Morro Bay Kangaroo Rat
(*Dipodomys heermanni morroensis*)

5-Year Review:
Summary and Evaluation

Photo by Moose Peterson

U.S. Fish and Wildlife Service
Ventura Fish and Wildlife Office
Ventura, California

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5-YEAR REVIEW
Morro Bay kangaroo rat (*Dipodomys heermanni morroensis*)

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

The Morro Bay kangaroo rat (*Dipodomys heermanni morroensis*) is a small, nocturnal, burrowing rodent (family Heteromyidae) with elongate hind legs for hopping. The species occurs on old, stabilized sand dunes (windblown sand deposited late to middle Pleistocene; Wiegers 2009) in the vicinity of Los Osos in San Luis Obispo County, California (Figures 1, 2). The range of the species is restricted to an area of approximately 12.4 square kilometers (km) (4.8 square miles (mi) generally corresponding to the distribution of Baywood fine sand (a soil type; Carpenter and Storie 1928) south and southeast of Morro Bay (Figure 3). The Morro Bay kangaroo rat was federally listed as endangered in 1970 (35 FR 16047). The species has not been observed in the wild since 1986 despite many trapping efforts, and the last individual in captivity died in 1993.

There are two primary causes of decline, which were identified in the recovery plan (Service 1982) and are ongoing. First, development in the vicinity of Los Osos, including homes, shopping centers, and parking lots, has resulted in direct loss of habitat. Second, in the absence of fire, its optimum habitat (the early stages of coastal dune scrub) has changed as a result of succession (the progressive replacement of one dominant plant community by another) to a dense, mature plant community lacking both open spaces required for movement and their food plants (Figure 4).

Because the Morro Bay kangaroo rat has not been observed in the wild since 1986 and because there are no longer any in captivity, we consider it as possibly extinct as does the California Department of Fish and Game (CDFG) 2000). However, in cooperation with our partners

Figure 1. The geographic distribution of the nine subspecies of *Dipodomys heermanni* in California. 1. *D. heermanni* a*renae*. 2. *D. heermanni berkeleyensis*. 3. *D. heermanni dixoni*. 4. *D. heermanni goldmani*. 5. *D. heermanni heermanni*. 6. *D. heermanni jolonensis*. **7. *D. heermanni morroensis*.** 8. *D. heermanni swarthi*. 9. *D. heermanni tularensis*. The geographic range of the Morro Bay kangaroo rat (*D. heermanni morroensis*) encompasses the community of Los Osos in San Luis Obispo County. This figure is adapted from Kelt (1988).

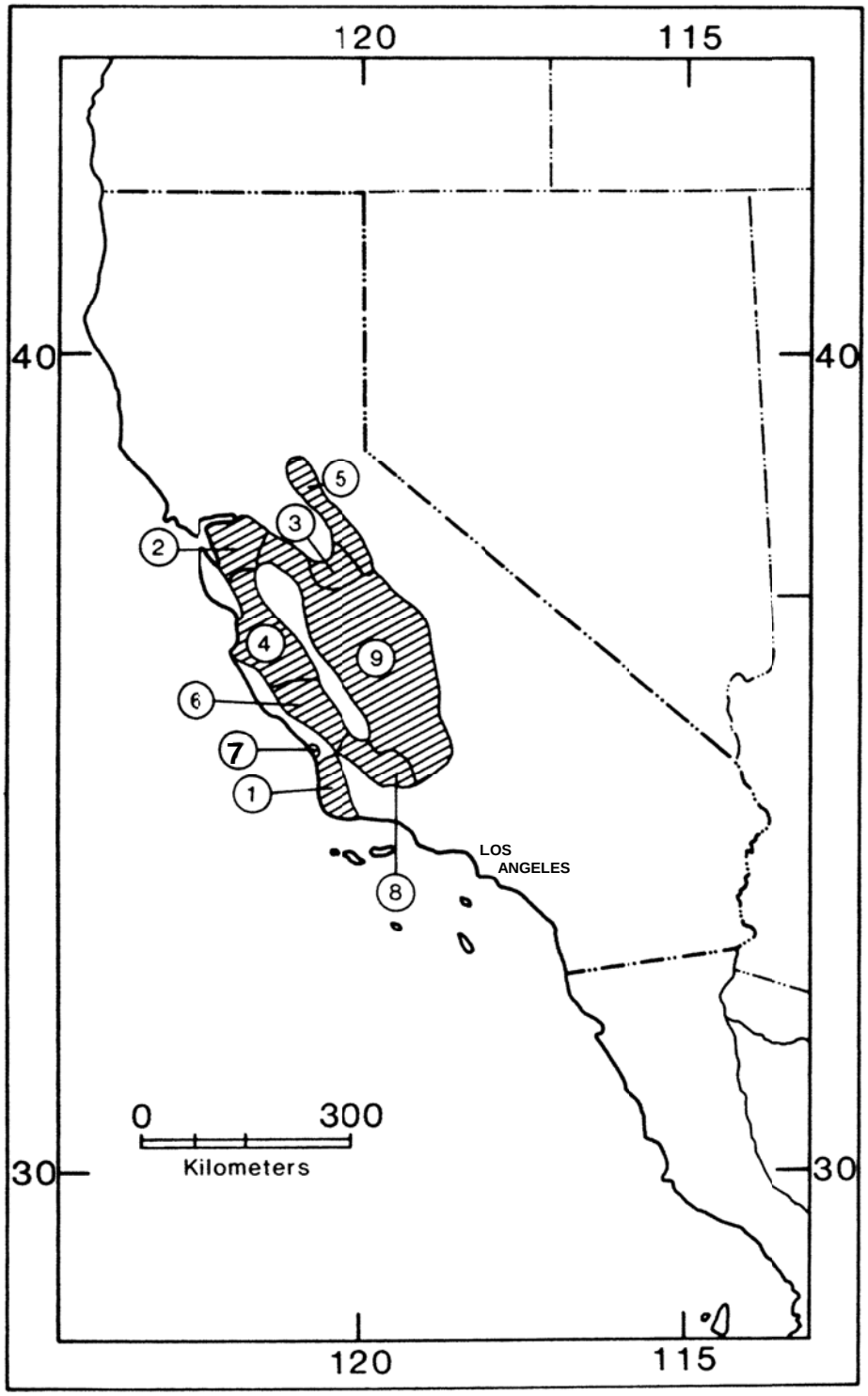
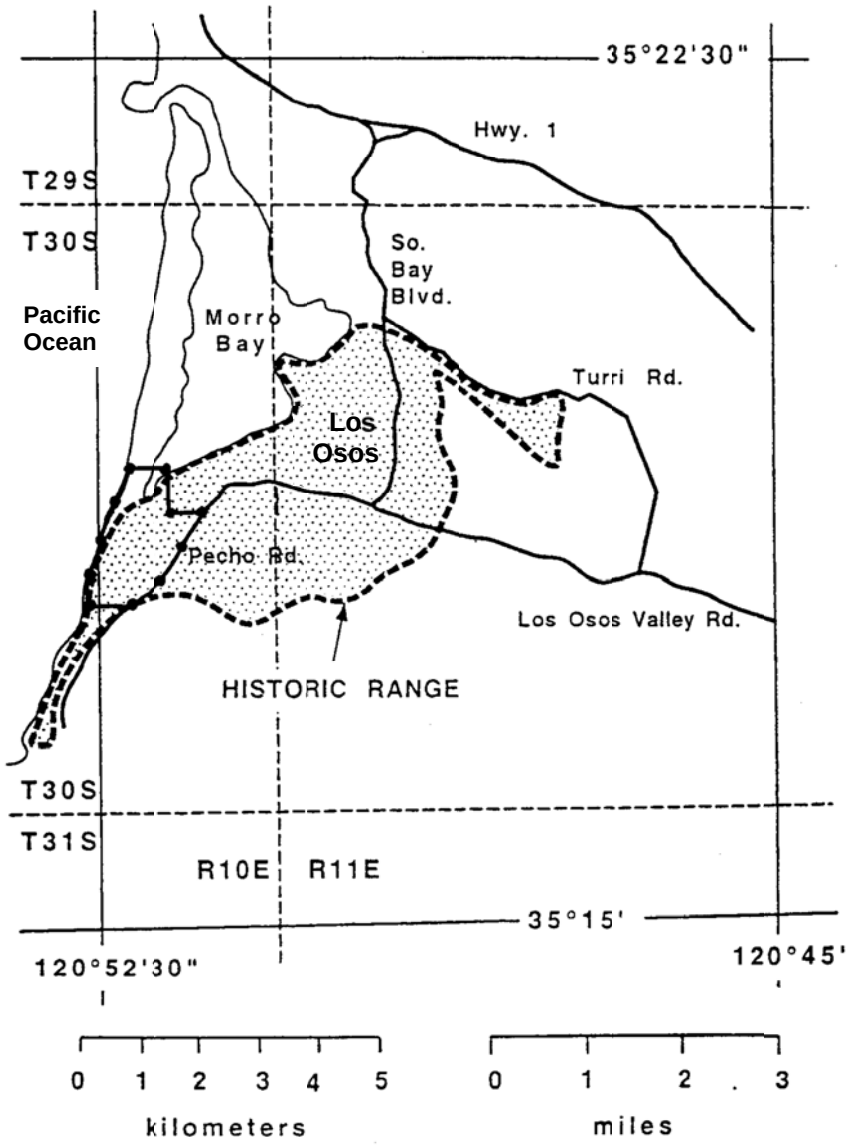


