TERRESTRIAL MAMMAL SPECIES OF SPECIAL CONCERN IN CALIFORNIA

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By

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Editor's note: A draft final version of this document was delivered by contractors to the Department of Fish and Game (Department) Wildlife Management Division in 1998. Consequently, most of the information contained herein is current as of 1998. To avoid potential confusion caused by the delay in the document's availability, however, the Department has subsequently inserted a few important updates (in brackets as Editor's notes).

Authorship of each species account is attributed to the original author(s); however, the Department made substantial edits to the draft final report. Edits were primarily to the Introduction and Results sections, as well as the Management Recommendations section of many species accounts for consistency and accuracy. In addition to producing the species distribution maps for this document, the Department added California Natural Diversity Data Base locality information through 1998 to the locality data provided by the contractors.

This report is intended as an interim update to Williams (1986), which will remain available via the Department's document library at http://nrm.dfg.ca.gov/documents. **Work on a new Mammal Species of Special Concern document will begin in 2009.**

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The final CDFG version is available at http://nrm.dfg.ca.gov/documents/DocViewer.aspx.

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TERRESTRIAL MAMMAL SPECIES OF SPECIAL CONCERN IN CALIFORNIA

Introduction

California possesses one of the richest mammalian faunas in the United States. The terrestrial mammal fauna, which excludes marine mammals, consists of 166 species, 15 of which are endemic (i.e., they occur only in California), and 420 subspecies. Considering species and subspecies together, approximately 25 percent are endemic to California. The state's enormous agricultural productivity, desirable living conditions, and associated population growth underlie major changes in the state's natural communities. For the terrestrial mammal fauna, the most important changes have been the conversion of native habitats to agricultural, suburban, and urban land uses, as well as timber harvest in parts of the state. These and other changes and land use practices described in this document have resulted in declines in the distribution and abundance of some taxa. As of 1998, there are 15 Threatened or Endangered terrestrial mammals that are protected under the California Endangered Species Act (CESA). [Editor's note: for current information about State- and Federally-listed species see http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/TEAnimals.pdf.]

The first Mammal Species of Special Concern (MSSC) document was prepared in 1986 (Williams 1986). This updated report on mammals joins similar Department of Fish and Game (Department) reviews of amphibians and reptiles (Jennings and Hayes 1994), fishes (Moyle et al. 1995), and birds (Remsen 1978). [Editor's note: A revised report on birds became available in late 2008; see http://www.dfg.ca.gov/wildlife/species/ssc/birds.html. Work on a new mammal species of special concern document will begin in 2009.] This document reviews the status of terrestrial mammal species and subspecies in California for the purposes of revising the previous MSSC list (generated by the 1986 document), compiling updated data on distribution and abundance, describing each species' biology and current threats, and recommending management actions.

A taxon is assigned Special Concern status when its population numbers are declining at a rate that could result in its becoming Threatened or Endangered in the future if efforts to stop or slow its declines are not successful, or, in some cases, because it historically occurred in low numbers and there are known threats to its persistence. [Editor's note: More current information about the Species of Special Concern designation is at http://www.dfg.ca.gov/wildlife/species/ssc/index.html.] Available scientific data indicate that some of these Special Concern taxa may meet the State definitions for Threatened or Endangered (see page 4 for definitions). This review excluded State-listed species but included Federally-listed species that are not State-listed.

"Species of Special Concern" (SSC) is a Department administrative designation, not defined by the California Endangered Species Act, and the Department is not required under State law to maintain the Special Concern list or periodically review population trends of species on the list. However, the Department determines SSCs to provide an early warning system that identifies declining species before they become Threatened or Endangered, and to learn whether reasonable action can be taken to avert listing. These status reviews are intended to lead to considerations and management efforts that reduce conflicts between conservation of the state's natural heritage and its economic development.

Under California Environmental Quality Act (CEQA) guidelines, the following sections can apply to SSCs:

15065. Mandatory Findings of Significance
(a) A lead agency shall find that a project may have a significant effect on the environment and thereby require an EIR to be prepared for the project where there is substantial evidence, in light of the whole record, that any of the following conditions may occur:
(1) The project has the potential to: substantially degrade the quality of the environment; substantially reduce the habitat of a fish or wildlife species; cause a fish or wildlife population to drop below self-sustaining levels; threaten to eliminate a plant or animal community; substantially reduce the number or restrict the range of an endangered, rare or threatened species….

15380. Definitions. Endangered, Rare or Threatened Species
(a) "Species" as used in this section means a species or subspecies of animal or plant or a variety of plant.
(b) A species of animal or plant is:
(1) "Endangered" when its survival and reproduction in the wild are in immediate jeopardy from one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, disease, or other factors; or
(2) "Rare" when either:
(A) Although not presently threatened with extinction, the species is existing in such small numbers throughout all or a significant portion of its range that it may become endangered if its environment worsens; or
(B) The species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range and may be considered "threatened" as that term is used in the Federal Endangered Species Act.
(c) A species of animal or plant shall be presumed to be endangered, rare or threatened, as it is listed in:
(1) Sections 670.2 or 670.5, Title 14, California Code of Regulations; or
(2) Title 50, Code of Federal Regulations Section 17.11 or 17.12 pursuant to the Federal Endangered Species Act as rare, threatened, or endangered.
(d) A species not included in any listing identified in subdivision (c) shall nevertheless be considered to be endangered, rare or threatened, if the species can be shown to meet the criteria in subdivision (b).

Methods

The methods focused on the objectives of updating the MSSC list consistent with the Department's definition of SSC (see below), and providing updated information on each taxon's status, distribution, biology, and recommendations for their management. Updating the list and the preparing this report involved the following steps:

The authors prepared a list of species and subspecies of terrestrial California mammals (Appendix 1) to provide the most current taxonomic list of California mammals, based on the existing literature. The list was based mainly on the synopses found in Hall (1981) and Reeder and Wilson (1994). A number of recent revisions for individual taxonomic levels (i.e., species, species groups, and families) were also considered. Discrepancies among any of these sources were resolved based on the professional judgement of the authors. Taxa endemic to California were identified. Taxa with highly restricted distributions were also identified, because of their potentially greater susceptibility to impacts.

The authors sought recommended changes to the previous list from qualified individuals. The

authors sent letters to 130 mammalogists, field biologists, and State/Federal resource managers to obtain information on existing Special Concern taxa, and solicit recommendations for additions and deletions to the current Special Concern list. They also requested information about population trends, threats, management recommendations, published and unpublished reports, and trapping records. The authors provided a list of potential Special Concern taxa in the information request (Appendix 2), although respondents were also asked to make recommendations and/or provide information on taxa not on the list. The list included then-current Special Concern taxa, candidates for listing by the USFWS[1], Federally-listed taxa not also listed by the State of California, and several taxa that initial review indicated could meet Special Concern criteria.

