton and the adjacent Naval Weapons Center, Fallbrook. At the onset of the study 79 populations of Stephens' kangaroo rat were identified. However, prior to the completion of the report, six of those populations were extirpated. The occupied areas tended to be small (68 sites were less than 40 hectares [100 acres]). Since O'Farrell and Uptain's report was completed, hundreds of surveys have been completed and the distribution of this species has been further refined. Thus, the present distribution of Stephens' kangaroo rat does not indicate the abundance of the species, nor its ability to persist in the face of expanding agricultural and urban development, it only indicates the historic limits of its occurrence.

Habitat Requirements

The characteristics of the habitat occupied by the Stephens' kangaroo rat reflect the species' burrowing, foraging, and predator avoidance behaviors. Ecological factors that affect the distribution of Stephens' kangaroo rat include, but are not limited to, an appropriate mix of vegetation, soils, and slope gradient (Bleich 1973 and Thomas 1975).

It is well documented that the Stephens' kangaroo rat is associated with sparsely vegetated habitats (Grinnell 1933, Lackey 1967a, Bleich 1973, Bontrager 1973, Thomas 1973, Bleich and Schwartz, 1974, Thomas 1975, and O'Farrell and Uptain 1989). In fact, this species is frequently found in close association with dirt roads, previously and currently disturbed areas, and/or other sites with a high percentage of bare ground (Thomas 1975, Jones & Stokes Associates 1983, O'Farrell and Clark 1987, and McClenaghan 1994). However, although the Stephens' kangaroo rat is found primarily in annual grassland or sparse sage scrub habitats where perennial cover is less than 30 percent (Lackey 1967a, Bleich and Schwartz 1974, and O'Farrell and Clark 1987), it has been trapped in brittle bush (*Encelia farinosa*) dominated sage scrub with an estimated shrub cover of over 50 percent (USFWS 1993). In general, however, perennial shrub cover and dense grasses restrict the presence of Stephens' kangaroo rat (Lackey 1967a, Bleich 1973, and Bontrager 1973).

The Stephens' kangaroo rat is native to open grassland and sparse coastal sage scrub habitats. Typical habitat consists of native and non-native annual herbs [e.g., gold fields (*Lasthenia* sp.) and filaree (*Erodium cicutarium*)], and native and non-native grasses [e.g., foxtail fescue (*Vulpea megalura*) and foxtail chess (Bromus rubens)]. The Stephens' kangaroo rat is also found in sparse coastal sage scrub habitat (e.g., cover usually less than 30 percent) where perennial species such as encelia (*Encelia farinosa*), coastal sagebrush (*Artemisia californica*), and California buckwheat (*Eriogonum fasciculatum*) occur. Certain non-native grasses (e.g., *Bromus diandrus*) can exclude this species from otherwise suitable habitat.

Soil type also influences distribution of kangaroo rats and has been shown to be a significant predictor of the presence or absence of Stephens' kangaroo rat (Price and Endo 1989). Because burrows are often as deep as 46 centimeters (18 inches) or more, depth of soil cover in occupied habitat is generally at least 50 centimeters (20 inches). O'Farrell and Uptain (1989) found this species on 36 types of well-drained soils. In the Santa Ana Mountains, the Stephens' kangaroo rat was restricted to gravelly soils (Bleich 1977). Near Fallbrook, the Stephens' kangaroo rat is found on soils containing high percentages of granule gravel (Bleich 1973). Lackey (1967a) reported this species from habitats having soils neither extremely dense nor largely sand. Bontrager (1973) found this species most abundantly in areas having extremely sandy soil. Patches of fine-grained soil may be needed for sandbathing (Price and Endo 1989). O'Farrell and Clark (1987) found that the Stephens' kangaroo rat prefers habitats low in rock cover. Although the Stephens' kangaroo rat generally does not occur in clay soils, presumably because of burrowing difficulties, this species' burrows have been observed in clay soil on Naval Weapons Center, Fallbrook, San Diego County and the San Jacinto Wildlife Area, Riverside County (USFWS 1993).

The Stephens' kangaroo rat has been documented from relatively flat terrain to fairly steep slopes. Bleich (1973) found this species on slopes of less than 11 percent. Moore-Craig (1984) indicated that the Stephens' kangaroo rat preferred areas with a slope of 7 to 10 percent. Price and Endo (1989) found that the Stephens' kangaroo rat was typically replaced on steeper slopes by the Pacific kangaroo rat (*Dipodomys agilis*). Though the Stephens' kangaroo rat inhabits land forms that are typically relatively level or gently sloping, they have been documented on slopes of at least 45 percent where the vegetative community and soils were appropriate (A. Davenport, Fish and Wildlife Service, pers. comm., 1996).

The Stephens' kangaroo rat is found from approximately 55 to 1,250 meters (180 to 4,100 feet) above mean sea level with most populations occurring below 610 meters (2,000 feet) (Lackey 1967a, Burke *et al.* 1991, and Montgomery pers. comm. 1994). The Anza Valley population is at the highest elevation at

approximately 1,100 to 1,250 meters (3,600 to 4,100 feet) (Montgomery, pers. comm., 1994).

Population Density

As is true for most small mammals, areas with apparently suitable habitat do not necessarily support Stephens' kangaroo rat populations. Population densities fluctuate greatly from year to year and location to location and can vary more than 10-fold in response to rainfall patterns (Price and Endo 1989).

Reported densities of Stephens' kangaroo rat range between 6 and 27.4 individuals per hectare (3 and 23.7 individuals per acre) during the summer months (Bleich 1973 and Thomas 1975). Fall and winter densities range from 4 to 12 individuals per hectare (2 to 6 individuals per acre) (Sork 1978 and Price and Endo 1989). According to O'Farrell and Uptain (1989), most of the currently occupied habitat contains populations of low [fewer than four individuals per hectare (fewer than two individuals per acre)] or medium density [four to eight individuals per hectare (two to four individuals per acre)], and only a few areas contain a high population density [greater than eight individuals per hectare (greater than four individuals per acre)]. McClenaghan and Taylor (1993a) reported average densities of 23.2, 31.0, and 41.8 individuals per hectare (11.6, 15.5, and 21.4 individuals per acre) at 3 locations in Riverside County during their 19-month study, recording peaks in Stephens' kangaroo rat numbers in late spring-early summer.

Home Range

Reported home ranges of individuals vary from approximately 0.05 hectare to nearly 0.2 hectare (0.1 acre to nearly 0.4 acre) (Thomas 1975 and Bleich 1977). Thomas (1975) noted that as the population density increased the mean home range size decreased. Kelly and Price (1992) found male home ranges were significantly larger and had more activity centers than female home ranges. They also observed seasonal variation in female home range size, with home ranges

being smaller during lactation. This variation was attributed to the necessity of females staying near the nest to feed and protect the young. Males, on the other hand, ranged widely and their activity centers often overlapped those of neighboring females. Male home ranges were also much more irregularly shaped than females. Female ranges were generally oval or circular in shape, usually had only one or two centers of activity, and home range overlap among females was minimal.

Dispersal

Price and Kelly (1992) found the Stephens' kangaroo rat to be highly sedentary. The majority of individuals first captured as adults maintained a home range center within 30 meters (100 feet) of the location where they were first observed. Individuals first captured as subadults were only slightly more mobile than the adults, with fewer subadult individuals persisting at the site of original capture. Median distances moved between first and last capture, as well as distances between first and last home range center, were short (20-40 meters or 65-130 feet) and similar between sexes and for individuals first captured as adults and subadults. Maximum distances between captures also were similar for different age classes and for males and females, varying between 170 and 350 meters (560 and 1,150 feet) for individuals first marked on the study grids. However, three females first marked off the study grids moved over 400 meters (1,310 feet), and one moved over 1,000 meters (3,280 feet). Price and Kelly (1992), however, believe that their data underestimate the frequency of long-distance dispersal.

Behavior

The Stephens' kangaroo rat is a solitary, nocturnal, burrowing granivore (seed eater) preferring open types of habitat (Bleich 1977 and Jones 1985). Though this species is solitary, in regards to use of its burrow, their burrows are frequently found in clusters suggesting a colonial association. There is little information on the life history or social behavior of Stephens' kangaroo rat under field conditions.

The large rear legs of the Stephens' kangaroo rat are used for jumping. The adaptive function of jumping in rodents focuses on feeding and predator evasion. It has been suggested that desert animals developed fleet-footedness to locate scarce foods (Bourliere 1955). Fleet-footedness may provide selective advantage to kangaroo rats who forage for seeds over a wider area than potential competitors such as pocket mice (*Perognathus* sp. and *Chaetodipus* sp.).

The Stephens' kangaroo rat lives in underground burrows that serve as daytime sleeping quarters and nesting sites. In areas with loose sandy soil, this species can excavate the burrow entirely on its own. These burrows are usually between 23 and 46 centimeters (9 and 18 inches) deep and between 1.8 and 2.1 meters (6 and 7 feet long) and often consist of continuous tunnels running from hole to hole with many side branches (O'Farrell and Uptain 1987). The burrows generally have side rooms and a den at the end of the main tunnel. In areas with firm soil, the Stephens' kangaroo rat may modify and utilize old pocket gopher (*Thomomys bottae*) and California ground squirrel (*Spermophilus beecheyi*) burrows (Thomas 1975). Food caches often are established within or around the burrow.

One characteristic behavior of the kangaroo rat is sand bathing. The Stephens' kangaroo rat frequently bathes in dry dusty pockets as a means of keeping its fur clean. Eisenberg (1963) reported that the pelage of *Dipodomys* becomes matted and greasy if no sand is present for this activity. This "bathing" leaves characteristics tracks and markings in the dusty areas within the animal's habitat.

Being entirely nocturnal, the Stephens' kangaroo rat forages at night. It is an herbivore and feeds primarily upon seeds of species such as filaree and brome (*Bromus* sp.) (Thomas 1975). It also feeds on fresh vegetation. Food sources vary in type and location depending upon the season. Foraging may occur for a few hours, during which time food items typically are stuffed into the fur-lined cheek pouches and brought back to the burrow. The Stephens' kangaroo rat, like other kangaroo rats, do not need free water, but obtains required moisture from seeds and plant materials.

Reproduction and Development

The mating season for the Stephens' kangaroo rat is late spring and early summer, Lackey (1967a) and Bleich (1973). O'Farrell and Clark (1987), however, found reproductively active males and females in estrous, pregnant, and/or lactating in July, suggesting either an extended breeding season or another late summer reproductive season. Montgomery (pers. comm. 1992) found estrous females in December, and believes reproduction to be weather and/or forage related. The average litter size for the Stephens' kangaroo rat is 2.5 individuals (Lackey 1967a).

Age at maturity is not known for the Stephens' kangaroo rat, but in some years young-of-the-year may reproduce. Under high rainfall conditions, females may produce two litters in one spring/summer season, and females born early in the season may mature quickly and produce their first litters by the end of the summer. During periods of little rainfall, reproduction may be suspended and survivorship can be low (Burke *et al.* 1991). Lackey (1967a) observed elaborate nest building by a pregnant female Stephens' kangaroo rat in captivity, which consisted of lining a wide-mouthed quart jar with a layer of finely chewed soft paper toweling. This behavior occurred up to 1 week before the young were born.