Figure 2. The historical distribution of the Morro Bay kangaroo rat (*Dipodomys heermanni morroensis*) in the vicinity of Los Osos, San Luis Obispo County, California. This figure is adapted from the Service (2000) and is based on Dixon (1918), Grinnell (1922), Stewart (1958), and Stewart and Roest (1960).



Historic Range — — — — — —

Designated Critical Habitat ——•——

Figure 3. Sandy soils in the vicinity of Los Osos, San Luis Obispo County, California. Stippling indicates Baywood fine sand, and it encompasses the community of Los Osos. Yellow on the Baywood fine sand indicates areas of urban development. Orange dots indicate the geographic range of the Morro Bay kangaroo rat (*Dipodomys heermanni morroensis*). X and # indicate where Morro Bay kangaroo rats were captured in 1957 and 1958 in a study to determine the species' geographic range (Stewart and Roest 1960). This figure is adapted from Villablanca (2009).

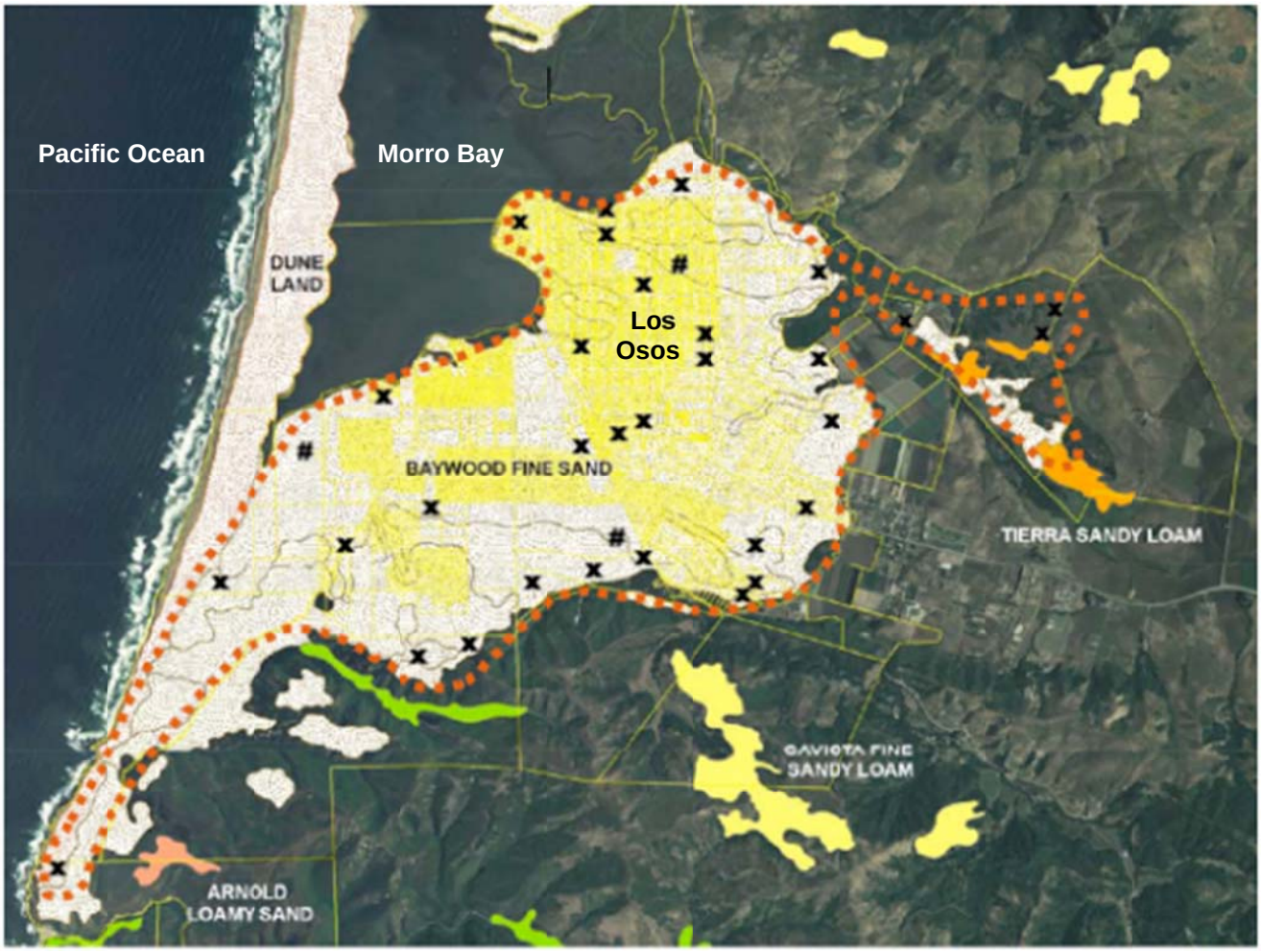


Figure 4. Succession of the early stages of coastal dune scrub to a dense, mature plant community on a study plot at Bayview in Los Osos, San Luis Obispo County, California. The letters a-e indicate the same sequence of distant peaks for alignment of the two photos. The upper photo shows the study plot with an early stage of coastal dune scrub in August 1984, when it was known to be inhabited by Morro Bay kangaroo rats (*Dipodomys heermanni morroensis* (Villablanca 1987). The lower photo shows the study plot with dense, mature vegetation (up to 1.6 meter (m) (5.2 feet (ft) height) in January 2008, which is now unsuitable for Morro Bay kangaroo rats. This figure is from Villablanca (2009).

(California Polytechnic State University, California Department of Parks and Recreation (CDPR), we are continuing to search for the species. The observations of potential signs (signs that may be evidence of the species, e.g., burrow entrance shaped like an upside down U with a runway, tail drag mark, surface seed pit cache; Stewart 1958, Villablanca 1987, Service and CDFG 1996) from 2008 to 2011 suggest that some isolated colonies may still persist in pockets of suitable habitat. In addition, we have been unable to conduct searches on several large, private properties of interest, including two where the species previously occurred.

Methodology Used to Complete This Review:

This review was prepared by the Ventura Fish and Wildlife Office, following the Region 8 guidance issued in March 2008. We used information from our files, the California Natural Diversity Database maintained by CDFG (2011), the published literature, and information from species experts. We received no information from the public in response to our Federal Register Notice initiating this 5-year review. This 5-year review contains updated information on the species' biology and threats, and an assessment of that information compared to that known at the time of listing. We focus on current threats to the species that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

Contact Information:

> **Lead Regional Office:** Larry Rabin, Deputy Division Chief for Listing, Recovery, and Environmental Contaminants, and Karen Jensen, Fish and Wildlife Biologist, Region 8, Pacific Southwest region; (916) 414-6464.
>
> **Lead Field Office**: Christopher Kofron, Fish and Wildlife Biologist, and Michael McCrary, Listing and Recovery Program Coordinator for Wildlife, Ventura Fish and Wildlife Office; (805) 644-1766, extensions 303 and 372.

Federal Register (FR) Notice Citation Announcing Initiation of This Review: A notice announcing initiation of the 5-year review of this species and the opening of a 60-day period to receive information from the public was published in the Federal Register on May 21, 2010 (75 FR 28636). No information was received as a result of this request.

Listing History:

> **<u>Original Listing</u>**
> **Notice:** 35 FR 16047
> **Date of Final Listing Rule:** October 13, 1970 (under the Endangered Species Preservation Act of 1966)
> **Entity Listed:** *Dipodomys heermanni morroensis* (subspecies)
> **Classification:** Endangered

State of California Designation and Listing
Designation Date by California State Legislature: 1968
Designation: Fully protected
Listing Date by California Fish and Game Commission: June 27, 1971
Classification: Endangered

Associated Rulemakings: Critical habitat was designated on April 11, 1977 (42 FR 40685).