The authors constructed a database of museum records and non-museum observations of California mammals. Specimen records of California mammals were requested from 44 museums (Appendix 3). Each museum was asked to provide standard museum data (locality, sex, date of capture, catalogue number, etc.) for all California specimens in its collection. When this was too difficult to provide (e.g., for museums lacking computer databases), records for a list of potential Special Concern taxa were requested. These records were used to create a computerized database of approximately 90,000 specimen records for all taxa, and 22,000 specimen records of potential Special Concern taxa. These records served three purposes: *a*) to confirm the distributions of species with restricted distributions identified using Hall (1981); *b*) to identify taxa with few California records; and *c*) to prepare the distribution maps for Special Concern taxa.

The list of Special Concern taxa was prepared based on inclusion criteria. The general criterion for including a species on the list is that it meets the definition for Special Concern. At the time this report was prepared, the Department defines Species of Special Concern as described below [Editor's note: current SSC info is at http://www.dfg.ca.gov/wildlife/species/ssc/index.html]:

"Species of Special Concern" (SSC) status applies to animals not listed under ESA or CESA, but which nonetheless 1) are declining at a rate that could result in listing, or 2) historically occurred in low numbers and known threats to their persistence currently exist. SSC share one or more of the following criteria:
"Species of Special Concern" (SSC) status applies to animals not listed under the Federal Endangered Species Act or the California Endangered Species Act, but which nonetheless 1) are declining at a rate that could result in listing, or 2) historically occurred in low numbers and known threats to their persistence currently exist. SSC share one or more of the following criteria:

1. *occur in small, isolated populations or in fragmented habitat, and are threatened by further isolation and population reduction;*
2. *show marked population declines. Population estimates are unavailable for the vast majority of taxa. Species that show a marked population decline, yet are still abundant, do not meet the Special Concern definition, whereas marked population decline in uncommon or rare species is an inclusion criterion;*
3. *depend on a habitat that has shown substantial historical or recent declines in size. This criterion infers the population viability of a species based on trends in the habitats upon which it specializes. Coastal wetlands, particularly in the urbanized San Francisco Bay and south-coastal areas, alluvial fan sage scrub and coastal sage scrub in the southern coastal basins, and arid scrub in the San Joaquin Valley, are examples of California habitats that have seen dramatic reductions in size in recent history. Species that specialize in these habitats generally meet the criteria for Threatened or Endangered status or Special Concern status;*
4. *occur only in or adjacent to an area where habitat is being converted to land uses incompatible with the animal's survival;*
5. *have few California records, or which historically occurred here but for which there are no recent records; and*

[1] ***The practice of designating Category 2 candidates for listing by the USFWS has since been discontinued. Under this previous classification, Category 1 species were those for which the USFWS had enough information to support listing as Threatened or Endangered. Category 2 species were those which may have been appropriate for listing, but sufficient data were not available to the USFWS to support a proposal for listing. Candidates for listing are now classified simply as "Candidates" and conform to the former Category 1 definition.***

6. *occur largely on public lands, but where current management practices are inconsistent with the animal's persistence.*

This designation is intended to result in special consideration for these animals by the Department, land managers, consulting biologists, and others, and is intended to focus attention on the species to help avert the need for costly listing under Federal and State endangered species laws and cumbersome recovery efforts that might ultimately be required. This designation also is intended to stimulate collection of additional information on the biology, distribution, and status of poorly known at-risk species, and focus research and management attention on them.
Department staff should consider SSCs during 1) the environmental review process, 2) conservation planning process, 3) the preparation of management plans for Department lands, and 4) inventories, surveys, and monitoring (conducted either by the Department or others with whom we are cooperating).

Taxa that are not State-listed but which may meet the definitions for such were also included on the Special Concern list. CESA defines an Endangered species as a native species or subspecies which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease. A Threatened species is one that is not presently threatened with extinction, but is likely to become an Endangered species in the foreseeable future in the absence of the special protection and management efforts (Fish and Game Code of California, §2062 and 2067). The Special Concern list was divided into taxa that may meet State definitions of Threatened or Endangered (Class I) and those that are of Special Concern and are not thought to be Threatened or Endangered (Class II).

Special consideration was given to taxa that occur on one or more lists of sensitive taxa maintained outside of the Department. These include taxa that are listed as Threatened or Endangered, candidates for listing, or found on a list of sensitive species by the U.S. Fish and Wildlife Service (USFWS), Oregon Department of Fish and Wildlife (ODFW), or the Arizona Game and Fish Department (AGFD). Special consideration was not specifically given to species and subspecies that are endemic to California; however, such species were more likely to meet the inclusion criteria than species whose distributions included neighboring states.

Species accounts and distribution maps were prepared for Special Concern taxa. Species accounts provide an overview of the species' description, taxonomy, life history, habitat relationships, status, and management recommendations. These accounts are based on published literature and unpublished reports, on the field experiences of the authors and, in some cases, on personal communications from experts. Distribution maps were prepared by the Department using ArcMap 9.2 to plot all available museum records and reliable non-museum observations in the database compiled by the authors, as well records in the Department’s California Natural Diversity Data Base (CNDDB).

Results

The list of terrestrial California mammals (Appendix 1) consists of 166 species, 15 of which are endemic, and 420 subspecies. Considering species and subspecies together, approximately 25 percent are endemic to California. There is broad agreement between existing reference taxonomies of California mammals (Hall 1981, Wilson and Reeder 1995) and separate taxonomic reviews. There are, however, a number of important differences in the nomenclature and taxonomic list of California mammals. This fauna differs from the list of Laudenslayer et al. (1991) through the addition of some taxa and the removal of others. The taxonomic decisions made in preparing Appendix 1 were those of the authors based on the best available scientific information and the rules of nomenclature.

The updated list of California Special Concern mammals contains 46 species or subspecies (Table 1).

[Editor's note: The authors did not explain why certain taxa on the Department's Mammal SSC list at the time this document was prepared were not included on their new list. However, most of the non-included taxa were those on the former Federal Category 2 candidate list, a list which did not require significant justification for inclusion of a taxon. The Category 2 candidate list and the addition of taxa to the Department's SSC list without rigorous documentation have both been discontinued.] The "additional status" column in Table 1 indicates whether or not the taxon is listed as Federally Threatened or Endangered, or if it is included on the current sensitive species lists maintained by ODFW or AGFD. The Special Concern list is divided into two groups, Class I and Class II. For Class I taxa, the available data indicate that the species may be Threatened or Endangered according to criteria defined by CESA. In some cases, the distinction of whether the taxon may meet State standards of Threatened or Endangered will require a more detailed status review than was undertaken here. The taxa in Class II are those with low or declining numbers of individuals, or low, scattered or highly localized populations that require active management to prevent them from becoming Threatened or Endangered species.