A comparison of the growth and development of the Stephens' kangaroo rat with Merriam's kangaroo rat (*Dipodomys merriami*) and desert kangaroo rat (*D. deserti*) revealed that the smallest species, Merriam's kangaroo rat, matures most rapidly and the largest species, desert kangaroo rat, matures the most slowly. Stephens' kangaroo rat is intermediate in both size and rate of maturation (Lackey 1967b).

Life Span and Survival Rate

Although McClenaghan and Taylor (1993b) documented that Stephens' kangaroo rat can live for more than 18 months, the average life span was estimated to be between 3.7 months and 7.5 months, depending on the study site. This estimate is

considered to be low because the study could not distinguish mortality from emigration; i.e., some of the Stephens' kangaroo rats presumed to have died may have emigrated out of the study area. McClenaghan and Taylor (1993a) found that within adult and subadult age classes, males and females had similar survival rates, but adults displayed higher survival rates than subadults.

Predation and Competition

Predators of the Stephens' kangaroo rat are probably similar to those of other desert rodents and include owls, snakes, foxes, coyotes, and feral and domestic cats (Munger *et al.* 1983). Owl pellet analyses indicates that the Stephens' kangaroo rat comprise a portion of the diets of barn owls (*Tyto alba*) and long-eared owls (*Asio otus*) (Bleich 1977).

Information on interspecific competition in the genus *Dipodomys* is primarily limited to species other than the Stephens' kangaroo rat. The morphologically similar Pacific kangaroo rat is the only other member of this genus that has been found to occur with this species. Rodents of the same genus and similar size rarely occur together. When they do, distinct habitats are used, as exemplified by patterns of distribution of Stephens' kangaroo rat and Pacific kangaroo rat. Where the Stephens' kangaroo rat and Pacific kangaroo rat occur together, the former is usually associated with annual grassland and the latter with sage scrub (Price *et al.* 1991), though there are many exceptions to this pattern. The spatial segregation of these two species with partially overlapping habitat niches may be maintained by interspecific competition. The divergent habitat selection of these two species may involve a suite of factors related to effects of habitat on predation risk, water balance, and foraging efficiency (Price *et al.* 1991). Although in captivity a Pacific kangaroo rat attacked a Stephens' kangaroo rat and won aggressive encounters (Stock 1974), habitat specialization may greatly limit interaction between the two species in the wild (Burke *et al.* 1991). In general, the Pacific kangaroo rat apparently does not greatly influence population size and distribution of the Stephens' kangaroo rat (Lackey 1967a).

Disease and Parasitism

Little is known of disease or parasitism in species of *Dipodomys*. Hill and Best (1985) examined the levels of coccidia (spherical-shaped bacteria) infection in five species of *Dipodomys* found in southern California (excluding the Stephens' kangaroo rat) and found that infection levels were generally low (8 percent). However, Stout and Duszynski (1983) found oocysts (encapsulated zygotes) of coccidia in the feces of 45 percent of the Pacific kangaroo rats and 35 percent of the Merriam's kangaroo rats that they examined. The importance of these and other parasites on desert rodent populations has not been assessed (Munger *et al.* 1983).

Reasons for Decline

The Stephens' kangaroo rat was listed as an endangered species based, in large part, on a dramatic decline in the amount of occupied and potential Stephens' kangaroo rat habitat in southern California. This conclusion was made following the evaluation of the following factors, as required in section 4(a)(1) of the Endangered Species Act of 1973, as amended. Specifically, the habitat of the Stephens' kangaroo rat had become greatly reduced as a result of agriculture, and more recently, urban development. These land uses have also resulted in increased fragmentation of the remaining habitat, making populations of Stephens' kangaroo rat more susceptible to the effects of some types of grazing, off-road vehicle activity, the use of rodenticides, genetic bottlenecks, local extirpation, and predators such as domestic cats (*Felis catus*) associated with adjacent development.

Habitat Destruction, Degradation, and Fragmentation

The primary cause of the decline of populations of Stephens' kangaroo rat has been the reduction and fragmentation of its habitat. Habitat loses are primarily the result of increased urbanization and, to a lesser extent, certain agricultural activities throughout the species' range. Urban development has permanently

removed habitat and has fragmented and isolated the remaining habitat of the species. Price and Endo (1988) estimated that lands potentially available for the Stephens' kangaroo rat based on soils and slope in 1984 represented approximately 40 percent of the 124,700 hectares (308,000 acres) of habitat that had originally existed for the species.

Although the loss and fragmentation of Stephens' kangaroo rat habitats have continued since the Federal listing of the species, there has been a reduction in the rate of direct loss of occupied habitat. The loss of habitat has been further minimized in western Riverside County with the approval in 1990 of the Short-term Habitat Conservation Plan, which established a set of reserve study areas that has minimized the internal fragmentation and loss of potential habitat in key localities. The implementation of the Short-term Habitat Conservation Plan also coincided with an apparent decreased rate of development beginning in 1992 associated with the overall downturn in the national economy.

Elimination of natural successional patterns has also played a role in the change in distribution of the species. The Stephens' kangaroo rat requires sparse coastal sage scrub and grassland. Many areas support sparse habitat as the result of disturbance activities, such as certain grazing regimes, brush removal, and fires. When these factors are removed, the habitat in most areas tends toward denser coastal sage scrub or introduced European grassland conditions that are not favorable to Stephens' kangaroo rat.

Predation

Many of the remaining populations of Stephens' kangaroo rat currently are adjacent to existing and future urban neighborhoods. Predation from domestic animals, especially domestic and feral cats, can be expected to continue and increase in the future. As the remaining populations are further surrounded by urban development, the ecology of other predators will be affected by isolation, fragmentation, and loss of habitat. Changes in the diversity and abundance of these predators could adversely affect the Stephens' kangaroo rat directly or

indirectly. There are a number of native predators that feed on kangaroo rats and other small mammals. In a natural system, this type of predation is normal and variable within and between years due to the changing densities and distribution of the predators and prey. In an urban environment, or along its interface with natural areas, predator densities can be artificially high due to the presence of domestic cats that are not dependent on the natural system for their survival. Therefore, predation by domestic cats can remain consistent through time on native mammals like the Stephens' kangaroo rat that occur near rural and urban development. This constant predation pressure can push small populations of native mammals past the point of recovery and result in their local extirpation.

Human Contact and Direct Mortality

Grazing, agricultural discing, off-road vehicle activities, and rodent control efforts all have the potential to reduce habitat suitability or result in direct mortality of the Stephens' kangaroo rat. Grazing that results in the long-term absence of food resources appears to adversely affect this species. Lack of food is especially apparent where grazers (e.g., horses) are maintained in relatively small enclosures. In this case, grazing combined with the crushing of burrows and compaction of the soil may result in the animal's extirpation.

Discing for agricultural purposes could result in the direct mortality of the Stephens' kangaroo rat and temporarily renders habitat unsuitable. This species is able to recolonize some disced fields within a few months, although discing can result in additional mortality if the fields are not left fallow.

The effects of off-road vehicle activity on the Stephens' kangaroo rat have not been quantified. It is likely that this activity would adversely affect Stephens' kangaroo rat at some level through direct mortality, destruction of vegetation, compaction of soil, and collapsing of burrows.

Traps and rodenticides have killed an unquantified number of Stevens' kangaroo rats. These activities are associated with agricultural activities, rodent control

measures in residential areas, and rodent control programs associated with earthen dam structures.

Disease

Although currently populations do not appear to be threatened by disease, with the reduction in size and isolation of the majority of remaining occupied areas, localized populations of the Stephens' kangaroo rat are likely to be more susceptible to extirpation following potential disease outbreaks in the future.

Conservation Activities

Four sections of the Endangered Species Act of 1973, as amended, provide protection and management authority for the Stephens' kangaroo rat. Section 6 authorizes cooperative agreements between the Fish and Wildlife Service and the States for listed species. Section 7(a) requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as endangered or threatened and with respect to its critical habitat, if any is designated. Regulations implementing this interagency cooperation provision of the Endangered Species Act are codified at 50 CFR Part 402. Section 7(a)(2) requires Federal agencies to insure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species or to destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into consultation with the Fish and Wildlife Service pursuant to the regulations at 50 CFR 402. Section 7 requires Fish and Wildlife Service review of Federal actions that would affect a species listed as endangered or threatened, or would adversely modify critical habitat designated under the provisions of section 4 of the Endangered Species Act for such species. Section 9 prohibits the taking of species listed as threatened or endangered under the provisions of section 4 of the Endangered Species Act. Section 10(a) authorizes the issuance of incidental take permits to non-Federal and private entities for the take of listed species, and establishes standards for the content of habitat conservation plans.

The Stephens' kangaroo rat was listed as a threatened species under the California Endangered Species Act in 1971. The California Department of Fish and Game is primarily responsible for the administration and enforcement of the California Endangered Species Act. In addition, under the terms of a Memorandum of Understanding with the Fish and Wildlife Service, the Department of Fish and Game is authorized to enforce section 9 of the Endangered Species Act.

Section 2080 of the California Fish and Game Code (Code) prohibits the import, export, take, possession, purchase, or sale of any endangered, threatened, or candidate species listed by the California Fish and Game Commission. As defined in the Code, "take" means to hunt, pursue, catch, capture, or kill or attempt the same. Exceptions to the take prohibition are as stated in sections 2081 and 2835. Section 2081 of the Code allows the Department of Fish and Game to "authorize individuals, public agencies, universities, zoological gardens, and scientific or educational institutions, to import, export, take or possess a listed species for scientific, educational or management purposes," under terms specified in a Memorandum of Understanding with the Department of Fish and Game. Sections 2800-2840 were added to the Code in 1991 as the result of approval of the Natural Communities Conservation Planning Act. These sections authorize the preparation and approval of Natural Community Conservation Plans for communities of plants and wildlife. Section 2835 explicitly provides for the authorization of take of listed species covered by Natural Communities Conservation Plans. At the present time, however, the Stephens' kangaroo rat is not a target species in any Natural Communities Conservation Plan.

The California Endangered Species Act requires State lead agencies as defined by the California Environmental Quality Act to consult with the Department of Fish and Game regarding any project with potential impacts on a State-listed species. The recent policy followed by the Department of Fish and Game in consultations has been that the project should result in no net loss of the species habitat. The Department of Fish and Game also coordinates consultations for actions involving Federal as well as State-listed species and is required, whenever possible, to adopt the Federal Biological Opinion as its finding.

Measures to conserve the Stephens' kangaroo rat have been occurring since its listing by the State. Following Federal listing, measures to conserve this species have increased. The following section contains brief descriptions of conservation activities of several Federal, State, county, and other agencies.

Federal Agencies

In addition to the Fish and Wildlife Service, Federal agencies that are actively involved in the conservation and management of the Stephens' kangaroo rat include Marine Corps Base, Camp Pendleton; U.S. Naval Weapons Center, Fallbrook; March Air Force Base; and the Bureau of Land Management. These agencies, which are all individually charged to utilize their resources to further the purposes of the Endangered Species Act, are individually treated below:

U.S. Fish and Wildlife Service

Since the listing of the Stephens' kangaroo rat by the California Department of Fish and Game in 1971, the Fish and Wildlife Service has attempted to conserve the species by seeking the support and cooperation of other government agencies and the interested public. Prior to the Federal listing of the species, the Fish and Wildlife Service coordinated with local jurisdictions on specific projects in the range of the Stephens' kangaroo rat and asked for focused surveys for the species and the avoidance of impacts to the species and its habitat.