Review History: A 5-year review has not been conducted previously. However, we reviewed the status of the species in the 1982 recovery plan (Service 1982) and in the 2000 draft revised recovery plan (Service 2000).

Species' Recovery Priority Number at Start of 5-Year Review: The recovery priority number for the Morro Bay kangaroo rat is 6C according to the Service's 2010 Recovery Data Call for the Ventura Fish and Wildlife Office, based on a 1 to 18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number indicates that the taxon is a subspecies facing a high degree of threat, with a low potential for recovery, and in conflict with development (48 FR 51985).

Recovery Plan or Outline

Name of Recovery Plan: Morro Bay Kangaroo Rat Recovery Plan.
Date Issued: August 18, 1982

Name of Draft Revised Recovery Plan: Draft Revised Recovery Plan for the Morro Bay Kangaroo Rat (*Dipodomys heermanni morroensis*).
Date Issued: January 25, 2000

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment Policy

The Endangered Species Act defines "species" as including any subspecies of fish or wildlife or plant, and any distinct population segment of any species of vertebrate wildlife. The policy regarding the recognition of distinct vertebrate population segments under the Act (Service and National Oceanic and Atmospheric Administration 1996) clarifies the interpretation of the phrase "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the Act.

There are no data supporting the concept of distinct population segments within the Morro Bay kangaroo rat. Rather, Matocq and Villablanca (2001) considered distinct population segments to be very unlikely due to the small and contiguous nature of its habitat (Figures 1, 2, 3). Therefore, the application of the distinct population segment policy is not addressed further in this review.

Information on the Species and its Status

Description

The Morro Bay kangaroo rat is the smallest of nine subspecies of *Dipodomys heermanni* (Kelt 1988), with adults weighing approximately 65 grams (2.3 ounces (Roest 1984). In addition to its smaller size, the Morro Bay kangaroo rat is diagnosed from the other eight subspecies by a combination of its darker brown coloration, incomplete or absent white hip stripe, and black stripe across the nose (Grinnell 1922).

Biology and Life History

Morro Bay kangaroo rats construct burrows in sandy soils with slopes of less than 15 degrees (Gambs and Holland 1988). Morro Bay kangaroo rats use and maintain multiple burrow systems (up to 10 were used simultaneously in an outdoor enclosure; Gambs and Nelson 1989). The main burrow is approximately 1.8 to 3.0 m (5.9 to 9.8 ft) long, with two or three rooms, one of which contains a nest. Each main burrow has one or two main entrances and two or three side tunnels which may be used for seed caches or escape routes (Stewart and Roest 1960, Gambs and Nelson 1990).

Morro Bay kangaroo rats are nocturnal, solitary, and territorial (Service 1982, Roest 1991). Trapping records indicate year-round activity (i.e., no dormancy period), with juveniles captured from March through November. Gestation is approximately 30 days, and sexual maturity is attained at approximately 4 months of age (Roest 1984). Reported sizes of litters ranged from one to four pups (Stewart and Roest 1960, Roest 1991). Longevity in the wild is probably 2 to 3 years (Service 1982).

In captivity, Morro Bay kangaroo rats ate seeds of the following local plant species when offered as food: *Corethrogyne filaginifolia* (common sandaster), *Lotus scoparius* (common deerweed), *Cirsium occidentale* (cobwebby thistle), *Horkelia cuneata* (wedgeleaf horkelia), *Mucronea californica* (California spineflower), *Salvia mellifera* (black sage), *Ericameria ericoides* (California goldenbush), *Dudleya caespitosa* (sealettuce), *Lupinus chamissonis* (chamisso bush lupine), and *Lupinus arboreus* (yellow bush lupine). In addition, the captive individuals accepted stems and leaves of *Lotus* sp., *Dudleya* sp., *Lupinus* sp., and *Bromus* sp.; and also ants, crickets, grasshoppers, and garden snails (Stewart and Roest 1960, Roest 1991).

Potential predators include the following (Gambs and Holland 1988): common kingsnake (*Lampropeltis getula*), gopher snake (*Pitupohis melanoleucus*), western rattlesnake (*Crotalus viridis*), barn owl (*Tyto alba*), great-horned owl (*Bubo virginianus*), American badger (*Taxidea taxus*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), domestic cat (*Felis catus*), domestic dog (*Canis lupus*), gray fox (*Urocyon cinereoargenteus*), and long-tailed weasel (*Mustela frenata*).

Spatial Distribution

Dipodomys heermanni inhabits central California from El Dorado County south to Santa Barbara County (Kelt 1988), occupying the California grassland and chaparral provinces of the Pacific

coast and San Joaquin Valley (Schmidly et al. 1993). The Morro Bat kangaroo rat subspecies is restricted to the vicinity of Los Osos, San Luis Obispo County. It occurs on old, stabilized sand dunes (windblown sand deposited late to middle Pleistocene; Wiegers 2009), with a geographic range of approximately 12.4 square km (4.8 square mi) corresponding generally to the distribution of Baywood fine sand south and southeast of Morro Bay (Stewart and Roest 1960, Service 2000). The nearest population of another subspecies (Lompoc kangaroo rat, *D. heermanni arenae*) is approximately 19 km (11.8 mi) to the southeast near Edna, San Luis Obispo County (Souza 1958).

Historically, most researchers have divided Los Osos into eight areas when referring to locations for Morro Bay kangaroo rats (Figure 5). These eight areas and the dates of the last capture of a Morro Bay kangaroo rat in each are the following: Hazard, 1957 (Stewart 1958); Pecho, 1979 (Toyoshima 1983); Bayview (previously Morro Palisades), 1986 (Gambs and Holland 1988); Los Osos Oaks, 1957 (Stewart 1958); Buckskin, 1985 (Villablanca 1987); Junior High/Santa Ysabel, 1984 (Roest in Villablanca 1987); Extension (or Turri Road), 1977 (Roest 1977); and Baywood Park, 1977 (Roest 1977). Additional details are provided in Appendix A.

Although no captures have occurred since 1986, pockets of suitable habitat remain in all eight areas. Because the detection of Morro Bay kangaroo rats at low density is especially difficult (F. Villablanca, California Polytechnic State University, pers. comm. 2010) and we have not been able to search on all private properties, isolated colonies could be persisting in any of the eight areas.

Many of the private landowners in the community of Los Osos have granted permission to conduct searches on their properties. We will continue to seek permission from other private landowners to conduct searches on their properties too.

Abundance

Estimates of population size and occupied habitat from 1957 to 1986 are shown in Table 1 and Figure 6. In brief, the population and occupied habitat declined from approximately 8,000 individuals (Stewart in Congdon and Roest 1975) on 6.5 square km (2.5 square mi) in 1957 (Stewart and Roest 1960) to 50 individuals on 12.6 hectares (ha) (31.1 acres (ac) in 1986 (Gambs and Holland 1988). The last time a Morro Bay kangaroo rat was captured in the wild was 1986 (Bayview, Gambs and Hollands 1988; an escapee from the outdoor enclosure at Pecho South was recaptured in 1988, Gambs and Nelson 1990). The species has not been observed in the wild since then, although numerous trapping efforts and visual surveys have been conducted including an extensive search from 2008 to 2011. As of 1999, the CDFG (2000) has considered the Morro Bay kangaroo rat as possibly extinct. As of 2011, because many years have now passed without a capture despite many search efforts, we also consider that the Morro Bay kangaroo rat is possibly extinct. However, based on recent potential signs of Morro Bay kangaroo rat activity at the Hazard, Pecho and Junior High/Santa Ysabel areas, some isolated colonies may still persist in pockets of suitable habitat (Villablanca, pers. comm. 2010). In addition, the status of the species on several larger private properties remains unknown because we have not been able to obtain permission to conduct surveys there.

Figure 5. Historical areas (place names) for the Morro Bay kangaroo rat (*Dipodomys heermanni morroensis*) in the vicinity of Los Osos, San Luis Obispo County, California. This figure is adapted from the Service (2000).