A third class of taxa appears on the Watch List in Table 2. The 22 Watch List taxa are those with restricted distributions that we do not currently consider to be Species of Special Concern. Watch List taxa merit field studies that yield data on the status of and trends in their populations, and monitoring of potential threats. Populations of these species should be assessed periodically and considered in management decisions and multispecies and habitat conservation plans. The Department's Resource Assessment and Nongame Wildlife programs provide mechanisms to help determine and monitor population status and trends. The Department's Conservation Planning Program provides a large-scale planning framework to conserve significant pieces of habitat for listed and special concern species. This document will help these programs determine priorities for species status assessment and monitoring and help large-scale conservation planning efforts determine which species should be included in plans.

The list of 46 Special Concern taxa contains five species or subspecies of shrews (11%), 14 bats (30%), two hares/rabbits (4%), 20 rodents (44%), and five carnivores (11%). Of these, 12 taxa may meet the criteria for State Threatened or Endangered (Class I) status.

The principal cause of population declines in Special Concern species has been and continues to be habitat loss. Habitat loss and associated declines in native mammals are generally the result of past and present increases in the state's human population. Habitat conversion as a result of population growth has been especially strong in the Sacramento and San Joaquin valleys, the south coast (Orange and San Diego counties) and Inland Empire (parts of Riverside and San Bernardino counties) and in the Sierra Nevada (especially in Nevada, Placer, and El Dorado counties). Much of this population growth has been suburban that followed agricultural conversion of native habitats starting in the last century, but much of it also has involved the direct conversion of native habitats. The habitats most influenced by such development are the coastal wetlands of the Bay Area and southern California, the grassland and arid scrub communities of the San Joaquin, Salinas, and Coachella valleys, and the riparian habitats of the Colorado River and San Joaquin Valley. Few species have benefited from these habitat changes, and those that have are often not native to California. For the areas where rapidly growing human population and associated habitat loss prompts the involvement of the Department's Conservation Planning Program, this document can help determine which species to include in the process and provide information about their biology and conservation needs.

There are a number of causes for the decline in bats. Bats, especially those that roost colonially, are highly susceptible to disturbance and subsequent mortality. Closure, human disturbance, and "pest

control" at colony sites (caves, mines, buildings and bridges) have had major adverse impacts on bat populations. Additional factors include unsustainable management practices of public and private forest lands for cavity-dwelling species, and farming practices such as removal of riparian forests and the use of insecticides. [Editor's note: The Department is a member of the Western Bat Working Group – a partner in the Coalition of North American Bat Working Groups – consisting of agencies, organizations and individuals interested in bat research, management, and conservation from 13 western states and the Canadian provinces of British Columbia and Alberta. The group works to facilitate communication and exchange of scientific and management information, and reduce risks of species declines. The Department also participates in the California Bat Working Group (which has similar objectives to the larger group), and contributes to bat conservation by conducting status assessments (based on the Mammal Species of Concern list), considering bats in timber harvest plans and other environmental review documents, collaborating with other agencies on bat conservation issues, and disseminating information about bats to the public. The Department began preparation of a statewide bat conservation plan during in 2004-2005 using Federal State Wildlife Grant funds – the plan will be completed in 2010.]

Special Concern taxa are not evenly distributed throughout the state. Only five species, all of which are bats, are found widely in the state. The largest number (40 taxa, or 48% of the total) occurs in southern California. Within southern California, the largest number of taxa (6) occurs in the coastal basins of Los Angeles County and western Riverside and San Bernardino counties. The remaining species occur in the mountains above the Los Angeles basin (3), in the Coachella Valley (2), along the Colorado River (5), and on the Channel Islands (2). Similar numbers of taxa are found in northern and Central California (9 and 10, respectively). In northern California, they occur in the north Coast Range (4 taxa), San Francisco Bay area (4), and Sacramento Valley (1). In central California, they occur in the San Joaquin Valley (5 taxa), Sierra Nevada (1), Coast Range (1), and in the Tahoe/Mono basins and Modoc Plateau (2).

Table 1. Mammal Species of Special Concern grouped according to whether they may currently meet State definitions of Threatened or Endangered (Class I) or Special Concern (Class II).

Scientific Name	Common Name	Additional Status
	Class I	
Sorex ornatus relictus	Buena Vista Lake shrew	FE [2002]
Macrotus californicus	California leaf-nosed bat	AC
Corynorhinus townsendii	Townsend's big-eared bat	OC
Myotis occultus	Arizona myotis	
Myotis velifer	cave myotis	
Aplodontia rufa nigra	Point Arena mountain beaver	FE
Aplodontia rufa phaea	Point Reyes mountain beaver	
Dipodomys merriami parvus	San Bernardino kangaroo rat	FE
Perognathus longimembris pacificus	Pacific pocket mouse	FE
Neotoma fuscipes riparia	Riparian woodrat	FE [2000]
Martes americana humboldtensis	Humboldt marten	OC (all subspecies)
Martes pennanti pacifica	Pacific fisher	OC
	Class II	
Sorex ornatus salicornicus	southern California salt-marsh shrew	
Sorex ornatus sinuosus	Suisun shrew	
Sorex ornatus willetti	Santa Catalina Island shrew	
Sorex vagrans halicoetes	salt marsh wandering shrew	
Choeronycteris mexicana	Mexican long-tongued bat	AT
Antrozous pallidus	pallid bat	OV
Euderma maculatum	spotted bat	AC
Lasiurus blossevillii	western red bat	AC?
Lasiurus xanthinus	western yellow bat	AC
Myotis thysanodes	fringed myotis	OV
Myotis volans	long-legged myotis	
Eumops perotis	western mastiff bat	
Nyctinomops femorosaccus	pocketed free-tailed bat	
Nyctinomops macrotis	big free-tailed bat	
Brachylagus idahonensis	pygmy rabbit	OV
Lepus americanus tahoensis	Sierra Nevada snowshoe hare	
Glaucomys sabrinus californicus	San Bernardino flying squirrel	
Spermophilus tereticaudus chlorus	Palm Springs ground squirrel	
Dipodomys nitratoides brevinasus	short-nosed kangaroo rat	
Dipodomys venustus venustus	Santa Cruz kangaroo rat	
Perognathus alticola alticola	white-eared pocket mouse	
Perognathus alticola inexpectatus	Tehachapi pocket mouse	
Perognathus inornatus psammophilus	Salinas pocket mouse	
Perognathus longimembris bangsi	Palm Springs pocket mouse	
Perognathus longimembris brevinasus	Los Angeles pocket mouse	
Arborimus albipes	white-footed vole	OU

Microtus californicus mohavensis	Mohave River vole	
Onychomys torridus ramona	Ramona grasshopper mouse	
Onychomys torridus tularensis	Tulare grasshopper mouse	
Sigmodon arizonae plenus	Colorado River cotton rat	
Zapus trinotatus orarius	Point Reyes jumping mouse	
Felis concolor browni	Yuma mountain lion	AE
Lutra canadensis sonora	southwestern river otter	AE
Spilogale putorius amphiala	Channel Islands spotted skunk	

Table 2. Watch List taxa: Terrestrial mammals not included on the Special Concern list, but whose status should be periodically re-evaluated.