Since the Federal listing of the species in 1988 (53 Federal Register: 38465) (USFWS 1988), the Fish and Wildlife, pursuant to its responsibilities under the National Environmental Policy Act and Endangered Species Act, has continued to ask for focused Stephens' kangaroo rat surveys in appropriate habitats throughout the historic range of the species and recommended avoidance of impacts. The Fish and Wildlife Service also has conducted numerous surveys on Federal lands. The Fish and Wildlife Service, in partnership with the California Department of Fish and Game, has authorized research projects pursuant to section 6 of the

Endangered Species Act that have provided for the identification and delineation of occupied and potential habitat. The Fish and Wildlife Service further has issued (a) recovery permits pursuant to section 10(a)(1)(A) of the Endangered Species Act that allow for Stephens' kangaroo rat surveys and management efforts, (b) section 10(a)(1)(B) permits that have provided for the incidental take of the species in conjunction with projects approved by State and local agencies, and biological opinions prepared pursuant to section 7 that allowed for the incidental take of the Stephens' kangaroo rat in conjunction with federally-sponsored or federally-regulated projects.

U.S. Marine Corps Base, Camp Pendleton

The U.S. Marine Corps Base, Camp Pendleton is developing a management plan for the Stephens' kangaroo rat. The local population is contained within the western San Diego County Management Area (MA). Current management is in accordance with the base Natural Resource Management Plan and section 7 Biological Opinions for specific projects and actions.

U.S. Naval Weapons Center, Fallbrook Annex

Naval Weapons Center, Fallbrook is located in the western San Diego County Planning Region and is adjacent to Marine Corps Base, Camp Pendleton. Current management is in accordance with the base Natural Resource Management Plan and section 7 Biological Opinions for specific projects and actions. Though management of the Stephens' kangaroo rat and its habitat is for the most part consistent with fire management and security concerns for the munitions storage on Naval Weapons Center, Fallbrook, a management plan for this species remains to be developed.

March Air Force Base

The U.S. Air Force has implemented a Land Use Strategy and Management of the Stephens' kangaroo rat on March Air Force Base (USFWS 1991). Specific

management actions to conserve the Stephens' kangaroo rat at March Air Force Base are being undertaken by The Nature Conservancy under contract with the Air Force. The 2,200 acres of Stephens' kangaroo rat management and open space areas on March Air Force Base were incorporated into the Habitat Conservation Plan as one of the core habitat reserves upon which the plan's conservation strategy was based. "Consistent with this fundamental purpose, the March JPC [JPC=Joint Powers Commission] has endorsed a strategy whereby MAFB [MAFB =March Air Force Base] lands now defined as SKR [SKR=Stephens' kangaroo rat] Management and Open Space Areas would be sold to [or] traded with private parties to secure SKR habitat in other locations that support the core reserves designated in the HCP. Due to the fact that land values on MAFB are significantly higher than those in other SKR core reserve areas, trading of the 2,200 acres in the SKR Management and Open Space Areas has the potential of securing a far greater amount of SKR habitat in the vicinity of reserves such as Lake Mathews, Lake Skinner, or the Potrero AEC."

Bureau of Land Management

The Bureau of Land Management administers scattered parcels throughout the range of the Stephens' kangaroo rat, which is contained within the South Coast Resource Area. Many of the parcels managed by the Bureau of Land Management have habitat occupied by Stephens' kangaroo rat, particularly in the vicinity of Steele Peak and Kabian Park (Montgomery 1989). Although the Bureau of Land Management does not have a Stephens' kangaroo rat management plan specific for those areas that contain Stephens' kangaroo rat populations and habitat, the Resource Management Plan for the Resource Area calls for the participation in conservation actions for the Stephens' kangaroo rat.

In general, the Bureau of Land Management will participate in the conservation of the Stephens' kangaroo rat primarily by consolidating their scattered holdings into more manageable and viable habitat units and by undertaking land acquisition and management. To that end, approximately 3,300 hectares (8,146 acres) of Bureau of Land Management land will be exchanged for an equivalent acreage within the

Lake Mathews-Estelle Mountain Core Reserve pursuant to the pertinent language in the Habitat Conservation Plan. In conjunction with the goals and requirements of the Habitat Conservation Plan for Riverside County, the Bureau of Land Management will receive a total of $3.6 million in Federal funds for land acquisition or management. It is currently anticipated $300,000 of the allocated funds may be used for management of the expanded core reserves within the Habitat Conservation Plan area. In addition, the Bureau of Land Management is responsible for the management, consistent with the Habitat Conservation Plan, of the Potrero Area of Critical Environmental Concern, the Steele Peak Core Reserve, and the Estelle Mountain portion of the Lake Mathews-Estelle Mountain Core Reserve.

In addition, one of the specific goals of the aforementioned Resource Area Resource Management Plan is the formation of a Potrero Area of Critical Environmental Concern, through land trades or sales, in the Badlands area in or adjacent to Potrero Creek. One of the principal resource focuses in this Area of Critical Environmental Concern would be habitat occupied by Stephens' kangaroo rat. Any and all such land trades, sales or other related Bureau of Land Management discretionary actions have required, and will require, consultation with the Fish and Wildlife Service under the provisions of section 7 of the Endangered Species Act and the implementing regulations pertaining thereto. This Resource Management Plan will be revised to reflect the current commitments under the Habitat Conservation Plan.

State Agencies

California Department of Fish and Game

The Department of Fish and Game is responsible for management of their lands within the Lake Perris-San Jacinto Core Reserve (i.e., San Jacinto Wildlife Area), and is a member of management committees being developed for other core reserves pursuant to the Stephens' Kangaroo Rat Habitat Conservation Plan for western Riverside County. Although the wildlife area is currently managed

primarily for waterfowl, Stephens' kangaroo rat populations occur in a number of locations. Approximately 80 hectares (200 acres) of habitat along Davis Road in the northern portion of the Wildlife Area was dedicated to the Department of Fish and Game as specific mitigation for the Stephens' kangaroo rat. The Department of Fish and Game has a direct role on the Reserve Management Committee for the Southwestern Riverside County Multiple-Species Plan and Lake Mathews-Estelle Mountain Core Reserve. Both of these areas have substantial populations of Stephens' kangaroo rat on public lands with multiple public ownerships, including lands acquired by the Wildlife Conservation Board. The Department of Fish and Game also has responsibilities under the California Endangered Species Act and the California Environmental Quality Act.

California Department of Parks and Recreation

The California Department of Parks and Recreation (State Parks) manages the land surrounding Lake Perris as a State recreational facility. The primary management objective of the area is the provision of water related recreational opportunities on the lake. However, because of the listing status of the Stephens' kangaroo rat, State Parks has conducted a number of studies on their lands to evaluate the status of Stephens' kangaroo rat populations and potential management practices on the recreation area. State Parks is a participant in the Habitat Conservation Plan in western Riverside County and is participating in the regional management of the species. State Parks is required to avoid impacts to Stephens' kangaroo rat within the Recreation Area and any new activities and projects proposed would require review and mitigation under the terms of the Habitat Conservation Plan and the California Endangered Species Act.

University of California

The University of California at Riverside manages the Motte Rimrock Reserve as part of the University of California Reserve System as a research and educational facility. Additional lands have been added to the reserve by the Riverside County Habitat Conservation Agency and the Wildlife Conservation Board for the benefit

of Stephens' kangaroo rat. The area is used by the University of California for ecological studies.

Local Agencies

Riverside County Habitat Conservation Agency

The Riverside County Habitat Conservation Agency is a joint powers agency and authority made up of the County of Riverside and the Cities of Corona, Hemet, Lake Elsinore, Moreno Valley, Perris, Riverside, Murrieta and Temecula. The Riverside County Habitat Conservation Agency was formed to act as the lead agency in the development and implementation of the Habitat Conservation Plan for the Stephens' kangaroo rat in western Riverside County. The agency's primary responsibilities have been to

- develop the Habitat Conservation Plan,
- collect mitigation fees imposed in the plan area,
- monitor the loss of Stephens' kangaroo rat habitat permitted during the preparation and implementation of the Habitat Conservation Plan,
- acquire lands to mitigate the permitted loss of Stephens' kangaroo rat habitat and provide for the management of reserve system pursuant to the Habitat Conservation Plan.

In addition, the agency has pursued other funding sources and developed partnerships with other agencies for the benefit of the Stephens' kangaroo rat and other biological resources in western Riverside County. In particular, the Riverside County Habitat Conservation Agency has cooperated with the Metropolitan Water District in the formation of multiple species reserves on the Santa Rosa Plateau and around Lake Skinner and the future Domenigoni Reservoir, and has completed an agreement for the Lake Mathews-Estelle Mountain area. The last two of these proposed multispecies reserves also support important populations of the Stephens' kangaroo rat.

As part of the Habitat Conservation Plan, the Riverside County Habitat Conservation Agency is implementing a conservation program that has four primary components:

(a) Establish, through acquisition (fee or conservation easement), a core reserve system consisting of a total of at least 16,680 hectares (41,221 acres), of which a minimum of 5,040 hectares (12,460 acres) will be Stephens' kangaroo rat habitat;

(b) Provide for, in conjunction with the Bureau of Land Management and the State, the ongoing adaptive management of the reserve system to assure the permanent conservation, preservation, restoration, and enhancement of the Stephens' kangaroo rat and its habitat within the reserves,

(c) Protect conserved Stephens' kangaroo rat habitat by limiting and mitigating projects within the reserves, and

(d) Expand, with the assistance of the Bureau of Land Management and the Fish and Wildlife Service, the current reserve configuration by 1,030 hectares (2,540 acres) of occupied Stephens' kangaroo rat habitat through acquisition, fee, conservation easements, or other means found to be acceptable by the Fish and Wildlife Service.

Funding for these components will be provided in large part by the Riverside County Habitat Conservation Agency, with assistance from the Federal government. As part of the Habitat Conservation Plan, the agency will ensure, through acquisition or other means, the conservation of 467 hectares (1,153 acres) of habitat within core reserves that are not protected by existing plans or agreements. The Riverside County Habitat Conservation Agency also will execute agreements relating to land dedication and other mitigation measures for the proposed expansion of El Sobrante Landfill, located adjacent to the Lake Mathews-Estelle Mountain Core Reserve. The agency additionally will provide

$10.1 million cash on hand and an additional $1.6 million towards habitat acquisition and the management of the Stephens' kangaroo rat within the Habitat Conservation Plan and promote its recovery. In particular, the Riverside County Habitat Conservation Agency will provide non-wasting endowments for the permanent management of three core reserves within the Habitat Conservation Plan area: (a) Lake Mathews-Estelle Mountain Core Reserve ($2,500,0000), (b) Motte Rimrock Core Reserve ($300,600), and Sycamore Canyon-March Air Force Base Core Reserve ($500,000). In addition, the Riverside County Habitat Conservation Agency will contribute a non-wasting endowment of $500,000 to the Southwestern Riverside County Multiple Species Habitat Management Committee and provide $100,000 to the City of Riverside to prepare a reserve management plan for the Sycamore Canyon-March Air Force Base Core Reserve. A non-wasting endowment is a fund that produces enough interest income to both provide the monies necessary for management of a reserve/species and maintenance/persistence of the fund.

Riverside County Parks and Open Space District

The Riverside County Parks and Open Space District (District) is a member of the Southwestern Riverside County Multiple Species Reserve Management Committee. Although the primary responsibility and interest of the District relative to the Stephens' kangaroo rat is the operation of the recreation facility adjacent to Lake Skinner, they are also part of the active natural resource management team for the Lake Skinner-Domenigoni Valley Core Reserve.