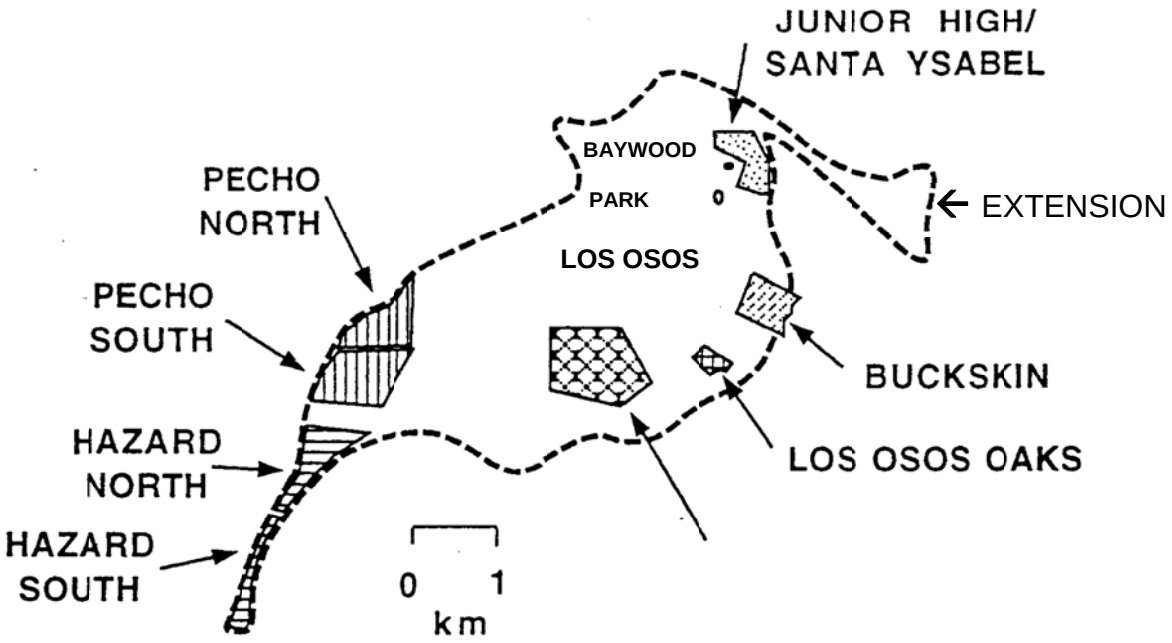
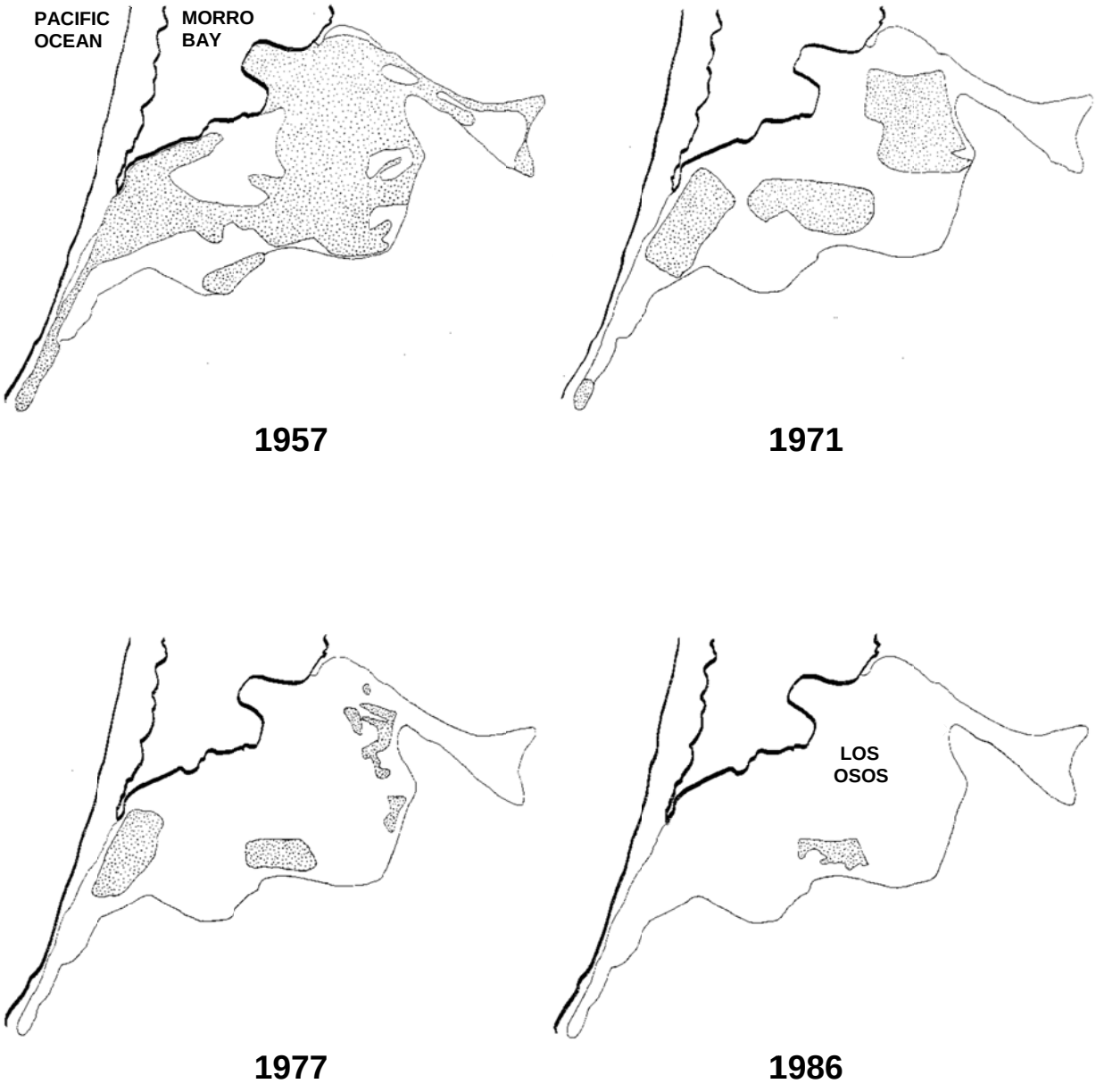


Table 1. Estimates of population size and occupied habitat for the Morro Bay kangaroo rat (*Dipodomys heermanni morroensis*), 1957 to 1986. The only capture of a Morro Bay kangaroo rat since 1986 was an escapee from the outdoor enclosure at Pecho South in 1988 (Gambs and Nelson 1990).

Year	Population Size	Occupied Habitat	Number Captured	Capture Area	Reference
1957	8,000[A]	< 6.5 square km[B] (2.5 square mi)		Many including: Hazard South Pecho South Pecho North 1000 foot hill Bayview Los Osos Oaks Buckskin (including APN 067-011-041) Junior High/Santa Ysabel Extension Baywood Park	[A]Stewart in Congdon and Roest 1975 [B]Stewart and Roest 1960
1971	3,000[C]	4.5 square km[C] (1.8 square mi)	8[D] 14[D] 17[D] 4[D]	Pecho South Bayview Buckskin (including APN 067-011-041) Junior High/Santa Ysabel	[C]Congdon and Roest 1975 [D]Congdon 1971
1977	1,500-2,000	93.5 ha (231 ac)	7 5 3 21	Pecho South Bayview Buckskin Junior High/Santa Ysabel	Roest 1977
1979	345	86.6 ha (214 ac)	2 19 4 11	Pecho South Bayview Buckskin Junior High/Santa Ysabel	Toyoshima 1983
1984	21	14.2 ha (35.1 ac)	6	Bayview	Gambs and Holland 1988
1985	51	13.3 ha (32.9 ac)	18	Bayview Buckskin	Gambs and Holland 1988
1985	50-150	13.3 ha (32.9 ac)	26 1	Bayview Buckskin	Villablanca 1987
1986	50	12.6 ha (31.1 ac)	24	Bayview	Gambs and Holland 1988

Figure 6. Areas known to be occupied by the Morro Bay kangaroo rat (*Dipodomys heermanni morroensis*) from 1957 to 1986 in the vicinity of Los Osos, San Luis Obispo County, California. Stippling indicates the occupied areas. This figure is adapted from Gambs (1986a).



From 2008 to 2011, the Service, California Polytechnic State University (Dr. Francis Villablanca and students), and CDPR have been conducting a search for the Morro Bay kangaroo rat. The search includes habitat assessments, visual surveys, and trapping throughout the known geographic range and also in adjacent and nearby areas with sandy soil. In addition, we are considering habitat restoration (prescribed burns) at several places where potential signs of Morro Bay kangaroo rats have been observed recently on State lands, with the intent to present any persisting colonies with opportunities to expand into optimum habitat.