Scientific Name	**Common Name**	**Additional Status**
Sorex ornatus salarius	Salinas ornate shrew	
Sorex vagrans paludivagus	Monterey vagrant shrew	
Scapanus latimanus insularis	Angel Island mole	
Scapanus latimanus parvus	Alameda Island mole	
Lasionycteris noctivigans	silver-haired bat	
Lasiurus cinereus	hoary bat	
Myotis evotis	long-eared myotis	
Myotis lucifugus	little brown bat - San Bernardino Mountains population	
Lepus americanus klamathensis	Oregon snowshoe hare	
Lepus townsendii townsendii	western white-tailed hare	OU
Dipodomys californicus eximius	Marysville kangaroo rat	
Dipodomys heermanni berkeleyensis	Berkeley kangaroo rat	
Perognathus inornatus neglectus	McKittrick pocket mouse	
Perognathus xanthonotus	yellow-eared pocket mouse	
Microtus californicus stephensi	south coast marsh vole	
Reithrodontomys megalotis distichlis	Monterey Bay harvest mouse	
Reithrodontomys megalotis longicaudus	harvest mouse, Santa Cruz Island population	
Sigmodon hispidus eremicus	Yuma hispid cotton rat	
Lynx rufus pallescens	pallid bobcat	
Martes americana sierrae	Sierra Nevada marten	OC (all subspecies)
Taxidea taxus	badger	

Legend for Tables 1, 2:
F (Federal): FE, Endangered; FT, Threatened; FC, Candidate for listing; FPE, Proposed Endangered
A (Arizona): AE, Endangered; AT, Threatened; AC, Candidate.
O (Oregon): OC, Critical; OV, Vulnerable; OU, Undetermined Status

Recommendations

The recommendations within the individual species accounts fall into the following main categories:

i) Implement Management Actions and Status Changes on Behalf of Individual Species, as Appropriate. This review identifies 12 Class I taxa (including subspecies) which may meet the criteria for Threatened or Endangered status under CESA, based on the available scientific evidence. Of these, two species are currently protected under the Federal Endangered Species Act (FESA). The designation of a taxon as Class I does not, however, necessarily mean that it should be petitioned for listing. Formal listing may be justifiably avoided or postponed if effective ongoing or recent efforts are already in place to conserve the species. If, in lieu of listing, new management efforts are feasible and implemented, the status of the species should be monitored closely to determine if the efforts are adequate to conserve the species. Should new or existing management actions prove ineffective, status reviews in accordance with CESA should be conducted. Species protection programs should continue to be a high priority; accordingly, the Species of Special Concern documents produced by the Department should be updated at least every ten years, and more frequently if staffing and funding resources allow.

ii) Protect Habitat. Impacts to habitat, mainly loss, but also fragmentation and degradation, are the principal threats facing Special Concern and listed taxa. Habitat impacts are diverse, including, for example, habitat conversion to agricultural and urban land uses, wetland and riparian degradation due to surface water diversion and groundwater pumping, timber harvesting, and destruction/disturbance of mines, caves, and structures used by roosting bats. The highest priorities for habitat protection for mammal Species of Special Concern remain those identified by Williams (1986): riparian forests and wetlands, especially those along the Colorado River and the San Joaquin Valley; tidal wetlands, especially those in San Francisco, San Pablo, and Suisun bays and in the south coast region; the grasslands and desert scrub communities in the San Joaquin and Salinas valleys; the alluvial fan sage scrub and coastal sage scrub communities of Riverside, San Bernardino, Los Angeles, Orange, and San Diego counties; and mature and old-growth coniferous forests. Most of these areas are where no large scale community conservation planning is occurring. In addition, over the last 40 years, 800,000 acres (16%) of Sierra Nevada hardwoods have been converted to other land uses and vegetation types (Standiford et al. 1996); over 80% of California's oak woodlands are privately-owned (Greenwood et al. 1993). The Department's Resource Assessment Program has identified the Sierra Nevada foothills as one of its highest priorities for species population assessment and monitoring

iii) Support the expansion of regional biodiversity conservation programs. Conservation efforts over the last 10 years have evolved from site-specific habitat conservation plans for individual listed species prepared as requirements for "take" permits under CESA and FESA, to regional multispecies habitat conservation plans that target a range of sensitive species. Regional conservation plans focus on conservation of natural communities, ecosystems, multiple listed and non-listed species, and the ecological processes necessary to sustain them. Implementing such regional plans combines the technical issues of conservation biology and the participatory issues in affected regions, especially in areas of high human population growth, resulting in better public support for conservation. Examples of these plans include CALFED Bay-Delta program, which includes species conservation and habitat restoration measures for the San Francisco Bay watershed and the footprints of the State and Federal Water Projects, and the Natural Community Conservation Planning program, a cooperative effort to conserve species at the ecosystem scale. These programs are an important complement to and extension of ongoing efforts to protect individual species and the habitats they

occupy. Regional programs should include species for which enough information is available to determine that the species can reasonably be assumed to be in the planning area and will be sustainably conserved under the program. Regional multispecies conservation planning has the potential to prescribe conservation actions for larger portions of California's landscape than any other tool or funding mechanism. Multispecies habitat conservation planning efforts are of high priority for the following areas: the east San Francisco Bay, including wetlands, riparian, and uplands of Contra Costa, Santa Clara, Alameda, and Solano counties; the southern San Joaquin Valley; the coastal and alluvial fan sage scrub habitats of the south coast region, including Los Angeles, San Bernardino, Riverside, Orange, and San Diego counties; the Coachella Valley region; and the wetlands and riparian habitats of the Central Valley and Colorado River basin.