San Diego County Parks Department

The San Diego County Parks Department manages Guajome Park, a resource based park along the San Luis Rey River east of the City of Oceanside. Though the park has supported a small population of Stephens' kangaroo rat in the recent past, there is no management plan and this small population is thought to have been extirpated due to the presence of invasive exotic grasses (A. Davenport, pers. comm., 1996).

City of Riverside

The City of Riverside is a member of the Riverside County Habitat Conservation Agency and manages Sycamore Canyon Park, one of the core reserves for Stephens' kangaroo rat in western Riverside County under their Habitat Conservation Plan. The City is in the process of developing an updated management plan to include their responsibilities for management of the Stephens' kangaroo rat in the park in coordination with March Air Force Base to the south.

Metropolitan Water District

The Metropolitan Water District is a key participant in Stephens' kangaroo rat conservation activities in western Riverside County. The Metropolitan Water District has committed to substantial conservation and mitigation efforts associated, in part, with the operation and development of major water storage and conveyance facilities in southern California. The Metropolitan Water District is a major landholder in the Lake Skinner-Domenigoni Reservoir and Lake Mathews areas. The Metropolitan Water District is a member of the Reserve Management Committee for the Southwestern Riverside County Multiple Species Habitat Conservation Plan Multiple Species Habitat Conservation Plan and is a member of the Reserve Management Committee for the Lake Mathews Multiple Species Habitat Conservation Plan.

Vista Irrigation District

Vista Irrigation District owns the watershed immediately around the Lake Henshaw reservoir in the Warner Valley. This area is managed as watershed for the reservoir, and Vista Irrigation District administers grazing leases on the property. Although there is a significant population of Stephens' kangaroo rat in this area there is no current management plan in place to ensure its continued existence. Currently the unplanned management of grazing is producing wide variations in the kangaroo rat populations.

Principles Followed in Developing the Recovery Plan

The following section describes the principles of conservation biology that were used to develop the criteria for downlisting and delisting of the Stephens' kangaroo rat and in defining the recovery strategy for the species.

The general conservation principles used in this document are based on current conservation theory and practice and include the following eleven considerations:

- Reserves that are well distributed across a species' native range will be more successful in preventing extinction than reserves confined to small portions of a species' range.

- Large blocks of habitat, containing large populations of the target species, are superior to small blocks of habitat containing small populations. Small population sizes or low population densities in vertebrates can result in deleterious effects on population characteristics and genetic composition.

- Blocks of habitat that are close together are better than blocks far apart.

- Habitat that occurs in less fragmented, contiguous blocks is preferable to habitat that is fragmented.

- Habitat patches that minimize edge-to-area ratios are superior to those that do not.

- Interconnected blocks of habitat are better than isolated blocks, and corridors or linkages function better when the habitat within them is represented by protected, preferred habitat for the target species.

- Blocks of habitat that are devoid of roads or otherwise inaccessible

to humans are better than accessible habitat blocks.

- Examples of the best remaining habitat should be included.
- The entire ecosystem required by a species and other co-dependent species should be protected.
- Heterogeneous terrain and vegetation should be included.
- Some geographically isolated Stephens' kangaroo rat populations should be included to reduce the potential for reserve-wide catastrophic effects.

Ruggiero *et al.* (1994) also present general guidelines that are useful in assessing the effects of proposed activities on population viability. The authors caution that these guidelines are not principles that have been extensively tested in a variety of geographic areas. Therefore they should be applied critically with full consideration of the unique circumstances associated with each analysis.

Connected is better than disjointed. Productive populations contribute immigrants to less productive populations, thus rescuing them from local extinction. Thus, population persistence may depend on habitat linkages.

Older is often more viable than younger. Disturbances associated with human activities have greatly reduced the amount of late-successional plant communities. Maintaining intact blocks of old-growth or mature (late-successional) forests, prairies, and desert communities may be important to conserving our most sensitive native wildlife.

Bigger is better than smaller. Habitat fragmentation is a major cause for the decline in biodiversity. The likelihood of population persistence decreases as habitat is lost due to smaller population sizes and the increased influence of negative edge affects.

High reproductive rates are more secure than low reproductive rates. Populations with low intrinsic rates of increase have higher extinction probabilities because of their slow recovery from low population levels.

Environmental conditions that increase variance in growth rates decrease probability of persistence. Populations that experience high variance in growth rates have reduced probabilities of persistence when their population size is reduced. They are more likely to enter an extinction vortex.

It would appear prudent to expand upon these principles by adding the following concerning catastrophes as identified and discussed by the Fish and Wildlife Service (1994):

The only protection against catastrophes is to have redundancy built into the management system. Several widely-spaced populations are not likely to be struck by the same catastrophic event at the same time. These catastrophic events may be physical disturbances such as fires or they may only affect the species in question (e.g., disease). "Catastrophes are rare events whose probabilities are hard to estimate, and because of the difficulty they are typically handled in ad hoc fashion outside of a formal PVA [population vulnerability analysis]", (Fish and Wildlife Service 1994). Catastrophic events can and do affect single populations with devastating results as evidenced by the decimation of the sole colony of black-footed ferrets following its infection with canine distemper in 1985 (May 1986).

Though an assessment of population vulnerability was used in the development of the Habitat Conservation Plan, it was not used as the basis for this recovery plan. The reason is best explained by exploring the principles, usefulness, and limitations of this approach in the conservation of endangered species. In theory, a viable population can maintain itself over an agreed upon time frame with an agreed-upon degree of certainty; for example, a 95% probability of survival over

100 years. (Gilpin and Soule 1986). A population vulnerability analysis is a tool for assessing the viability of a population through investigation of population parameters. The result of this process ends in the determination of a theoretical population number, the minimum viable population. It is important to note that this process is instructive only and is not meant to provide an absolute answer. Properly used, population vulnerability analyses provide a comparative tool for analyzing alternate reserve configurations and in assessing or discovering aspects of a species' life history most sensitive to management intervention.

Population viability is influenced by both deterministic and stochastic factors. Deterministic factors lead to long-term population trends. Deterministic factors may include such parameters as the amount of suitable habitat, predation rates, reproduction rates, etc. Stochastic factors are random or unpredictable events that may cause an instantaneous extinction, or more commonly, reduce a population to the point where it enters one of several "extinction vortices"; i.e., positive feedback loops of biological and environmental interactions that have further negative impacts on a population, possibly leading to its extinction (Gilpin and Soule 1986). Efforts to manage a species or its habitat can alter some deterministic factors, but it will likely be much more difficult to ameliorate or minimize the stochastic ones.

Generally, small populations are more vulnerable than large ones. Noss and Cooperrider (1994) identified four major factors that predispose small populations to extinction:

1) Environmental variation and natural catastrophes. Unusually harsh weather, fires, or other unpredictable environmental phenomena.

2) Chance variation in age and sex ratios or other population parameters.

3) Genetic deterioration. Small isolated populations are prone to inbreeding depression and genetic drift or random changes in gene

frequencies.

4) Many species are distributed as systems of local populations linked by occasional dispersal that wards against genetic deterioration or detrimental changes in population characteristics.

Lacy (in press) concludes "[because of the important role of stochastic factors on small populations, it will not be sufficient to stop the deterministic decline of a population. Managers will have to minimize the natural stochasticity of the system, and then put the population into a strong deterministic **increase**, so that it can overcome the stochastic processes and recover to healthy and stable levels."

Population vulnerability analyses are important tools for attempting to quantify both the threats to a species as well as the consequences of conservation actions. In a review of the subject, Boyce (1992) expressed regret that often population vulnerability analyses do not explicitly include management actions. He argues that one of the greatest values of population vulnerability analysis modeling is the opportunity to evaluate the efficacy of various management options.

When evaluating the results of a population vulnerability analysis, several considerations should be made. Lacy (in press) reviewed both the limitations and strengths of population vulnerability analysis. Limitations he identified include:

- Natural systems are too complex for any existing model to accurately predict population dynamics.

- Our understanding of the extinction process is inadequate, as is reflected in the uncertainties of any population vulnerability analysis output.

- Most population vulnerability analysis models assume that population changes occur at discrete time steps. This assumption is not an accurate reflection of all wild populations.

- The spatial structure of most population vulnerability analysis models is unrealistically simple.

- There are very few species for which long-term data that allow estimation of the amplitude of environmental fluctuations and its impact are available. Even less data is available on the frequency and impacts of catastrophes such as epidemic diseases and severe weather.

- Few population vulnerability analysis model validation studies have been conducted.

- Often, those using a population vulnerability analysis model have a poor understanding of the assumptions, algorithms (mathematical procedures for solving problems), and structure of the model they are using.

- Unless a lot of sensitivity testing is done, it is easy to come to incorrect conclusions about which of the numerous factors in a population vulnerability analysis model are primary determinants of population dynamics.

- Although several general population vulnerability analysis simulation models are available and are being used on a wide variety of species, no general model would be as good as a comparable model designed specifically for the population of concern, and designed by the biologists who will be applying the model. However there are advantages to using general models, i.e.; they have been extensively tested.

- Most population vulnerability analysis models to date were developed to model populations of vertebrates that are long-lived and have low birth rates.

- Population vulnerability analysis is, by definition, an assessment of the probability of persistence of a population over defined time frames. Yet,

- Population vulnerability analysis is, by definition, only a theoretical a assessment of the probability of persistence of a population over defined time frames. It may not accurately predict actual outcomes.

Strengths Lacy identified include:

- Most of the limitations cited above are also limitations to more traditional population ecology models. Population vulnerability analysis has added an important, though not ultimate tool to the study, management, and conservation of wildlife.

- Population vulnerability analysis is a process for explicitly incorporating what we do know about population dynamics into an overall model that will facilitate examination and testing of various hypotheses about the viability of small populations. The proper use of population vulnerability analysis can help to identify critical factors for study, management, and monitoring.

- Population vulnerability analysis models are important teaching tools.

As with any other modeling, population vulnerability analysis is only as good as the parameter estimates and assumptions upon which it is built. The viability of rare species is often difficult to determine because a population vulnerability analysis requires data that are often not readily available (Fish and Wildlife Service 1994). These data may include individual longevity, habitat suitability, age structure, etc. Estimates of the necessary parameters are usually incorporated into a population vulnerability analysis. However, often small changes in these parameters can have profound changes in the estimated time to extinction. Therefore, it is prudent that as much biological information as is possible or practicable be obtained before attempting a population vulnerability analysis.

Therefore, the less known about the species and the ecosystem in which it exists, the less confidence should be placed upon the results. This includes both past

population characteristics and land use information and future projections of these data.

Because listed species are by definition endangered or threatened, they are likely to already be dangerously close to, or within, an extinction vortex. As a result, any population vulnerability analysis should be conducted in a manner that results in conservative estimates of the species or populations viability. Furthermore, as Lacy (in press) states, population vulnerability analysis should be used as part of an adaptive management strategy, not as the basis of a singular inflexible management prescription.

Notwithstanding the power and value of modeling, there are several caveats that should be recognized when interpreting results. Stephens' kangaroo rat models to date do not account for successional processes, because it has been assumed in the modeling process that habitat distribution or carrying capacity for Stephens' kangaroo rat will remain the same into the future. This was a simplifying assumption in the modeling process to allow for computational ease and does not reflect how habitats change from year to year due to varying climatic conditions (e.g., El Nino). What this process implies is that monitoring and management activities should focus on maintaining, on average, at least the initial condition, acreage, and configurations of Stephens' kangaroo rat habitat in the future.