Habitat

Morro Bay kangaroo rats inhabit sandy soils (compacted, not loose; Roest 1973) in several types of vegetation. The optimum habitat is the early stages of coastal dune scrub (Figure 4), and for which the last known colonies showed a preference (Gambs and Holland 1988). This plant community is characterized by scattered shrubs less than 0.9 m (3 ft) tall, interspersed with annual plants and bare ground. Some of the characteristic plants in this habitat are *Cardionema ramosissimum* (sandcarpet), *Ceanothus cuneatus* (buckbrush), *Cirsium occidentale, Croton californicus* (California croton), *Eriogonum parvifolium* (seacliff buckwheat), *Horkelia cuneata*, *Lotus scoparius*, and grasses (Roest 1973, Gambs and Holland 1988).

The Baywood fine sand in the vicinity of Los Osos supports a natural mosaic of coastal dune scrub, chaparral, and coastal oak woodland (Service 2000). As the young coastal dune scrub matures, the vegetation becomes taller and denser which inhibits germination of annual plants. The changing habitat becomes less favorable to Morro Bay kangaroo rats as succession progresses (Congdon and Roest 1975).

Mature coastal dune scrub and chaparral are dense, shrub-dominated plant communities with relatively few open spaces. Morro Bay kangaroo rats do not inhabit dense vegetation (or oak groves (Stewart and Roest1960) because it likely inhibits their movement and also lacks their food plants (Service 1982). The openness of the vegetation is likely the most important characteristic of its natural habitat (Villablanca 1987), along with sandy soil.

Genetics

Morro Bay kangaroo rats have low genetic diversity. Matocq and Villablanca (2001) demonstrated that the low genetic diversity in the Morro Bay kangaroo rat is historical (pre-1918) rather than resulting from a recent population decline. In addition, using mitochondrial DNA sequences and nuclear microsatellite allele frequencies, Villablanca (2007) concluded that the Morro Bay kangaroo rat is genetically differentiated from all other subspecies of *D. heermanni* and is an evolutionarily significant unit (as defined by Moritz 1994).

Species-specific Research and/or Grant-supported Activities

The Morro Bay kangaroo rat has been the subject of many research and grant-supported activities since listing. The following is a list of funded activities since issuance of the draft revised recovery plan (Service 2000).

2010. Search for the endangered Morro Bay kangaroo rat in 2010, year 2. (Dr. Francis Villablanca, California Polytechnic State University, San Luis Obispo; from the Service).

2008. Search for the endangered Morro Bay kangaroo rat in 2008, year 1. (Dr. Francis Villablanca; from the Service).

2006. Genetic and morphological distinction of the Morro Bay Kangaroo Rat. (Dr. Francis Villablanca; from CDFG with section 6 funds from the Service).

2005. Genetic diversity and genetic distinction of the endangered Morro Bay Kangaroo Rat. (Dr. Francis Villablanca; from CDFG with section 6 funds from the Service).

2002. Field surveys for Morro Bay Kangaroo Rats. (Dr. Roger Gambs, California Polytechnic State University, and Dr. Francis Villablanca; from CDFG with section 6 funds from the Service).

Five-Factor Analysis

The Morro Bay kangaroo rat was initially listed as endangered in 1970 under the Endangered Species Preservation Act of 1966. The species subsequently received additional Federal protection with passage of the Act in 1973. Because it was listed as endangered prior to the Act, there was no formal listing package identifying threats.

The recovery plan (Service 1982, p. 25) stated the following as the primary reason for the decline: "The basic reason for the decline of the Morro Bay kangaroo rat population is the loss of suitable habitat, resulting from two main causes. First, the human population of the Baywood-Los Osos community…has increased 600 percent during the past 20 years... Human population growth has been accompanied by a building boom which has replaced much of the original kangaroo rat habitat with homes, gardens, shopping centers, parking lots, and roads. These developments have completely destroyed major portions of the original kangaroo rat range… Second, areas which still remain in a natural state have not been disturbed by fire or any other factor for over 30 years. The resulting growth and maturation of the vegetation into mature coastal scrub has long passed the point at which kangaroo rats can easily move about and still find their natural foods. The shrubby vegetation has replaced the low herbaceous vegetation which forms the optimum habitat for the animals." The recovery plan (Service 1982) identified the following as additional threats to the species: predation by cats, destruction of burrows by off-highway vehicles and horses, habitat fragmentation, fragmentation of larger populations into small subpopulations, and perhaps reduction in genetic diversity.

The draft revised recovery plan (Service 2000) identified the following as ongoing threats: direct loss of habitat by urban development, changes in the vegetation of the remaining habitat, predation by cats and dogs, destruction of burrows by off-highway vehicles and pedestrians, competition with other burrowing rodents, fragmentation of larger populations into small subpopulations, and perhaps inbreeding.

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

It is estimated that less than 1 percent of the optimum habitat (early stages of coastal dune scrub) now exists in the geographic range of the Morro Bay kangaroo rat (Villablanca, pers. comm. 2011a). Loss of habitat by development and vegetation change continues to be the primary threat.

Since issuance of the recovery plan (Service 1982), Morro Bay kangaroo rats have been captured in three areas: Bayview (last capture in 1986, Gambs and Holland 1988); Buckskin (last capture in 1985, Villablanca 1987); and Junior High/Santa Ysabel (last capture in 1984, Roest in Villablanca 1987). Bayview (approximately 83 ha (205 ac) and Junior High/Santa Ysabel (approximately 24 ha (59 ac) are now mostly under ownership by the CDFG and CDPR and protected from development. However, much of Junior High/Santa Ysabel was cleared and plowed by the previous owner in the few years prior to 2002 when purchased by the CDPR (Villablanca, pers. comm. 2010). The Buckskin area is privately owned and much is now developed for urban and agricultural purposes. Only pockets of suitable habitat remain in these four areas.

Morro Bay kangaroo rats were last captured at Hazard and Los Osos Oaks in 1957 (Stewart 1958), at Pecho in 1979 (Toyoshima 1983), and in the Extension and Baywood Park in 1977 (Roest 1977). Hazard (approximately 74 ha (183 ac) and Los Osos Oaks (approximately 36.4 ha (90 ac) are now mostly under ownership by the CDPR. Pecho (approximately 165 ha (408 ac) is now mostly under ownership by the CDPR and CDFG. The Extension and most of Baywood Park are privately owned, and much of both are developed for urban, agricultural or industrial purposes. Only pockets of suitable habitat remain in these four areas.

The potential loss and modification of habitat by development is still a major threat to any persisting colonies on private lands. We have not been able to conduct surveys on four private properties: the main Buckskin property (26.3 ha (65 ac), APN 074-222-013); APN 067-011-041 (16.0 ha (40 ac), immediately northwest of the main Buckskin property); APN 067-012-018 (5.7 ha (14 ac), Junior High/Santa Ysabel area, immediately west of APN 067-011-041); and APN 074-229-024 (21.9 ha (54 ac), Baywood Park area). These four private properties comprise 6 percent of the historic geographic range. Any persisting colonies of Morro Bay kangaroo rats on State lands are secure from loss and modification of habitat by development.

Any persisting colonies of Morro Bay kangaroo rats on State and private lands continue to be threatened by habitat loss and modification due to dense native vegetation (early stages of coastal dune scrub succeeding to dense mature vegetation in the absence of fire). In addition, *Ehrharta calycina* (perennial veldt grass, a nonnative species) is causing habitat loss and modification. Also, depending upon the particular location, pedestrians, off-highway vehicles, and horses have potential to disturb the habitat and destroy burrows (Service 1982, 2000).

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for any purpose is not a threat in 2011. It has never been a threat in the past and was not identified as a threat in the recovery plan or draft revised recovery plan.

FACTOR C: Disease or Predation

Disease is not a known threat in 2011, and it has never been identified or suggested as a threat in the past. However, predation by feral and domestic cats was suggested as a threat by several researchers (e.g., Stewart and Roest 1960, Congdon and Roest 1975, Toyoshima 1983, Villablanca 1987, Gambs and Holland 1988) and identified as a threat in the recovery plan (Service 1982) and draft revised recovery plan (Service 2000). In consideration of the known predation by cats on other small mammals (e.g., Gray 1999, Fitzgerald and Turner 2000), we recognize cats as a threat to any persisting Morro Bay kangaroo rats in 2011.

Gambs and Holland (1988) listed dogs as potential predators, and the Service (2000) identified dogs as a threat. We agree that dogs are potential predators but consider the threat minute when compared to other threats at this point in time.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of regulatory mechanisms was not identified as a threat to the Morro Bay kangaroo rat in either the recovery plan or draft revised recovery plan, and we have no information that would indicate it is a threat currently.