iv) Expand field studies. Field studies are needed to better understand the distribution, abundance, and habitat requirements of Special Concern and Watch List taxa. The Department's resource assessment program can play an important role in assessing distribution, abundance and population trend. The Department's State Wildlife Plan (to be completed in 2005) can help direct and prioritize surveys, monitoring and research needs for these taxa. Key populations should be monitored to document population trends. The need is most urgent for the following mammals: Townsend's big-eared bat (*Corynorhinus townsendii*), California leaf-nosed bat (*Macrotus californicus*), southwestern river otter (*Lutra canadensis sonora*), Pacific pocket mouse (*Perognathus longimembris pacificus*), and the San Bernardino kangaroo rat (*Dipodomys merriami parvus*). Given the increasingly fragmented nature of California's natural communities, as well as the increasing reliance on small, fragmented reserves, field studies should also be conducted on dispersal abilities and other aspects of natural history that influence the ability of species to maintain metapopulation structure in fragmented habitats. Field studies are also needed on the badger (*Taxidea taxus*), possibly relying on photographic stations, due to its low natural densities and elusive habits. This species may meet the criteria for the Special Concern list, but data on its distribution and abundance are lacking.

v) Expand public education and awareness activities. To educate California's citizens, the Department will disseminate this document to agencies and other interested parties via our website to help inform the both the public and private sectors of the continued decline of California's native mammal fauna and associated habitats.

vi) Implement species reintroduction measures where appropriate. Species reintroductions are appropriate only under special circumstances. For the majority of Special Concern and listed taxa, the root cause of population declines is habitat loss. For these taxa, the costs of habitat restoration and reintroduction efforts would be prohibitive, with little or no chance of success. For species which have been extirpated from all or part of their original range in California, but for which apparently suitable habitat exists, reintroduction remains a conservation alternative to be evaluated on a case-by-case basis. One possible example is the Humboldt marten, which has apparently been extirpated from the forests of the north coast region.

Species Accounts

Buena Vista Lake shrew, *Sorex ornatus relictus*

Paul W. Collins

Description: A small (98-105 mm TL), dull blackish to gray-brown shrew with a relatively short (35-39 mm), faintly bicolored tail, dark at terminus above and below; smoke gray ventrum; and relatively broad, flat skull (Grinnell 1932, Owen and Hoffmann 1983). Weight between 4.1 and 7.6 g (Williams et al. 1998). *S. o. relictus* has a darker dorsal pelage than the sympatric *S. o. ornatus*, which has a more grayish brown pelage and occurs in more upland habitats. Compared to *S. o. ornatus*, *S. o. relictus* is slightly larger, has a shorter tail, a shorter and heavier rostrum, and a higher brain-case (the latter two characters are discernable only in prepared skeletons) (Grinnell 1932).

Taxonomic Remarks: Grinnell (1932) described *S. o. relictus* based on specimens collected from the vicinity of Buena Vista Lake, Kern County; there are eight other subspecies of *Sorex ornatus* (Hall 1981, George 1988, Wilson and Reeder 1993). Grinnell (1932) suggested that intergradation between *S. o. relictus* and *S. o. ornatus* probably occurred along the lower courses of streams which entered the Kern-Tulare basin. A review of the systematics of *S. ornatus*, including *S. o. relictus*, based on biochemical and morphometric data, and an evaluation of the population genetics of fragmented, restricted populations such as are found in *S. o. relictus*, is underway (J. Maldonado 1992 pers. comm.).

Distribution: According to Grinnell (1933), the Buena Vista Lake shrew historically occupied marshlands throughout the southern end of the San Joaquin Valley from the Tulare Lake Basin in Kings County south to the vicinity of Bakersfield and Buena Vista Lake in Kern County. It probably occurred in the wetland habitats around the original historic Buena Vista, Tulare and Kern Lakes and along streams and sloughs throughout the lake basins (Grinnell 1932, 1933, Williams and Kilburn 1992). Grinnell (1933) listed its elevational range as below 300 ft (92 m).

When the Buena Vista Lake shrew was described by Grinnell (1933), its distribution had already been greatly reduced by the drainage of lakes and sloughs in the southern San Joaquin Valley. Since then, the loss of habitat has increased: Buena Vista Lake and the surrounding lakes and marshes have been drained and cultivated, and most watercourses have been channelized, with steep walls, and are maintained free of vegetation (Williams and Kilburn 1992). The species is now known to occur only at Kern Lake Preserve (Freas 1990, J. Maldonado pers. comm.) and at the Kern National Wildlife Refuge. Disjunct populations of this taxon may still occur in the vicinity of the Buena Vista Lake Aquatic Recreation Area, at the Kern National Wildlife Refuge, at the Tule Elk Reserve, and along sloughs and canals on the Valley floor leading into Goose Lake Slough (Williams 1986, Williams et al. 1998). Recent surveys have failed to confirm its presence at the following locations: The Nature Conservancy's Paine Wildflower Preserve, the Voice of America Transmitter site west of Delano (Clark et al. 1982), the Tule Elk Reserve (Maldonado 1992), and Goose Lake Slough (Germano and Tabor 1993).

Life History: The life history of the Buena Vista Lake shrew has not been studied, but is likely similar to other subspecies of *Sorex ornatus*. The information cited here is based on studies of other subspecies of *Sorex ornatus* (Owen and Hoffmann 1983, Zeiner et al. 1990). The short life span, limited reproductive potential, and narrow habitat requirements of ornate shrews may be considered limiting factors. Ornate shrews can be active during the day and night, but *S. o. sinuosus* is reportedly more active at night, especially during the breeding season (Rust 1978). During hot summer weather in dry habitats, ornate shrews may restrict their daytime activity to burrows of other

animals (Pearson 1959).

Ornate shrews possess high minimum (4.5 Kcal/day) and maximum (6.0 Kcal/day) metabolic rates (Newman and Rudd 1978a) which require an individual to consume a large volume of food daily to survive. Torpor has been observed in *Sorex ornatus* (Newman and Rudd 1978b) and may be an adaptation which ornate shrews use to reduce the amount of food needed daily in order to survive periods of adverse weather or food shortages. The metabolic rate and weight of *Sorex ornatus* increases during the spring and early summer breeding season and decreases slightly during the late summer and fall (Newman and Rudd 1978a).

Most *Sorex ornatus* breed from early spring through May with some limited late summer and early fall breeding generally by young born during the early part of the previous spring (Owen and Hoffmann 1983). The majority of females give birth in the spring to a single litter of four to six young following an estimated 21 day gestation period (Owen and Hoffmann 1983). The life expectancy of most ornate shrews is 12 to 16 months (Rudd 1955a), resulting in high annual turnover (Owen and Hoffmann 1983).

In favorable habitat, ornate shrews reach densities as high as 111/ha (Owen and Hoffmann 1983). Recent trapping results for *S. o. relictus* indicate they exist at much lower densities, probably no more than 10-15/ha (Williams et al. 1988). While ornate shrew populations are not limited by food availability (Newman 1970), they may affect the density and diversity of invertebrate prey (Owen and Hoffmann 1983). Ornate shrews forage throughout the day and night on insects and other invertebrates under logs, rocks and in leaf litter (Zeiner et al. 1990). As far as is known, they do not store or cache food.