It should also be noted that the probabilities of persistence for the modeling used for the Habitat Conservation Plan (i.e., Gilpin, 1993) were based on at least one animal being left alive at the end of the prescribed period. Thus, the use of this type of model to determine whether or not a viable population will exist at some point in the future is not appropriate. Clearly, a more conservative threshold would be required to estimate the minimum number of animals necessary to maintain genetic diversity of a recovered species. Moreover, even if modeling were designed to assess the viability of a population at some time in the future, the results should be used with extreme caution because of the tremendous, untractable, variability that exists in biological systems. As stated previously, the current state-of-the-science indicates that the real value of modeling lies in its use

as a comparative tool when accessing different reserve design configurations.

Given the above caveats and results of the above analysis and all other relevant information, it is clear that redundancy in number of preserves is needed to ensure that viable populations or groups of populations are resistant to catastrophic events in all conservation planning areas. The establishment of reserves and the perpetuation of these populations will likely ensure the survival of the Stephens' kangaroo rat in this area. In addition, the survival of these populations will help conserve the remaining genetic and ecological diversity of the species.

Maintenance of Distinct Population Units

Populations of Stephens' kangaroo rat occur in three geographically distinct regions of southern California, with varying patterns of occurrence within each of these areas. These regions have relatively large geographically distinct populations and scattered remnants of formerly interconnected populations. Because of the distribution of the species, the location of conservable populations in both Riverside County and San Diego County, the presence of genetic basal and derived groups in populations of the Stephens' kangaroo rat, and the unequal potential to establish ecosystem based reserves around most remaining populations of this species, the following approach was developed to aid in the conservation and ultimate recovery of this species.

For clarity and the purpose of discussion, the distribution of the species has been divided between the Western Riverside County conservation planning region and the San Diego County conservation planning region. Due to the presence of different land uses and managers, these regions are further divided into conservation planning areas and conservation units (e.g., reserves)(Figure 3). Conservation planning areas encompass significant population groups of the Stephens' kangaroo rat whereas conservation units coincide with specific populations.

For Riverside County, there is the Habitat Conservation Plan Conservation Planning Area and the Non-Habitat Conservation Plan Conservation Planning Area. For San Diego County, there is the Western Conservation Planning Area and Central Conservation Planning Area. Conservation of populations in each of these areas will ensure the conservation of the genetic diversity that exists in this species. In addition, conservation of populations located in areas that will not be isolated from their surrounding biological community should ensure the recovery of the species in the wild through the maintenance of the entire ecosystem upon which it depends. The current location and estimated acreage of populations of the Stephens' kangaroo rat is based on data derived from O'Farrell and Uptain (1989), Montgomery (1989), RECON (1992), Riverside County Habitat Conservation Agency (1995), and unpublished information on file with the Fish and Wildlife Service at the Carlsbad Field Office, Carlsbad, California. These data represent a reasonable representation of the location and extent of significant, conservable, populations of this species (Table 1, Figure 4).

Western Riverside County Conservation Planning Region

The Western Riverside County Conservation Planning Region contains several relatively large contiguous populations of the Stephens' kangaroo rat. Many of these populations are located within the boundaries of the Habitat Conservation Plan, whereas several are located outside its boundary. To adequately address the issues facing these populations the planning region is divided into the Habitat Conservation Plan Conservation Planning Area and the Non-Habitat Conservation Plan Conservation Planning Area. Some of the populations outside the boundary of the Habitat Conservation Plan are important in that they are not surrounded by urban development and are therefore protected from the deleterious effects of reserves that are too small to maintain their biological community/diversity.

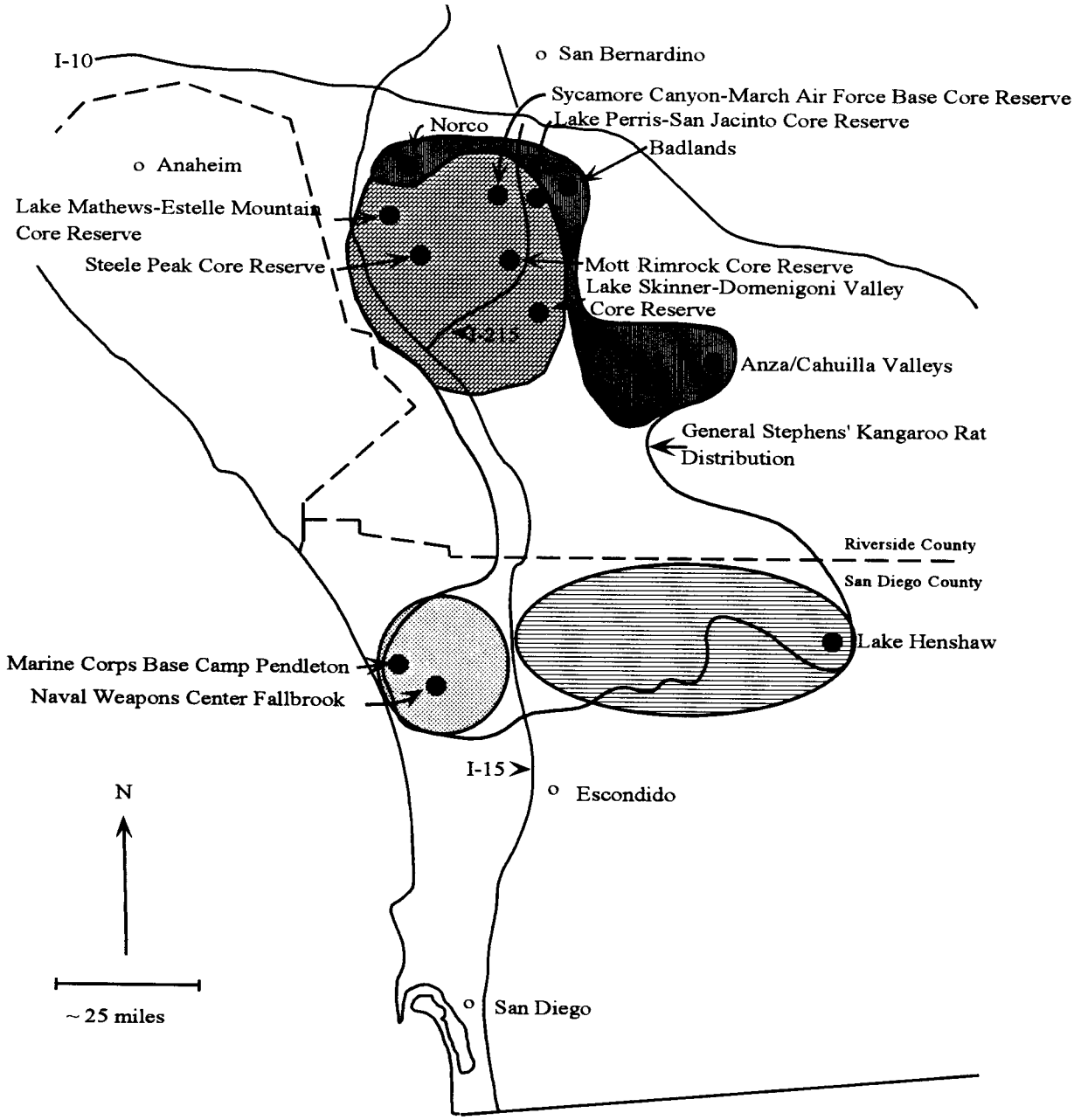

Figure 3. General location of conservation planning areas.

HCP Conservation Planning Area

Non-HCP Conservation Planning Area

Western Conservation Planning Area

Central Conservation Planning Area

Table 1. Stephens' Kangaroo Rat Conservation Planning Areas and Conservation Units

Conservation Planning Regions	Conservation Planning Areas	Conservation Units/Reserves	Priority[1]	Hectares (Acres) of Stephens' Kangaroo Rat Habitat[2]	Degree of Threat[3]
Western Riverside County	Habitat Conservation Plan	*Lake Skinner-Domenigoni Valley Core Reserve*	2	805 (1,988)	3
		Motte Rimrock and Steele Peak Core Reserves	2	484[4] (1,195)	1
		Lake Mathews-Estelle Mountain Core Reserve	1	1,726 (4,264)	3
		Sycamore Canyon-March Air Force Base Core Reserve	2	548 (1,355)	3
		Lake Perris-San Jacinto Core Reserve	1	1,528 (3,775)	3
		Potero Area of Critical Environmental Concern	3	7 (18)	1
	Non-Habitat Conservation Plan	*Norco*	3	405 (1,000)	1
		Badlands	2	1,002 (2,477)	1
		Anza and Cahuilla Valleys	2	324[5] 1142 (800)	2
San Diego County	Western San Diego County	*Naval Weapons Center, Fallbrook*	1	1,093 (2,700)	3
		Marine Corps Base, Camp Pendleton	1	324[5] (800)	3
	Central San Diego County	*Lake Henshaw*	1	4,600 (11,362)	2

[1] First Priority reserves (designated "1" above) are the largest and Third Priority reserves ("3" above) are the smallest.

[2] Estimates of occupied habitat for the Stephens' kangaroo rat

[3] For Degree of Threat, "1" denotes the highest relative degree of threat to the designated reserve, "3" denotes a low degree of threat.

[4] Made up of several isolated concentrations of Stephens' kangaroo rat. There are approximately 136 hectares (335 acres) of occupied habitat at Motte Rimrock and approximately 348 hectares (860 acres) of occupied habitat at Steele Peak.