The following is a brief summary of the primary Federal and State laws that apply.

The Act is the primary Federal law providing protection for this species. The Service's responsibilities include administering the Act, including sections 7, 9, and 10 that address take. Since listing, the Service has analyzed the potential effects of Federal projects under section 7(a)(2), which requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. A jeopardy determination is made for a project that is reasonably expected, either directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its reproduction, numbers, or distribution (50 Code of Federal Regulations (CFR) 402.02).
A non-jeopardy opinion may include reasonable and prudent measures that minimize the amount or extent of incidental take of listed species associated with a project. Incidental take refers to taking of listed species that results from, but is not the purpose of, carrying out an otherwise lawful activity by a Federal agency or applicant (50 CFR 402.02). In cases where some incidental take is unavoidable, the Service works with the agency to include additional conservation measures to minimize negative impacts. For projects without a Federal nexus that may negatively impact listed species, the Service may issue incidental take permits pursuant to section 10(a)(1)(B). To qualify for an incidental take permit, applicants must develop, fund, and implement a Service-approved habitat conservation plan that details measures to minimize and mitigate the project's adverse impacts to listed species. Regional habitat conservation plans in

some areas now provide an additional layer of regulatory protection for covered species, and these habitat conservation plans are coordinated with the State's related Natural Community Conservation Planning program.

The California State Legislature designated the Morro Bay kangaroo rat as a fully protected species in 1968. A fully protected species may not be taken or possessed at any time, and no State licenses or permits may be issued for their take except for collecting for necessary scientific research.

The Morro Bay kangaroo rat was listed as endangered in 1971 under the California Endangered Species Act (CESA). The CESA (California Fish and Game Code, section 2080 *et seq*.) prohibits the unauthorized take of State-listed threatened or endangered species. The CESA requires consultation with the CDFG for activities that may affect a State-listed species and mitigation for any adverse impacts to the species or its habitat. Pursuant to CESA, it is unlawful to import or export, take, possess, purchase, or sell any species or part or product of any species listed as endangered or threatened. The State may authorize permits for scientific, educational, or management purposes, and to allow take that is incidental to otherwise lawful activities.

FACTOR E: Other Natural or Manmade Factors Affecting Continued Existence

Habitat Fragmentation

Since at least the early 1970's (Congdon and Roest 1975), the habitat of the Morro Bay kangaroo rat has become increasingly fragmented by development, resulting in the loss of habitat connectivity across the landscape (Service 1982) and the isolation of Morro Bay kangaroo rats into small subpopulations (Service 2000). Habitat fragmentation is a threat when the species is extirpated from a site that has become isolated due to surrounding development or other activities, which makes it unlikely the site will ever be re-populated by immigration (Service 1982).

In addition, habitat fragmentation reduces or in some cases eliminates the possibility of any movement of Morro Bay kangaroo rats between sites, which in turn limits gene flow and genetic diversity. Thus, genes that may convey selective advantage at various points in time have not been exchanged between subpopulations since the landscape became discontinuous (Villablanca 1987). Inbreeding can result with deleterious effects including reduced vigor, low fecundity, and sterility (Lande 1988).

Stochastic Events

Species with small populations are vulnerable to extinction by stochastic events (Ricklefs 2008). This means that chance or random events can cause the population size to decrease, possibly down to extinction. Examples include severe storms, freezes, harsh winters, fires, and droughts, all of which can have catastrophic effects on small populations (Mangel and Tier 1994). Because the Morro Bay kangaroo rat may be persisting as only a few isolated colonies in pockets of suitable habitat in a small geographic area, stochastic events are an ongoing threat.

Invasive Plant Species

Ehrharta calycina now occurs throughout the range of the Morro Bay kangaroo rat, in particular comprising dense stands among the native vegetation in the Hazard, Pecho, and Junior High/Santa Ysabel areas. *Ehrharta calycina* is a threat because it can eliminate the open spaces required by the Morro Bay kangaroo rat. Also, the nonnative *Sorghum bicolor drummondii* (Sudangrass) was identified as a threat on the main Buckskin property (Villablanca 1987); however, our current knowledge of this property is limited because we have not been able to gain access.

Dense Native Vegetation

Dense native vegetation as a result of fire control in the Los Osos area is one of two primary causes of the species' decline. The optimum habitat of the Morro Bay kangaroo rat is the early stages of coastal dune scrub. The natural cycle for this vegetation type in the absence of periodic fires is to succeed to a dense, mature plant community. As this occurs, the habitat becomes progressively less suitable for Morro Bay kangaroo rats (e.g., Roest 1973, Congdon and Roest 1975) by eliminating open spaces needed for both movement and food plants. Historically, fire would burn the dense vegetation and return it to the early stages. In the absence of fire, the vegetation progresses and remains as dense, mature coastal scrub and chaparral, which excludes Morro Bay kangaroo rats (Service 1982).

Competition with Other Burrowing Rodents

Morro Bay kangaroo rats were found to be denser in areas dominated by early stages of coastal dune scrub, where other species of small mammals were found to be absent or at low densities (Gambs 1986d). As the more open vegetation becomes denser due to fire control, the small mammal community also changes. This likely puts Morro Bay kangaroo rats into competition with other species of rodents (e.g., Stewart in Service 1982, Gambs and Holland 1988, Gambs and Nelson 1990). Also, California ground squirrels (*Spermophilus beecheyi*) moved into areas where the habitat was restored at Pecho, which Gambs (1989) and Gambs and Nelson (1990) considered a serious threat. In addition, numerous burrows of Botta's pocket gophers (*Thomomys bottae*) were observed while conducting surveys for the Morro Bay kangaroo rat from 2008 to 2010 (Villablanca, pers. comm. 2010). Although we have no data, we suspect that Botta's pocket gophers could disturb or destroy the burrows of Morro Bay kangaroo rats. In brief, we consider competition with other rodents, including burrowing rodents, to be a threat to any persisting colonies of Morro Bay kangaroo rats in 2011.

Climate Change

Current climate change projections for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). Climate simulations have shown that California temperatures are likely to increase by 1.5 degrees Celsius (2.7 degrees Fahrenheit) under a lower emissions scenario, and by up to 4.5 degrees Celsius (8.1 degrees Fahrenheit) under a higher emissions scenario (Cayan et al. 2008).

Because of the diversity of the landscape, it is unknown if climate change will result in a warmer trend in California with localized drying, higher precipitation events, or other effects. While we lack adequate information to make specific and accurate predictions regarding how climate change in combination with other factors such as small population size will affect the Morro Bay kangaroo rat, limited-ranged species are likely to be more vulnerable to extinction due to these changing conditions. Our major concern is the effects of extreme weather events (e.g., severe storm, harsh winter, severe drought) due to climate change on any persisting colonies of the Morro Bay kangaroo rat.

III. RECOVERY CRITERIA

Recovery plans provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed species, and on criteria that may be used to determine when recovery goals are achieved. A recovery plan was issued in 1982 (Service 1982) and a draft revised recovery plan in 2000 (Service 2000). The latter document (Service 2000, p. 34) states the following: "…Morro Bay kangaroo rats may be reclassified as threatened when an effective genetic population size (N_e) of 500 has been achieved (translating to an actual census size of about 2,000 individuals), and then sustained with a mean at that level for 10 consecutive years, with adequate geographic distribution."

Because a Morro Bay kangaroo rat was last captured in 1986 and the last captive individual died in 1993 (Thompson et al. 1995), the draft revised recovery plan has not been finalized. As of 2011, we recognize that the Morro Bay kangaroo rat is possibly extinct. However, because potential signs have been observed recently by an expert on the species, we believe that some isolated colonies may still persist in pockets of suitable habitat. Therefore, the goal at this point in time is to locate any colonies that may still persist.

IV. SYNTHESIS

There are two primary causes of the decline of the Morro Bay kangaroo rat, as stated previously in the recovery plan (Service 1982). First, direct loss of habitat has occurred from development in the vicinity of Los Osos, including homes, shopping centers, other buildings, roads, and parking lots. Second, in the absence of fire, its optimum habitat comprising the early stages of coastal dune scrub has progressed to a dense, mature plant community lacking open spaces for the species' movement and food plants. Other threats include predation by cats, habitat fragmentation, stochastic events, invasive plant species, competition with other burrowing rodents, and extreme weather events. As a result of all of these threats, the species may be extinct. The last capture of a Morro Bay kangaroo rat occurred in 1986, and the last captive individual died in 1993.