Habitat: The Buena Vista Lake shrew probably shows the same habitat preferences as other subspecies of *Sorex ornatus*: dense vegetative cover; a mixture of logs, branches, and detritus/debris and leaf litter; a year-round supply of invertebrate prey; and close proximity to surface water (Collins and Martin 1985, Maldonado 1992). Buena Vista Lake shrews inhabited Valley freshwater marshes around the perimeter of Buena Vista Lake (Grinnell 1932), and probably occurred in similar marshlands throughout the Tulare Basin (Williams 1986). The Buena Vista shrew may be largely confined to areas of dense understory riparian and emergent marsh vegetation along streams and canals, and around the perimeter of remaining sloughs and lakes at the southern end of the San Joaquin Valley. Recent captures of shrews at the Kern Lake Preserve were made within a meter of the water line of Gator Pond in the shaded understory of cottonwood-willow riparian habitat, in dense stands of cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.), or occasionally in dense patches of alkali heath (*Frankenia grandifolia*) (J. Maldonado pers. comm.). A partial list of plants found at many capture sites is: Fremont cottonwood (*Populus fremontii*), willow (*Salix* spp.), pickleweed (*Salicornia* sp), alkali heath (*Frankenia grandifolia*), wild-rye (*Elymus* sp.), and Baltic rush (*Juncus balticus*). Many capture sites contain a well-developed ground layer of dead branches, leaf litter, downed logs, exposed cottonwood and willow roots, and high soil moisture (J. Maldonado pers. comm.).

Status: Class I. This taxon may meet CESA criteria for listing as Endangered because of its extremely restricted distribution (only two known extant populations) and small population size, highly specific habitat preferences, and continued habitat loss from agricultural and urban development, and flood control activities. The conversion of lakes and sloughs in the southern San Joaquin Valley to agriculture, diversion of fresh water supplies, and channelization of streams and rivers have eliminated most of the wetland habitat that once supported this taxon (Williams 1986). The Buena Vista Lake bed is now cultivated, and Kern Lake has been reduced to 33 acres with a

small pond and artificially-maintained wetlands and a series of dry upland habitats (Williams et al. 1998). As Williams (1986) points out, this taxon may be extant at the Kern National Wildlife Refuge, in wetlands of the Kern River percolation area, and along sloughs and canals on the valley floor leading into Goose Lake. However, trapping efforts during the past decade at a number of wetland sites in the southern San Joaquin Valley have located only two small disjunct populations. Due to its small, restricted, populations, the Buena Vista Lake shrew is also threatened by environmental, demographic, and genetic stochasticity (Williams et al. 1998).

The decision whether to proceed with listing the Buena Vista Lake shrew will likely be bolstered by the outcomes of following two activities. First, U.S. Fish and Wildlife Service efforts to negotiate a Conservation Agreement with the Kern Lake Preserve, owned by the J.G. Boswell Company, have failed (Williams et al. 1998). Without a conservation agreement, the water may be diverted for agriculture, which may result in impacts to the Preserve's wetland habitats. Second, management of the Kern Fan Water Bank Project was recently abandoned by the Department of Water Resources and turned over to the Kern County Water Agency (Williams et al. 1998). This creates uncertainty over how the project will be designed and managed, and whether conservation of candidate and listed species will be a component of the project. These projects could potentially protect enough Buena Vista Lake shrew habitat to preclude the need for listing. The failure of both projects to effect habitat conservation for the Buena Vista Lake shrew would necessitate providing protection to the species under CESA. [Editor's note: The Buena Vista Lake shrew was Federally-listed as endangered on April 5, 2002.]

Management Recommendations: The highest priority is to protect the only known Buena Vista Lake shrew population and its habitat at the Kern Lake Preserve. Recovery of the species will require better protection and/or restoration of riparian woodland and freshwater marsh habitat along sloughs, channels, streams, rivers and historic lake basins in southwestern San Joaquin Valley. The recovery plan for upland species of the San Joaquin Valley (Williams et al. 1998) includes more detailed versions of the following recommendations: *i)* use greater efforts to locate other extant populations of Buena Vista Lake shrews within the southwestern Tulare Basin, *ii)* ensure that any flood control and water banking project on the Kern Fan includes creation and restoration of wetland habitat for the shrew, *iii)* reestablish shrews at the Tule Elk Reserve near Tupman if a permanent water supply can be secured, *iv)* resolve the taxonomic identity of ornate shrews on the Kern national Wildlife Refuge, *v)* survey other potential habitat areas including the Buena Vista Golf Course and Buena Vista Aquatic Recreation Area, and *vi)* reevaluate the status of the Buena Vista Lake shrew within three years of recovery plan approval.

Additional surveys of remaining wetland habitats within the species' historic range should be surveyed, including, but not limited to Kern National Wildlife Refuge, Tule Elk Reserve, and Buena Vista, Jerry and Goose Lake Sloughs (Williams 1986, Williams et al. 1998). Additional information is also needed on the basic biology of the species, including population density, home range, movement, breeding biology, habitat associations, and extent of remaining suitable habitat. A better understanding is also needed of the species systematic status and whether the remaining populations are showing signs of population bottlenecking and inbreeding.

Southern California salt marsh shrew,
Sorex ornatus salicornicus
Paul W. Collins

Description: von Bloeker (1932b), based on ten specimens, described this taxon as a small (85-102 mm TL), dark shrew with a relatively short (29.5-42 mm), bicolored tail; drab gray ventrum; and small, flattened skull. *S. o. salicornicus* has a darker dorsal pelage than the sympatric *S. o. ornatus*, which has a more grayish brown pelage and occurs in more upland habitats (von Bloeker 1932b). Compared to other subspecies of ornate shrews, *S. o. salicornicus* is smaller, has a shorter tail, and a smaller, more flattened skull (the latter character discernable only in prepared skeletons).

Taxonomic Remarks: on Bloeker (1932b) described this taxon as having a smaller skull than any other previously named subspecies of *Sorex ornatus*, and suggested that it was intermediate in color and external characters between *californicus* and *relictus*. Pelage color that is darker than that of sympatric *S. o. ornatus* has also been described for other marsh-dwelling subspecies (*relictus* and *sinuosus*) (Owen and Hoffmann 1983). A taxonomic review of this and other subspecies of ornate shrews is underway, using morphologic and genetic data, and may result in consolidation of some of the weakly differentiated subspecies with *S. o. ornatus* (J. Maldonado pers. comm.).