[5] Acreage of occupied habitat not fully determined

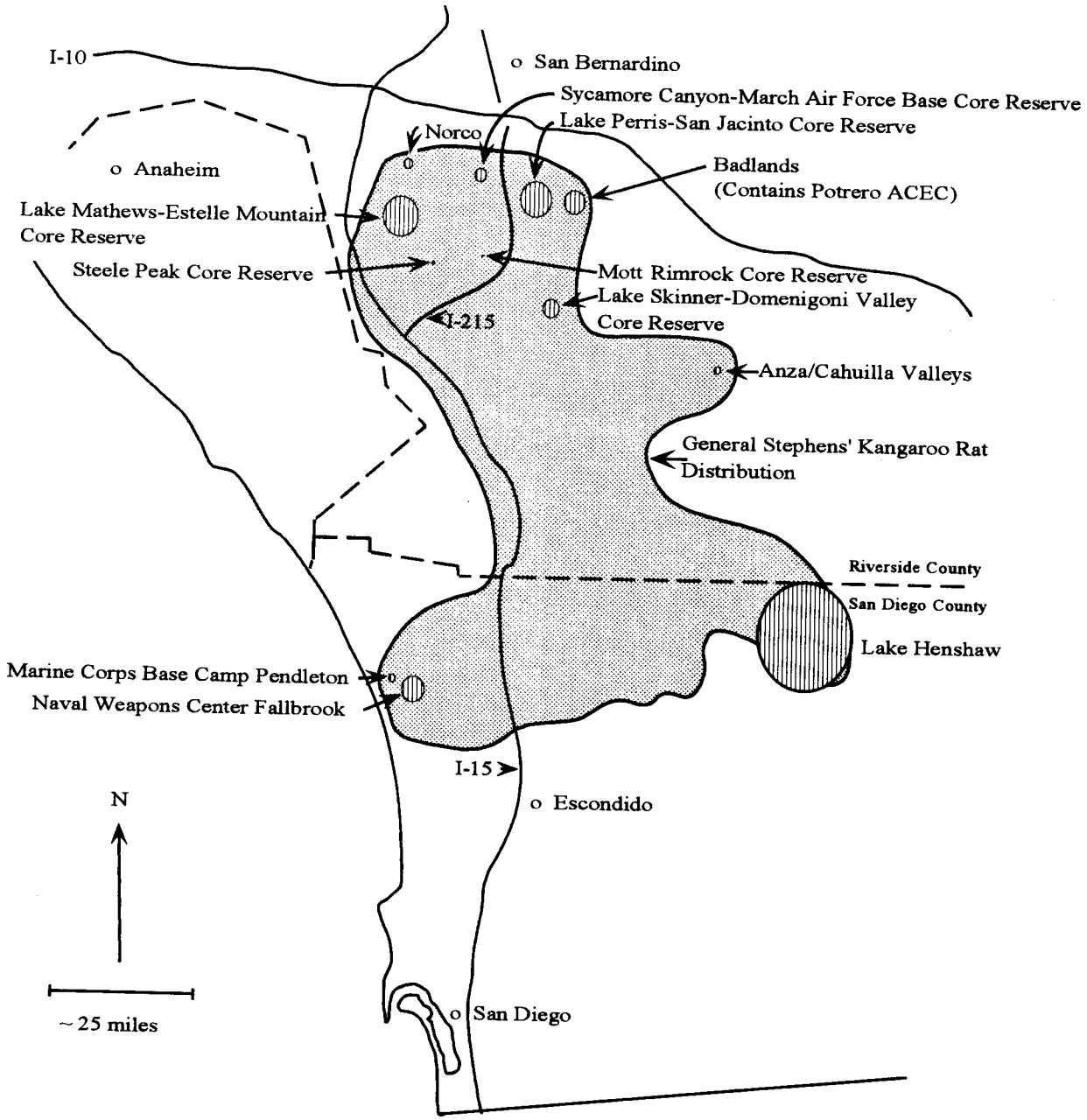

Figure 4. Relative sizes of remaining populations of the Stephens' kangaroo rat targeted for conservation (Populations are approximately 10X actual size for graphical presentation and are scaled relative to the Lake Henshaw group).

Habitat Conservation Plan, Conservation Planning Area

The majority of remaining Stephens' kangaroo rat populations and habitat in western Riverside County are within the boundaries of the Habitat Conservation Plan. The area encompassed by the Habitat Conservation Plan includes the cities of Corona, Hemet, Lake Elsinore, Moreno Valley, Perris, Riverside, Temecula, and Murrieta. The Habitat Conservation Plan covers approximately 216,080 hectares (534,000 acres) and encompasses approximately 12,140 hectares (30,000 acres) of Stephens' kangaroo rat-occupied habitat. Within the boundaries of the Habitat Conservation Plan, relatively substantial populations of Stephens' kangaroo rat were identified in eight localities, with smaller patches distributed throughout the Perris Plain, San Jacinto Valley, Gavilan Plateau, and intermediate areas between the Santa Ana Mountains on the west and the Badlands on the east. In 1988, at the beginning of the planning process for the Habitat Conservation Plan, the amount of habitat occupied by the Stephens' kangaroo rat in this area was estimated at between 8,090 and 8,900 hectares (20,000 and 22,000 acres). The current estimate of occupied habitat in the planning area for the Habitat Conservation Plan is approximately 12,140 hectares (30,000 acres).

Completion of the Habitat Conservation Plan will result in the protection and management of populations in a system of reserves totaling more than 6,070 hectares (15,000 acres) of occupied habitat in seven areas: Lake Mathews-Estelle Mountain Core Reserve, Lake Perris-San Jacinto Core Reserve, Lake Skinner-Domenigoni Valley Core Reserve, Sycamore Canyon-March Air Force Base Core Reserve, Motte Rimrock Core Reserve, Steele Peak Core Reserve, and Potrero Area of Critical Environmental Concern. The majority of the habitat in these areas, approximately 5,040 hectares (12,460 acres), is currently in public ownership. The Habitat Conservation Plan provides for the addition of approximately 1,500 hectares (3,700 acres) of occupied habitat to the reserve system (combined Riverside County Habitat Conservation Agency and Bureau of Land Management commitments under the Habitat Conservation Plan). All reserve lands will be managed for the Stephens' kangaroo rat under the terms of the Habitat Conservation Plan.

Non-Habitat Conservation Plan, Conservation Planning Area

Additional habitat occupied by relatively large contiguous populations of the Stephens' kangaroo rat occur outside the area covered by the Habitat Conservation Plan in Riverside County. This habitat occurs in the Norco Hills, in habitat located east of Moreno Valley in the geologic formation known as the Badlands, and in the Anza and Cahuilla Valleys.

Norco

The Stephens' kangaroo rat population in Norco Hills currently includes approximately 400 hectares (1,000 acres) of occupied habitat and an additional undefined area of potential habitat in an undeveloped area of low rolling hills adjacent to the Santa Ana River in the City of Norco. These lands are in private ownership and are subject to ongoing indirect impacts of adjacent land uses.

To date, the Fish and Wildlife Service has issued three incidental take permits for portions of this population. These permits included provisions for on-site preservation, which enables the potential establishment of a local reserve. Given the hilly terrain and the land use designation in the City of Norco's General plan, a portion of the remaining Stephens' kangaroo rat occupied habitat in the area may be undevelopable. In any case, the City of Norco's rural nature and interest in maintaining open space corridors and horse trails are largely compatible with the needs of Stephens' kangaroo rat. Conservation of a viable population in this area would contribute to the recovery of the species by maintaining the distributional range and remaining genetic diversity of the species.

Badlands

The Badlands population includes occupied habitat in a number of valleys, which are generally associated with land disturbed or modified by fire, grazing, agriculture, or other activities. The primary areas of occupied habitat in the Badlands are Potrero Creek, Laborde Canyon, Jackrabbit Canyon, and Lamb Canyon. The majority of occupied habitat in the Badlands area is adjacent to

Potrero Creek. The habitat in these valleys is geographically and topographically buffered from the direct and indirect effects of urban and agricultural activities that exist throughout the rest of western Riverside County. Current threats to these populations include urban development proposed for Potrero Creek and potential changes in agricultural practices and other land uses that might affect the suitability of habitat for the Stephens' kangaroo rat.

Potrero Valley represents the northeasterly extent of the Stephens' kangaroo rat's distribution. The 810 hectares (2,000 acres) of contiguous habitat in the Potrero Valley represents one of the largest remaining contiguous blocks of high elevation habitat within the range of the species. Currently, this population is the farthest removed from development in Riverside County and is adjacent to large tracts of Federal land managed for natural resources. The Badlands population is unique in Riverside County in that it represents the only population remaining that is naturally protected by rugged terrain and adjacent open space. The size and location of this population should allow for the dynamic natural process of population expansion and contraction with minimal risk of local extirpation.

The prospects for maintaining a population of Stephens' kangaroo rat in the wild in Riverside County will improve substantially if the large and relatively undisturbed San Jacinto/Badlands biological community is conserved and maintained. A large reserve connecting populations in the Lake Perris-San Jacinto Core Reserve and Potrero Creek through the Badlands represents the last opportunity to maintain a connection between populations of Stephens' kangaroo rat near the core of its historic range that are not otherwise confined to relatively small regional preserves. The development of landscape connections between and among the major reserves inside and outside the Habitat Conservation Plan planning area and other undevelopable natural areas (e.g., Cleveland National Forest) are unlikely due to the presence and distribution of private lands.

If the Potrero Valley or Badlands are isolated from the Perris Plain, the result will be a decrease in biological diversity and increased risk to the Stephens' kangaroo rat at the Lake Perris-San Jacinto Core Reserve through the disruption of its biological community. Once the biological community and diversity are diminished by fragmenting habitat into smaller, more isolated patches, Stephens' kangaroo rat managers likely will be forced into ever increasing intensive

(and inherently risky) management strategies to maintain this species. Relying on intensive management could forestall the ecosystem level recovery and delisting of this otherwise recoverable species.

Anza and Cahuilla Valleys

The Anza and Cahuilla Valleys population is an inland extension of the range of Stephens' kangaroo rat into another high elevation valley. The population occupies lands currently used for agriculture (primarily grazing) on and around Cahuilla tribal lands, at an elevation between 1,040 and 1,250 meters (3,400 and 4,100 feet) above mean sea level. Although the area has not been surveyed comprehensively, approximately 159 hectares (392 acres) of habitat were occupied by the Stephens' kangaroo rat in 1994 (A. Davenport, pers. comm., 1997) and up to several thousand hectares of habitat with some potential to support this species have been identified in the area. The Fish and Wildlife Service will not rely on tribal lands to achieve recovery objectives unless opportunities on non-tribal lands are exhausted first.

Small isolated patches of habitat occupied by the Stephens' kangaroo rat have been identified in the upper Santa Margarita River drainage along Temecula Creek, from Vail Lake eastward to Aguanga Valley. The current status of these populations is unknown.

San Diego County Conservation Planning Region

The San Diego County Conservation Planning Region contains several relatively large populations. To adequately address the issues facing these populations the planning region is divided into the Western Conservation Planning Area and the Central Conservation Planning Area. These populations are essential to the recovery of the species because they are large and not isolated from the surrounding biological community and represent the most southern distribution of the species.

Western Conservation Planning Area

Populations of the Stephens' kangaroo rat in coastal San Diego County are centered along two major drainages, the Santa Margarita and the San Luis Rey Rivers. The primary areas of occupied habitat occur on two Department of Defense facilities, Marine Corps Base, Camp Pendleton and Naval Weapons Center, Fallbrook. These areas offer real opportunities to maintain the current biological diversity and ecosystems associated with these populations. Activities on either of these facilities that may affect the Stephens' kangaroo rat require consultation with the Fish and Wildlife Service prior to their implementation.

Marine Corps Base, Camp Pendleton supports approximately 324 hectares (800 acres) of occupied habitat in several areas in the central and southern portions of the base. There is some potential for expansion of habitat occupied by this species, as well as the maintenance and enhancement of existing habitat and connections between occupied patches. Potential threats to the Stephens' kangaroo rat populations include expansion of the support facilities on the base and expansion of areas of active training and maneuvering that may occur as part of the Department of Defense's Base Closure and Realignment Program.

Naval Weapons Center, Fallbrook supports approximately 1,093 hectares (2,700 acres) of occupied habitat. Naval Weapons Center, Fallbrook is used primarily for munitions storage. As a result of security requirements and fire suppression and prevention needs, the vegetation on much of Naval Weapons Center, Fallbrook is maintained as sparse grassland, habitat suitable for the Stephens' kangaroo rat. Current threats to the population on the facility are low, but changes in habitat management practices could have an adverse effect on this important population.