Despite many trapping efforts since 1986, the Morro Bay kangaroo rat has not been captured again. However, a species expert has recently observed potential signs, suggesting that some isolated colonies may still persist in pockets of suitable habitat. In addition, we have not been able to search on several, large private properties of interest, including two where the species previously occurred. Therefore, in cooperation with our partners (California Polytechnic State University, CDPR), we will continue to search for the Morro Bay kangaroo rat. In summary, the

Morro Bay kangaroo rat still meets the definition of endangered, and we recommend no status change at this time.

V. RESULTS

Recommended Listing Action

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (indicate reason for delisting according to 50 CFR 424.11)
    ____ *Extinction*
    ____ *Recovery*
    ____ *Original data for classification in error*
_X_ No Change

New Recovery Priority Number and Brief Rationale: Not applicable.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

1. We recommend that searches for the Morro Bay kangaroo rat continue on State lands, in particular at Hazard, Pecho, Junior High/Santa Ysabel, and Bayview. However, rather than using the traditional transect method as employed in almost all previous trapping efforts, we now recommend that grid trapping and/or saturation trapping be used where potential signs are observed. Also, we recommend that (a) bait stations with cameras, (b) cameras at potential burrows, and (c) sniffer dogs be used as additional detection methods. These methods may be more effective at detecting a species possibly persisting in isolated colonies at low density.

2. Restoring the existing, mature habitat to an early stage may attract Morro Bay kangaroo rats from any nearby persisting colonies. Therefore, we recommend that habitat restoration be conducted on State lands. In particular, prescribed burns should be conducted where recent potential signs were observed by a species expert at Pecho South, Hazard South, Bayview, and Junior High/Santa Ysabel. Any prescribed burn should include a monitoring program with pre-burn/post-burn assessments.

3. We recommend that efforts continue for gaining permission to conduct surveys on the following private properties: the main Buckskin property (26.3 ha (65 ac), APN 074-222-013); APN 067-011-041 (16.0 ha (40 ac), immediately northwest of the main Buckskin property); APN 067-012-018 (5.7 ha (14 ac), Junior High/Santa Ysabel area, immediately west of APN 067-011-041); and APN 074-229-024 (21.9 ha (54 ac), Baywood Park area). Morro Bay kangaroo rats were last captured on the main Buckskin property in 1985 (Villablanca 1987), on APN 067-011-041 in 1971 (Congdon 1971), and on a property adjacent to APN 074-229-024 in 1957 (Stewart 1958). The current status of the species on these four properties cannot be determined until surveys are conducted.

4. We recommend that the search area be expanded further eastward toward Edna and southward toward Pismo Beach. This is in consideration of an individual Morro Bay kangaroo rat recorded near the eastern end of Los Osos Valley Road (35.2564 degrees north, 120.6946

degrees west) in the southwestern part of the city of San Luis Obispo (Villablanca 2007), approximately 12.5 km (7.7 mi) beyond the known geographic range. The origin of this specimen is questioned (Villablanca, pers. comm. 2011b).

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

Morro Bay kangaroo rat (*Dipodomys heermanni morroensis*)

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

Appropriate Listing/Reclassification Priority Number: N/A

Review Conducted By: Christopher Kofron

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve Diane K. Noda Date 5/26/11

APPENDIX A: Historical Areas for the Morro Bay Kangaroo Rat (*Dipodomys heermanni morroensis*)

Historically, researchers have divided Los Osos into eight areas when referring to locations. These are: Hazard, Pecho, Bayview (previously Morro Palisades), Los Osos Oaks, Buckskin, Junior High/Santa Ysabel, Extension (or Turri Road), and Baywood Park (Figure 5). However, the extent and boundaries of each area are not consistent in all reports, in particular for Pecho North and Pecho South, and Hazard North and Hazard South. Therefore, we follow the approximate boundaries as shown by the Service (2000). The following is a brief description of each area, along with a summarized history of Morro Bay kangaroo rats at each.

Hazard

Montaña de Oro State Park (approximately 5,463 ha (13,499 ac) is in western and southwestern Los Osos. The Hazard area (approximately 74 ha (183 ac) is west of Pecho Valley Road in the western part of the park. Two sections have been recognized, Hazard North (approximately 17 ha (42 ac) and Hazard South (approximately 57 ha (141). Hazard North extends southward approximately 0.7 km (0.4 mi) from an unnamed dirt road (35.2939 degrees north, 120.8724 degrees west, near the southern extent of critical habitat) to Hazard Canyon. Hazard South extends southward approximately 1.6 km (1.0 mi) from Hazard Canyon to Spooner's Cove. The integrity of both sections is now threatened by *Ehrharta calycina*.

Although Hazard North appears to have some suitable habitat even in 2011, the Morro Bay kangaroo rat has never been recorded here. Roest (in Service 1982) observed potential sign here in 1980. No individuals were captured by trapping in 1984 and 1985 (Villablanca 1987), and visual surveys were negative in 1991 (Gambs et al. 1992) and 2010 (Villablanca, pers. comm. 2010).

Morro Bay kangaroo rats were last captured at Hazard South in 1957 (Stewart 1958). Diagnostic signs (signs accepted as evidence of the species) were reported here in 1971 (Service 2000) and 1977 (Stewart in Roest 1977). Trapping in 1983 (Gambs 1986c) and 2010 (Villablanca, pers. comm. 2010) resulted in no captures. Potential signs were observed at Hazard South in 1991 (Gambs et al. 1992) and 2010 (Villablanca, pers. comm. 2010).

Pecho

The Pecho area is in western Los Osos and comprises approximately 165 ha (408 ac) west of Pecho Valley Road, with its northern boundary at Morro Bay and southern boundary at an unnamed dirt road (35.2939 degrees north, 120.8724 degrees west, near the southern extent of critical habitat) approximately 0.7 km (0.4 mi) north of Hazard Canyon. Unpublished reports refer to Pecho North and Pecho South, with bisection usually by Seascape Place (previously called Old Army Road). Most of this area is now part of Montaña de Oro State Park. Seventeen hectares (42 ac) of private land (previously known as the Hotel Site) along Seascape Place were purchased and added to Montaña de Oro State Park in 2006 (Sneed 2006). Approximately 20 ha (49 ac) of Pecho South comprise the western section of Morro Dunes Ecological Reserve, which the CDFG purchased in 1978 specifically for conservation of the Morro Bay kangaroo rat.

Morro Bay kangaroo rats were captured at Pecho North in 1957 (Stewart 1958) and 1973 (*n* = 1, Roest 1973). Trapping with no captures occurred in 1971 (Congdon 1971), 1977 (Roest 1977), 1985 (Villablanca 1987), 1985 (Gambs 1985), 1986 (Gambs 1989), 1987 (Gambs 1989), 1988 (Gambs 1989), 1989 (Gambs 1989), 1995 (Morro Group, Inc. 1996), 2008 (Villablanca 2009), and 2010 (Villablanca, pers. comm. 2010). Visual surveys were negative in 1989 (Gambs and Nelson 1990), 1991 (Gambs et al. 1992), 1996 (O'Farrell 1996b as cited in O'Farrell 2003), and 1998 (O'Farrell 1998a). Diagnostic sign was observed in 1971 (Congdon 1971, Congdon and Roest 1975), and potential signs were observed in 1995 (Morro Group, Inc. 1996), 2008 (Villablanca 2009), 2010 (Villablanca, pers. comm. 2010), and 2011 (Villablanca, pers. comm. 2011a).

Morro Bay kangaroo rats were captured at Pecho South in 1957 (Stewart 1958), 1971 (*n* = 8, Congdon 1971), 1973 (*n* = 6, Roest 1973), 1977 (*n* = 7, Roest 1977), 1978 (*n* = 8, Toyoshima 1983), 1979 (*n* = 4, Toyoshima 1983), and 1988 (*n* = 1, escapee from outdoor enclosure, Gambs and Nelson 1990). Trapping with no captures occurred in 1983 (Gambs 1986c), 1984 (Gambs 1986b, c; Villablanca 1987), 1985 (Gambs 1986b), 1987 (Schneider 1988), 1989 (Gambs and Nelson 1990), 1995 (Morro Group, Inc. 1996), and 2010 (Villablanca, pers comm. 2010). Visual surveys were negative in 1991 (Gambs et al. 1992), 1996 (O'Farrell 1996b as cited in O'Farrell 2003), 1997 (Service 2000), and 1998 (O'Farrell 1998a). Potential signs were observed in 1982 (Service 2000), 1995 (Morro Group, Inc. 1996), and 2010 (Villablanca, pers. comm. 2010).