Distribution: The Southern California salt marsh shrew is confined to coastal salt marshes in Los Angeles, Orange, and Ventura counties (Williams 1986). Historically, it was reported from Point Mugu marsh in Ventura County south to the vicinity of Naples in Los Angeles County (von Bloeker 1932b, Grinnell 1933). Since its original description, additional records ascribed to the subspecies have extended its range south to salt marshes around Anaheim and Newport bays, Orange County (Williams 1986, Feldmeth et al. 1989). Surveys during the 1980s and 1990s reported small populations at Point Mugu marsh (C. Drost pers. comm., J. Maldonado pers. comm.), Ballona Wetlands near Playa Del Rey (Friesen et al. 1981), and Seal Beach National Wildlife Refuge and Bolsa Chica Ecological Reserve in Anaheim Bay (Feldmeth et al. 1989). Based on specimen records, the altitudinal range of this taxon is at or near sea level (Grinnell 1933).

Life History: The natural history of the southern California salt marsh shrew is not well known. However, it is expected to be similar to other marsh-dwelling ornate shrews such as *S. o. salicornicus*, which subsist on a diet composed largely of amphipods, isopods, insects and other invertebrates (Williams 1986, Friesen et al. 1981).

Habitat: Grinnell (1933) described the species' habitat as *Salicornia* marshes. At the Seal Beach National Wildlife Refuge it occurred in salt marsh dominated by *Salicornia virginica*; at Bolsa Chica Ecological Reserve, it occurred in dense *Salicornia* and salt grass (Feldmeth et al. 1989). Its occurrence in association with dense willow (*Salix* spp.) and bulrush (*Scirpus* sp.) thickets near Point Mugu (J. Maldonado pers. comm.) suggests it occurs in a broader range of wetland habitats than first thought. The habitat characteristics of southern California salt marsh shrews may be similar to those which Johnston and Rudd (1957) recorded for other salt marsh-inhabiting populations of ornate shrew: dense vegetative ground cover, protected nesting sites above mean high tide which are free from inundation, and moist surroundings.

Status: Class II. The southern California salt marsh shrew has been impacted by habitat loss and fragmentation as a result of dredging for harbors, channelizing and diking for flood control, and urban development. These activities have also eliminated transitional upland habitat around the margins of remaining coastal salt marshes, which are used as refuge sites to escape flooding during high tides and periodic storms (Williams 1986). Predation by feral and domestic cats and introduced

red foxes is another factor which is adversely affecting southern California salt marsh shrews.

No range-wide surveys have been undertaken to determine the population status of *S. o. salicornicus*. It is possible, however, to assess its status based on survey efforts during the past two decades at salt marshes within its historic range. Survey results from 1989 to 1993 indicate that *S. o. salicornicus* occurs in low numbers at Ballona Wetlands, the Seal Beach National Wildlife Refuge and the Bolsa Chica Ecological Reserve, and Point Mugu Duck Club (Feldmeth et al. 1989, Friesen et al. 1981 (J. Maldonado pers. comm., C. Drost pers. comm.).

Available data indicate that there may be as few as six disjunct patches of salt marsh habitat remaining, and only two populations. The species may be Threatened or Endangered; however, its recommended status is as a species of Special Concern because of the need for additional information. Results of the recommended additional field studies may result in the need to list.

Management Recommendations: A status survey is needed to determine the extent of remaining habitat for this taxon and the presence/absence of the species in these patches. A better understanding is also needed on the species' habitat relations and requirements and natural history. The localities to be surveyed include Point Mugu and the Ventura and Santa Clara River estuaries in Ventura County, Ballona Wetlands and Malibu Lagoon in Los Angeles County, and salt marshes in Orange County at Seal Beach National Wildlife Refuge, Bolsa Lagoon, and Upper Newport Bay. Studies are underway on the systematics of *S. o. salicornicus* (J. Maldonado pers. comm.). These studies should address levels of genetic variability within the subspecies, and evaluate whether there has been genetic subdivision (e.g., drift) among the small populations.

Suisun shrew, *Sorex ornatus sinuosus*
Paul W. Collins

Description: This is a small (91-108 mm TL), dark, nearly black shrew with a long (35-48 mm), nearly unicolored tail; steely black dorsum; dark clove-brown ventrum; and slightly larger, higher skull with a somewhat broader rostrum (Grinnell 1913, Jackson 1928, Rudd 1955a, Museum Specimen Inventory). *S. o. sinuosus* is the darkest subspecies of ornate shrew (Owen and Hoffmann 1983). According to Grinnell (1913), *sinuosus* is easily distinguished from adjacent upland *californicus* by its slightly larger size, darker coloration, and deep clove-brown colored ventrum (which is silvery-gray in *californicus*). The summer pelage of *sinuosus* is paler and more brownish (less blackish) than the winter pelage (Grinnell 1913). Weight is from 3.4-6.8g for males and 3.3-6.7g for females (Rudd 1955b), generally heavier than sympatric *californicus* (Rudd 1955b).

Taxonomic Remarks: Grinnell (1913) described the Suisun shrew as a species, *S. sinuosus*. Brown (1970, 1974) found the karyotypes of *S. ornatus* and *S. sinuosus* to be similar, and both distinct from *S. vagrans* populations in the San Francisco Bay area. He also found that the karyotypes found in Bay area populations that were previously thought to be *S. v. vagrans*, or hybrids of *vagrans*, *ornatus*, and *sinuosus*, were more similar to *ornatus* and *sinuosus*. Based on additional genetic studies, Brown and Rudd (1981) included the Suisun shrew as a subspecies of *S. ornatus*. Hall (1981) recognized the species status of *sinuosus* whereas others (Williams 1979, Junge and Hoffmann 1981, Wilson and Reeder 1993) recognized it as a subspecies of *S. ornatus*.

The systematics of shrews in the San Francisco Bay region remains complex and unresolved. *S. o. californicus* are considered to occupy upland habitats in the region whereas two different, darker subspecies occupy the salt marshes: *S. v. halicoetes* in the South Bay, and *S. o. sinuosus* in the North Bay (San Pablo and Suisun bays) (Junge and Hoffmann 1981). Rudd (1955b) evaluated morphological variation in salt marsh-inhabiting populations of shrews along the north shore of San Pablo (Tolay Creek) and Suisun bays. Based on the intermediate nature of morphological characters found in the shrew populations at Tolay Creek, he concluded that hybridization could be occurring between *S. vagrans vagrans* and *S. sinuosus*. However, Brown (1970, 1974) determined that the purported hybrid populations in the San Pablo Bay area possessed karyotypes typical of *S. ornatus*, and found no evidence of interbreeding between *vagrans* or *ornatus* despite the occurrence of populations of both species near Petaluma and north of San Rafael. Brown and Rudd (1981) concluded that "populations from Tolay, Novato, and San Antonio Creeks and from the Petaluma River that were once considered *S. vagrans* or hybrids are now considered slightly differentiated populations of *S. o. californicus*," while populations on Tubbs Island and in marshes east of Sonoma Creek are *S. o. sinuosus*. The identity of shrews from Solano County in the vicinity of Lake Chabot (Williams 1986), and from salt marshes along the lower part of the Napa River, approximately 5 mi (8 km) northwest of Vallejo (Longhurst 1940) remain uncertain.