Central Conservation Planning Area

The major central San Diego County population exists in the upper San Luis Rey River drainage. This population occurs adjacent to Lake Henshaw. The population at Lake Henshaw occurs in an area of approximately 4,600 hectares (11,362 acres) of suitable habitat that is distributed across low rolling hills between 820 and 940 meters (2,700 and 3,100 feet). The habitat in the

area is a mix of native annuals and herbs, native perennial grasses, and non-native annual grasses. The majority of the area is owned and managed by Vista Irrigation District, a local water provider, as watershed for the reservoir. The most apparent existing land use in the area is cattle grazing. The current status of this population is unknown, as are the potential threats to the population. O'Farrell (pers. comm.) suggested that the area occupied by the Stephens' kangaroo rat in this area had decreased by as much as a factor of 10 in the recent past due to the development of thick stands of stipa grass (*Stipa* sp.). Since this apparent decrease, the population has apparently rebounded due to a modification in grazing practices and a reduction in the density of stipa (O'Farrell, pers. comm., 1996). This area represents a large and important portion of the current range of the Stephens' kangaroo rat and is important for the recovery of the species due to its location and size. Its location is important because it is possible to maintain broad landscape connections with large expanses of natural habitat (i.e., U.S. Forest Service lands) and thus maximize the areas' biological diversity. The size of the population is important in that, with the proper management, it is unlikely to experience the deleterious effects of genetic bottlenecks.

Recovery Strategy

The recovery strategy for the Stephens' kangaroo rat focuses on (1) working with land owners and managers to preserve and protect significant populations of the Stephens' kangaroo rat through the establishment of reserves throughout representative portions of its range; (2) protect conserved populations of the Stephens' kangaroo rat and their habitat; (3) eliminating or minimizing unnatural mortality factors; and (4) developing and implementing a Stephens' kangaroo rat outreach program.

Because of land uses associated with the Stephens' kangaroo rat, the potential to conserve this species in reserves that are not isolated from the surrounding biological communities has been eliminated in a large portion of its range. Therefore, conservation of this species will involve the establishment of two basic types of reserves. The two types of reserves are best described as (1) reserves that will require low levels of management (ecosystem based) and (2) reserves that will require high to intensive levels of management (non-ecosystem based) to conserve the species.

Ecosystem based reserves are not isolated from large expanses of natural habitat and are anticipated to retain their biological diversity. In addition, this type of reserve should need only minimal management due to the integrity of the natural system and allow for the relatively rapid recovery of the species in the wild (Figure 5). Non-ecosystem based reserves are biologically isolated for the most part from large expanses of natural habitat, are anticipated to lose biological diversity, and are anticipated to require high to intensive management. This type of reserve is usually associated with a habitat conservation plan that has been submitted with an application for an incidental take permit under the Endangered Species Act. Both types of reserves are necessary in maintaining the genetic and phenotypic diversity of the species and to conserve representative populations of the species. In addition, both types of reserves are also important in that they provide redundancy and, therefore, some margin of safety against catastrophic events that could extirpate the species from significant portions of its range.

The maintenance of habitat quality is essential for the conservation of this species. The presence of invasive exotic grasses can exclude this species from large areas of otherwise suitable habitat. In addition, the development of stands of European grasses in habitat occupied by the Stephens' kangaroo rat can result in the extirpation of this species from these areas. Therefore, the suppression of these grasses will be a principle element of management plans developed for this species.

Minimizing mortality includes the prevention of wide scale discing of occupied habitat, preventing the use of rodenticides and the indiscriminate use of pesticides within and immediately adjacent to conservation units, and minimizing predation due to introduced predators. Minimizing the impacts due to non-native predators will be especially important for the reserves that are isolated from the surrounding natural system and bordered by urban and rural development. In these cases, domestic cats are anticipated to be an issue that requires attention by reserve managers.

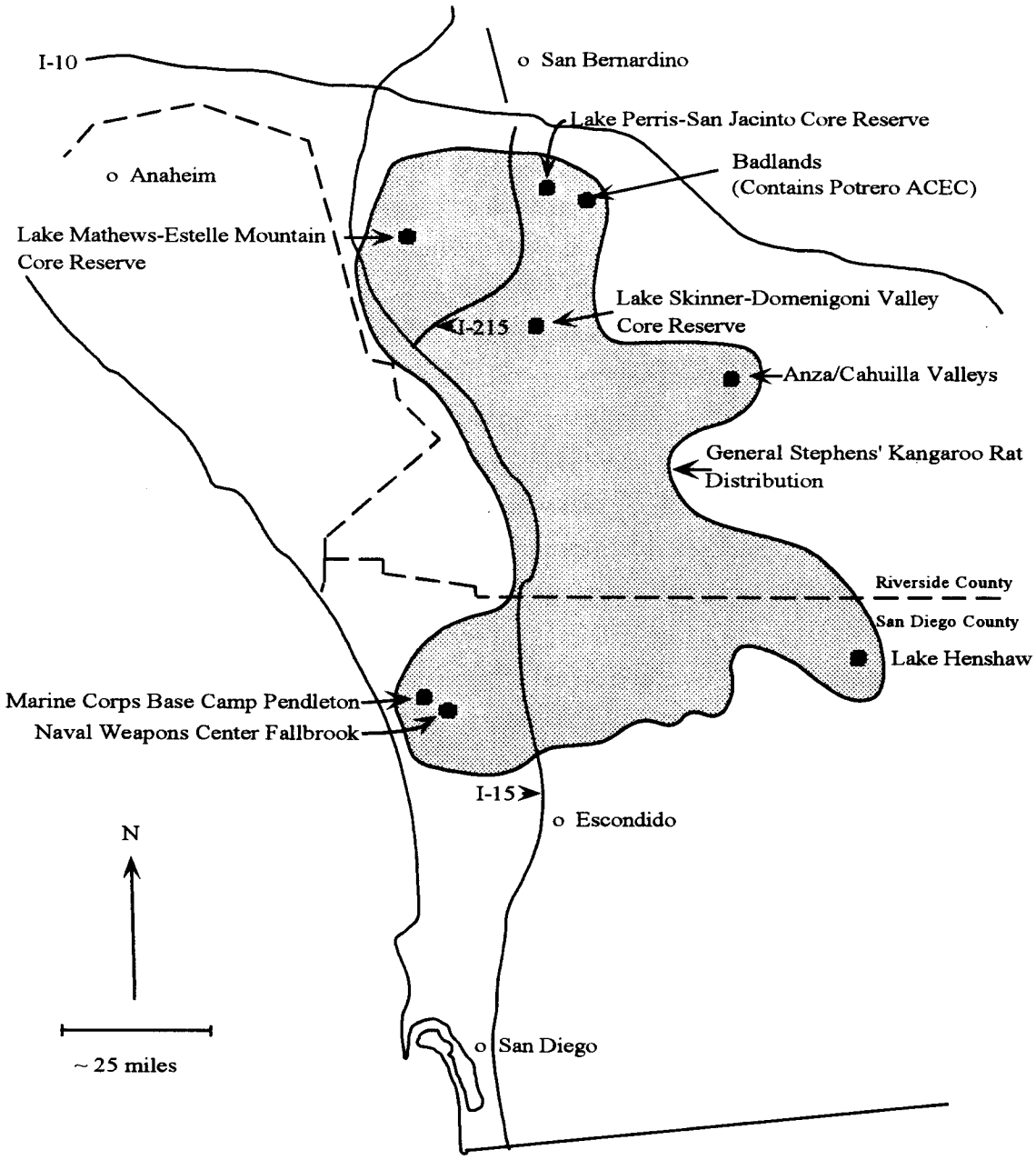

Figure 5. Locations of populations that can be conserved with an intact ecosystem (Landscape connections of these populations with the surrounding natural habitats have not been precluded by current and planned development).

The development of a Stephens' kangaroo rat outreach program is important because of the presence of misinformation concerning the conservation and recovery of this species and biological conservation efforts in general. This program should focus on the conservation of species at the ecosystem level and stress the importance of maintaining an areas' biological diversity and functional integrity.

II. RECOVERY

Objectives and Criteria

The ultimate objective of this recovery plan is to protect and maintain sufficient populations and habitat of the Stephens' kangaroo rat to allow the removal of this species from the List of Endangered and Threatened Wildlife pursuant to the Endangered Species Act. The recovery of the Stephens' kangaroo rat will involve a two-stage process, beginning with reclassification of the species from endangered to threatened status.

Downlisting Criteria

The Stephens' kangaroo rat may be considered for reclassification to threatened status when the following criteria are met:

1) establishment of four reserves, which encompass at least 6,070 hectares (15,000 acres) of occupied habitat and are permanently protected, funded, and managed, and are located in western Riverside County (inside or outside the Habitat Conservation Plan planning area), and

2) establishment of one ecosystem based reserve in either western or central San Diego County that is permanently protected, funded, and managed.

The 6,070 hectare (15,000 acre) requirement in western Riverside County is based on, and compatible with, the Habitat Conservation Plan. Conservation objectives in San Diego County are established to maintain the distribution of the Stephens' kangaroo rat throughout representative portions of its range.

Delisting Criteria

The Stephens' kangaroo rat could be considered for delisting by the year 2001 if the long-term survival of the species is assured by the following criteria:

1) a minimum of five reserves in western Riverside County, of which one is ecosystem based, and that encompass at least 6,675 hectares (16,500 acres) of occupied habitat that is permanently protected, funded, and managed, and

2) two ecosystem based reserves in San Diego County. One reserve needs to be established in the Western Conservation Planning Area and one reserve needs to be established in the Central Conservation Planning Area. These reserves must be permanently protected, funded, and managed.

Narrative

I. Preserve and Protect Populations of the Stephens' Kangaroo Rat Throughout Representative Portions of its Range

A. Downlisting

1. Establish Ecosystem Based Conservation Unit

To conserve the geographic distribution, and phenotypic and genetic diversity of this species, and guard against the anticipated deleterious affects of diminishing biological diversity associated with small biologically isolated reserves on the recovery of the Stephens' kangaroo rat, establish a minimum of one ecosystem based reserve in San Diego County.

2. Protect Smaller, More Isolated Conservation Units

To conserve the geographic distribution, and phenotypic and genetic diversity of this species, establish non-ecosystem based reserves. Because of the importance of populations in areas that have become or are becoming urbanized, conserve at least 6,070 hectares (15,000 acres) of occupied habitat in a minimum of four reserves that are permanently protected, funded, and managed (inside or outside the Habitat Conservation Plan Conservation Planning Area). These reserves are inherently unstable due to their configurations and current or future isolation from surrounding natural habitat due to current and future development. These reserves are anticipated to require intensive management.

B. Delisting

1. Establish Ecosystem Based Conservation Units

To conserve the geographic distribution, and phenotypic and genetic diversity of this species, and guard against the anticipated deleterious effects of diminishing biological diversity associated with small biologically isolated reserves, establish a minimum of three ecosystem based conservation units.

a. Establish one ecosystem based conservation unit in Riverside County

b. Establish two ecosystem based conservation units in San Diego County. Establish one conservation unit in the Western San Diego County Conservation Planning Area and establish one conservation unit in the Central San Diego County Conservation Planning Area.

II. Protect Conserved Populations of the Stephens' Kangaroo Rat and their Habitat

A. Prevent Destruction and Degradation of Habitat

1. Post and fence perimeter of conservation units.
2. Monitor and stop unauthorized activities in conservation units and prevent the destruction of occupied and potential habitat (e.g, by discing and/or grading).
3. Maintain Habitat Quality.

The habitat quality of the Stephens' kangaroo rat needs to be actively maintained throughout large portions of its range due to the presence of invasive European grasses that degrade its habitat.

a. Develop management plans that include the management of exotic plants, including European grasses.
b. Prevent the introduction of exotic plants in conservation units.