Bayview

Bayview Ecological Reserve (83 ha (205 ac) comprises the eastern section of Morro Dunes Ecological Reserve, which was purchased by the CDFG in 2001 specifically for conservation of the Morro Bay kangaroo rat. Previously it was privately owned and known as Morro Palisades. This property is in southern Los Osos, immediately west of Bayview Drive and south of Highland Drive. Its northern and eastern boundaries border residential developments, its southern boundary borders private land with steeply-sloping hills, and its western boundary borders the undeveloped Broderson site. The Broderson site (32.4 ha (80 ac), also part of Bayview, is owned by the Los Osos Community Services District which intends to construct a wastewater percolation field here.

Morro Bay kangaroo rats were captured at Bayview in 1957 (Stewart 1958), 1971 (*n* = 14, Congdon 1971), 1977 (*n* = 5, Roest 1977), 1978 (*n* = 5, Toyoshima 1983), 1979 (*n* = 21, Toyoshima 1983), 1984 (*n* = 6, Gambs 1986d), 1985 (*n* = 18, Gambs 1986d; *n* = 25, Villablanca 1987), and 1986 (*n* = 24, Gambs and Holland 1988). Diagnostic signs were observed in 1989 (Gambs and Nelson 1990), 1990 (O'Farrell 2003), and 1991 (Gambs et al. 1992). Potential sign was observed in 2008 (Villablanca 2009). Trapping efforts were negative in 1997 (O'Farrell 1997b), 2002 (O'Farrell 2003), and 2008 (Villablanca 2009). Visual surveys were negative in 2000 (O'Farrell 2000), 2001 (O'Farrell 2001a, b), and 2004 (Villablanca 2004).

Los Osos Oaks

Los Osos Oaks State Preserve (36.4 ha (90 ac) is in southeastern Los Osos. It is now bounded by Los Osos Valley Road and a mobile home park to the north, residential development to the south and west, and Los Osos Creek and agricultural fields to the east. This property includes the Glen site referred to in some reports (e.g., Villablanca 1987). The area previously occupied by the Morro Bay kangaroo rat comprises 1.3 ha (3.2 ac). The CDPR acquired the main property in 1971 to conserve the dwarfed, 800-year-old *Quercus agrifolia oxyadenia* (coastal live oak) trees. The major plant communities are *Q. agrifolia oxyadenia* forest and coastal sage scrub, with riparian vegetation along Los Osos Creek. The last capture of a Morro Bay kangaroo rat in this area was in 1957 (Stewart 1958). Trapping resulted in no captures in 1971 (Congdon and Roest 1975), 1984 (Villablanca 1987), 1986 (Gambs 1986a), 1990 (Gambs 1990), 1991 (Gambs et al. 1992), 1995 (O'Farrell 1995 as cited in O'Farrell 2003), and 2002 (O'Farrell 2003). Visual surveys were negative in 1975, 1977 (Service 2000), 1978 (Toyoshima 1983), and 2008 (Villablanca 2009). Diagnostic signs were observed here in 1990 (Gambs 1990) and 1991 (Gambs et al. 1992).

Buckskin

The main Buckskin property (26.3 ha (65 ac), APN 074-222-013, privately owned) is in northeast Los Osos: at the northern terminus of Buckskin Drive, at the eastern terminus of Nipomo Avenue, and west of Los Osos Creek. Morro Bay kangaroo rats were captured on the main Buckskin property or immediate vicinity in 1957 (Stewart 1958), 1971 (n = 17, Congdon 1971), 1977 (n = 3, Roest 1977), 1979 (n = 5, Toyoshima 1983), and 1985 (n = 1, Villablanca 1987). Potential sign was observed in 1991 (Gambs et al. 1992). Trapping with no captures occurred in 1996 (O'Farrell 1996a as cited in O'Farrell 2003), and visual surveys were negative in 1998 (O'Farrell 1998d). Factors likely contributing to the species decline here include dirt bikes (Toyoshima 1983), *Sorghum bicolor drummondii* becoming a dominant plant, and predation by cats (Villablanca 1987). We were unable to obtain permission to survey on the main Buckskin property in 2008, 2009, and 2010.

APN 067-011-041 (16.0 ha (40 ac), privately owned) is immediately northwest of the main Buckskin property. APN 067-012-018 (5.7 ha (14 ac), privately owned) is immediately west of APN 067-011-041, at the northern terminus of Sage Avenue. Morro Bay kangaroo rats were captured on APN 067-011-041 in 1957 (n = 2; Stewart 1958, Stewart and Roest 1960) and 1971 (Congdon 1971). We were unable to obtain permission to survey on these two properties in 2008 (APN 067-012-018) and 2010 (APN 067-011-041).

Junior High/Santa Ysabel

The Junior High/Santa Ysabel area is adjacent to Los Osos Middle School in northeastern Los Osos: east of South Bay Boulevard, west of Los Osos Creek, south of Santa Ysabel Avenue, and north of Pismo Avenue. Much of the area (24 ha (60 ac) was purchased by the CDPR in 2002 specifically for conservation of the Morro Bay kangaroo rat, and it is now part of Morro Bay State Park. Most other smaller parcels in this area remain in private ownership.

Morro Bay kangaroo rats were captured in this area in 1957 (Stewart 1958), 1977 (*n* = 12, Roest 1977), 1978 (*n* = 5, Toyoshima 1983), 1979 (*n* = 11, Toyoshima 1983), and 1984 (*n* = 1, Roest in Villablanca 1987). Trapping with no captures occurred in 1971 (Congdon 1971), 1985 (Villablanca 1987), 1996 (O'Farrell 1996a as cited in O'Farrell 2003), 2008 (Villablanca 2009), and 2010 (Villablanca, pers. comm. 2010). Visual surveys within the area were negative in 1986 (Roest in Gambs 1986a), 1989 (Gambs and Nelson 1990), 1995 (O'Farrell 1995 as cited in O'Farrell 2003), and 1998 (O'Farrell 1998b, c, d). Diagnostic signs were observed in 1985 (Villablanca 1987), 1990 (Gambs et al. 1992), and 1991 (Villablanca 1991 as cited in Gambs 1993). Potential signs were observed in 1993 (Gambs 1993), 2008 (Villablanca 2009), and 2010 (Villablanca, pers. comm. 2010).

Extension

The Extension (or Turri Road site) is the name applied to the northeastern part of the geographic range (Congdon and Roest 1975): east of Los Osos Creek, south of Turri Road, and north of Warden Creek. The four private properties comprise approximately 176 ha (435 ac) of the known geographic range (Stewart and Roest 1960). Morro Bay kangaroo rats were trapped here in 1957 and 1977. Stewart (1958) captured five individuals on APN 067-011-003, and Roest (1977) captured two individuals on the Lee property (APN 067-011-049). Trapping resulted in no captures in 1983 (Gambs 1986c), 1984 (Villablanca 1987), 2008 (Villablanca 2009), and 2010 (Villablanca, pers. comm. 2010). Visual surveys were negative in 1971 (Congdon and Roest 1975) and 1980 (Roest in Service 1982). Potential sign was observed in 2008 (Villablanca 2009).

Baywood Park

Baywood Park was the original town on the south side of Morro Bay. It is now part of the community of Los Osos and is the most intensely developed part. In general, Baywood Park is situated west of South Bay Boulevard, north of Los Osos Valley Road, and east of Doris Avenue. Stewart and Roest (1960) captured Morro Bay kangaroo rats here in 1957 and 1958 at approximately 10 locations, some which are now developed. Congdon (1971) reported potential sign at one location in 1971, and Roest (1977) captured two individuals at one location in 1977.

A few large open areas still remain in 2011, including the Elfin Forest (approximately 26 ha (64 ac), owned by the State of California and County of San Luis Obispo), the Tri-W site (4.7 ha (12 ac), APN 074-229-017, owned by the Los Osos Community Services District), and APN 074-229-024 (21.9 ha (54 ac), privately owned). The Elfin Forest was visually surveyed in 2010 with negative results (Villablanca, pers. comm. 2010). The Tri-W site was visually surveyed in 2000 and 2004 with negative results (O'Farrell 2000, Villablanca 2004). Although APN 074-229-024 was visually surveyed in 2000 with negative results (O'Farrell 2000), it should be surveyed again. We were unable to obtain permission to conduct surveys on APN 074-229-024 in 2010. Several other trapping and/or visual surveys in Baywood Park were also negative: in 1984 and 1985 (Villablanca 1987), in 1997 (O'Farrell 1997a), and in 2010 (Villablanca, pers. comm. 2010).