B. Eliminate Unnatural Mortality Factors

1. Pesticides

Additional unnatural mortality can occur following the application of rodenticides and other pesticides.

a. Prevent the use of rodenticides in conservation units
b. Prevent the indiscriminate application of other pesticides in conservation units

2. Non-Native Predators

The Stephens' kangaroo rat is also susceptible to predation from introduced predators. Introduced predators such as domestic cats can maintain artificially high predation on native rodents. Therefore, especially for reserves that are not ecosystem based, establish management plans that will minimize, and preferably prevent, the effects of predation.

III. Establish Research Program

A considerable amount of research has been conducted on the biology of the Stephens' kangaroo rat in the last 10 years as the result of its listing by the State and the Fish and Wildlife Service and the subsequent development of Habitat Conservation Plans, natural resource management plans, and section 7 consultations. There has been some work on reintroduction and potential habitat management and modification techniques. However, there continues to be a need for information on the following topics: (1) the relationship of the Stephens' kangaroo rat to its associated biological community; (2) the ecology of the plant communities used by the Stephens' kangaroo rat; (3) the effects of reserve size on biological community structure and function; (4) yearly monitoring of the status of conserved Stephens' kangaroo rat populations; (5) suppression and/or eradication of exotic plants (e.g., *Bromus diandrus*); (6) development of appropriate

habitat management techniques; (7) control of exotic predators; and (8) development of a population characteristics model. Future research should focus on these eight areas. The accomplishment of this research should be pursued by conservation unit and reserve managers in cooperation with the Fish and Wildlife Service, the Department of Fish and Game, and the academic community to ensure the scientific validity of the data, results, and conclusions.

A. Investigate the relationship of the Stephens' kangaroo rat with its associated biological community.

The relationship of the Stephens' kangaroo rat to other members of its biological community has not been investigated adequately. Understanding more about the relationships between Stephens' kangaroo rats and other members of its biological community will likely be necessary in smaller reserves. As smaller reserves lose members of the biological community, the relationships among other members will likely change. The effects of change on Stephens' kangaroo rat needs to be understood to ensure appropriate management activities.

B. Investigate the role of pathogens in the ecology of the Stephens' kangaroo rat.

The role of pathogens and parasites in structuring animal communities is not well understood. Knowledge regarding this topic may prove to be essential in maintaining the biological diversity of small isolated reserves and ultimately the Stephens' kangaroo rat.

C. Investigate the ecology of the plant communities that constitute habitat for the Stephens' kangaroo rat.

Because the suitability of habitat is a key element in maintaining populations of the Stephens' kangaroo rat, investigate the ecology of these plant communities. Of special importance is the role of fire, and the presence of exotic grasses, in structuring plant communities. Understanding more about the ecology of these plant communities will help guide appropriate management activities for suppressing and possibly eradicating exotic plants.

D. Investigate the effects of reserve size and configuration on biological community structure and function.

Reserves of different sizes and configuration provide an opportunity to investigate the affects of these factors on the general biological community and specific species. In addition, investigating the changes that occur in the smaller reserves may provide an indication of what to expect for the larger reserves at some later date. Developing an understanding of the processes that occur should help in the development of management strategies designed to ameliorate these effects.

E. Obtain baseline data on the distribution and abundance of the Stephens' kangaroo rat and their habitat in each conservation planning region.

Though these data collection efforts should focus on the conservation units , initial efforts should include surveys of the status of populations throughout the remainder of the range, except in areas covered by Habitat Conservation Plans.

F. Investigate suppression and eradication techniques for introduced invasive plants such as European grasses.

G. Develop appropriate habitat management techniques.

Continue research on the effects of grazing, controlled burns, vegetation mowing, and tilling as habitat management tools for the Stephens' kangaroo rat. In addition, develop management techniques for the Stephens' kangaroo rat that are compatible with management of other species and resources.

H. Develop, implement, and evaluate a Stephens' kangaroo rat population monitoring protocol.

I. Develop a comprehensive model of Stephens' kangaroo rat population characteristics throughout its range, for each conservation planning area , and for each conservation unit.

Development of a population vulnerability analysis based on a complete data set would help guide management decisions.

IV. Develop Outreach Program

One of the major difficulties in the development and implementation of conservation efforts for the Stephens' kangaroo rat has been public resistance based on the perceived intrusiveness of mandated protection actions and the lack of perceived benefit of these protective actions. The conservation units, especially those in the urbanizing portion of western Riverside County, can provide a unique opportunity for educating the public on some of the benefits of conservation activities. Visitor and interpretive centers should be developed in one or more of the reserves. These should be coordinated with and provide facilities for a broader effort to educate the public about Stephens' kangaroo rat, its associated

biological community, and other conservation issues. This program should involve schools, museums, universities, conservation groups, and other local organizations.

A. Distribute education material
B. Provide information to land managers
C. Provide information to private sector
D. Establish observation areas
E. Provide photographs of the Stephens' kangaroo rat and its habitat

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III. IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines the specified actions and estimated costs for the recovery of the Stephens' kangaroo rat. It is a guide for meeting the objectives discussed in the "Recovery" section of this plan and depicts priorities, task numbers, descriptions, durations, responsible agencies, and estimated costs. The implementation schedule utilizes the numbering system from the narrative outline in the Recovery section of this document to identify recovery actions. These actions, when accomplished, should bring about the recovery of the Stephens' kangaroo rat and the protection of the species' essential habitat. Because the monetary needs for all parties involved in recovery are identified, this schedule reflects the total estimated financial requirements for the recovery of the species. All costs related to recovery efforts except those associated with possible land acquisition costs are estimated and included in the schedule.

Priority numbers given in Column 1 of the implementation schedule are defined as follows:

Priority 1 — An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

Priority 2 — An action that must be taken to prevent a significant decline in species population or habitat quality, or some other significant negative impact short of extinction.

Priority 3 — All other actions necessary to provide for full recovery of the species.

Legend

TBD=To be determined; amount depends on whether or not land is protected by acquisition, fee, or conservation easement.

Acronyms used:

BLM = Bureau of Land Management, U.S. Department of the Interior
CDFG = California Department of Fish and Game
MCBCP = Marine Corps Base, Camp Pendleton
NWCF = Naval Weapons Center, Fallbrook
RCHCA = Riverside County Habitat Conservation Agency
UC = University of California, TBD = to be determined
USFS = U.S. Forest Service
USFWS = U.S. Fish and Wildlife Service, Department of the Interior
MWD = Metropolitan Water District
VID = Vista Irrigation District

III. Implementation Schedule

Priority Number	Task Number	Task Description	Task Duration (yrs)	Responsible Party(s)	Total Cost $1,000's	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
1	I.A.2	Protect smaller, more isolated conservation units.	5	USFWS, BLM, CDFG, RCHCA, MAFB	TBD	TBD	TBD	TBD	TBD	TBD
1	I.B.1.a	Establish one ecosystem based conservation unit in Riverside County.	5	USFWS, BLM, USFS, CDFG, RCHCA	TBD	TBD	TBD	TBD	TBD	TBD
2	II.A.2	Eliminate discing and grading of habitat in conservation units.	5	USFWS, BLM, USFS, MAFB, MCBCP, NWCF, CDFG, RCHCA, MWD, VID, UC	10	2	2	2	2	2
2	II.A.3.a.	Reduce impacts of exotic plants in conservation units.	Ongoing	USFWS, BLM, USFS, MAFB, MCBCP, NWCF, CDFG, RCHCA, MWD, VID, UC	100	20	20	20	20	20
2	II.A.3.b.	Prevent introduction of exotic plants in conservation units.	Ongoing	USFWS, BLM, USFS, MAFB, MCBCP, NWCF, CDFG, RCHCA, MWD, VID, UC	10	2	2	2	2	2
2	I.A.1.	Establish ecosystem based conservation unit in San Diego County.	5	USFWS, BLM, USFS, MCBCP, NWCF, CDFG, SDCO, VID	50	10	10	10	10	10
2	I.B.1.b.	Establish one additional ecosystem based conservation unit in San Diego County.	5	USFWS, BLM, USFS, MCBCP, NWCF, CDFG, SDCO, VID	50	10	10	10	10	10

III. Implementation Schedule (continued)

Priority Number	Task Number	Task Description	Task Duration (yrs)	Responsible Party(s)	Total Cost $1,000's	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
2	II.B.1.a.	Prevent use of rodenticides in conservation units.	5	USFWS, BLM, USFS, MAFB, MCBCP, NWCF, CDFG, RCHCA,MWD, VID, UC	10	2	2	2	2	2
2	II.B.1.b.	Prevent indiscriminant use of pesticides in conservation units.	5	USFWS, BLM, USFS, MAFB, MCBCP, NWCF, CDFG, RCHCA, MWD, VID, UC	10	2	2	2	2	2
2	II.B.2.	Reduce predation from introduced predators.	Ongoing	USFWS, BLM, USFS, MAFB, MCBCP, NWCF, CDFG, RCHCA, MWD, VID, UC	100	20	20	20	20	20
2	III.A.	Investigate relationship of Stephens' kangaroo rat with its biological community.	10	USFWS, CDFG	200	40	40	40	40	40
2	III.B.	Investigate role of pathogens in ecology of the Stephens' kangaroo rat.	5	USFWS, CDFG,	100	20	20	20	20	20
2	III.C.	Investigate ecology of plant communities that constitute habitat for the Stephens' kangaroo rat.	5	USFWS, CDFG	100	20	20	20	20	20
2	III.D.	Investigate reserve size and configuration on biological community structure and function.	Ongoing	USFWS, CDFG	100	20	20	20	20	20

III. Implementation Schedule (continued)

Priority Number	Task Number	Task Description	Task Duration (yrs)	Responsible Party(s)	Total Cost $1,000's	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
2	III.E.	Determine distribution and abundance of Stephens' kangaroo rat.	5	USFWS, BLM, CDFG, RCHCA, MWD, VID, MCBCP, UC, RCHCA	100	20	20	20	20	20
2	III.F.	Investigate supression and eradication techniques for introduced grasses.	5	USFWS, CDFG	50	10	10	10	10	10
2	III.G.	Develop habitat management techniques.	5	USFWS, CDFG	50	10	10	10	10	10
3	II.A.1.	Post and fence conservation units where appropriate and as needed.	5	USFWS, BLM, USFS, MAFB, MCBCP, NWCF, CDFG, RCHCA, MWD, VID, UC	50	10	10	10	10	10
3	III.H.	Develop, implement, and evluate a Stephens' kangaroo rat monitoring protocol.	2	USFWS, CDFG	20	10	10	0	0	0
3	III.I.	Develop complete population cracteristics model for the Stephens' kangaroo rat.	5	USFWS, CDFG	20	0	0	0	10	10
3	IV.A.	Distribute educational material.	Ongoing	USFWS, CDFG	25	5	5	5	5	5
3	IV.B.	Provide information to land managers.	Ongoing	USFWS, CDFG	10	2	2	2	2	2
3	IV.C.	Provide information to private land owners.	Ongoing	USFWS, CDFG	5	1	1	1	1	1
3	IV.D.	Establish observation areas.	2	USFWS, CDFG	20	10	10	0	0	0
3	IV.E.	Provide photos.	Ongoing	USFWS, CDFG	10	2	2	2	2	2
Totals additional costs are yet to be determined (TBD)					1,200	248	248	228	238	238