Distribution: *S. o. sinuosus* has a restricted geographic distribution. It occurs in tidal and brackish marsh communities along the north shore of San Pablo and Suisun bays, from Sonoma Creek and Tubbs Island, Sonoma County on the west (Brown and Rudd 1981), eastward to Grizzly Island, Solano County (Williams 1986). Although Rudd (1955a) identified the range of *sinuosus* as extending west to the mouth of Petaluma Creek, recent studies suggest that shrews inhabiting tidal and brackish marshes west of Sonoma Creek (Brown and Rudd 1981) and east of Grizzly Island (Williams 1983) are *S. o. californicus*.

Life History: There is somewhat more information available on the biology of *S. o. sinuosus* compared to other subspecies of *Sorex ornatus*. Life history data of *S. v. halicoetes* and *S. o. relictus*

probably also apply to this taxon (see *S. v. halicoetes* and *S. o. relictus* accounts). As with other *S. ornatus* subspecies, reproduction in *sinuosus* from late February, peaks in April and May, with a second smaller breeding peak in late summer and early fall as young of the previous spring begin to breed (Rudd 1955b, Owen and Hoffmann 1983). Suisun shrews are active both day and night but during the breeding season are more active nocturnally (Newman and Rudd 1978a, Rust 1978).

Suisun shrews have high minimum (4.5 Kcal/day) and maximum (6.0 Kcal/day) metabolic rates which require that individuals consume a large volume of food daily to survive (Newman and Rudd 1978a). Torpor has been observed in *S. o. sinuosus* (Newman and Rudd 1978b), which enhances survival by reducing energy intake demands. Although Suisun shrews were found to be one of the largest small mammal consumers of energy in the salt marsh community, their numbers are apparently not limited by food availability (Newman 1970). Densities have been recorded up to 111/ha (Newman 1970), with substantial seasonal and annual fluctuations. No data are available on home range size. Diet is probably composed largely of amphipods, isopods, insects and other invertebrates.

Habitat: *S. o. sinuosus* inhabits salt and brackish marshes around the northern margins of San Pablo and Suisun bays (Owen and Hoffmann 1983). According to Williams (1986), Suisun shrews inhabit "tidal marshes characterized in order of decreasing tolerance to inundation, by *Spartina foliosa*, *Salicornia ambigua*, and *Grindelia cuneifolia*, and brackish marshes dominated by *Scirpus californicus* and *Typha latifolia*." In general, salt marsh shrews prefer areas of low, dense vegetation, which provide adequate cover and nesting places along with a plentiful supply of invertebrates (Johnston and Rudd 1957, Rudd 1955b). According to Rudd (1955b), structure rather than species composition of a plant community determined whether an area was suitable for Suisun shrews. Hadaway and Newman (1971) captured Suisun shrews most often at the junction between *Salicornia* marshes and upland levees vegetated with coyote brush (*Baccharis* sp.) and grasses. Rudd (1955b) suggested that driftwood and other surface litter above the mean high-tide line is an important habitat feature for nesting and foraging. Like *S. vagrans halicoetes*, Suisun shrews probably inhabit marshlands 1.8 to 2.4 m above sea level which are not regularly flooded by tidewater (Johnston and Rudd 1957).

Contiguous upland habitats may provide important refuge during flooding of salt marshes (Williams 1983). However, Hadaway and Newman (1971) recorded no difference in the catch effort of *S. o. sinuosus* between dry periods and periods of inundation which they felt indicated that this species may react to flooding by staying within its home range rather than seeking higher ground.

Status: Class II. Recent trapping efforts suggest that the Suisun shrew is rare, but data are insufficient to consider listing appropriate. Also, this taxon's habitat is protected by virtue of its occurrence with the salt marsh harvest mouse (*Reithrodontomys megalotis*) and California clapper rail (*Rallus longirostris obsoletus*), both of which are protected under State and Federal endangered species acts. All of the marshes from which Suisun shrew populations are known are proposed as critical habitat for the salt marsh harvest mouse (Shellhammer et al. 1984).

This taxon has been adversely affected by the degradation and loss of salt and brackish marsh habitats in the San Pablo and Suisun bays. When Europeans arrived in the San Francisco Bay Area more than 200 years ago, the salt and brackish marshes around San Pablo and Suisun bays covered 547 square kilometers (Shellhammer et al. 1984). Since then, more than 77% (421 of 547 sq km) of these marshes have been filled, flooded, or converted to other types of vegetation (Jones and Stokes et al. 1979). Today there are only 70 sq km of marsh present around San Pablo Bay and 55.7 sq km around Suisun Bay (Shellhammer et al. 1984). Loss of this amount of marsh habitat has undoubtedly

had a profound effect on the overall size and distribution of Suisun shrew populations and is the principal reason for concern about the present status of this taxon.

There are few recent records of the Suisun shrew. Except for Williams' (1983) study, there have been no other range-wide attempts made to locate and determine the status of extant populations of *S. o. sinuosus*. Williams (1983) reported a dead specimen on Grizzly Island in 1983 but survey efforts the same spring and summer in marshes throughout San Pablo and Suisun bays resulted in no captures. One individual was captured along the northern perimeter of Suisun Bay in 1985 (Williams 1986). Surveys at the Mare Island Naval Shipyard in Solano County captured two individuals in September 1987 and 16 between May and October 1990 (California Natural Diversity Data Base records). Maldonado (pers. comm.) captured a total of 16 individuals in late July and early August 1990 at the Grizzly Island Wildlife Area and at Rush Ranch. Although these records indicate that populations of this taxon occur in and around San Pablo and Suisun bays, the remaining potential habitat has been estimated at several thousand acres distributed among two dozen patches of marshland (Williams 1983).

The decline of the Suisun shrew is attributable to: *a*) loss and fragmentation of salt and brackish marsh in the San Pablo and Suisun bays due to diking, flooding, and filling of marshes for urban, industrial, and agricultural developments; *b*) the loss of adjoining upland habitats; *c*) habitat degradation due to sediment deposition from hydraulic mining in the Sierra Nevada Mountains during the 1980s; and d) creation of diked wetlands, bordered by steep earthen levees, which are managed solely for waterfowl (Williams 1983, 1986; Shellhammer et al. 1984).

The grassland and unsubmerged halophytic borders above the remaining marsh habitats, which serve as refuge for shrews during the highest tides and extended periods of flooding, have also been reduced (Shellhammer et al. 1984). And while the reduced refuged space along dikes may be sufficient for shrews to escape normal high tides, it may be insufficient for populations to survive during longer periods of prolonged flooding (Williams 1983). The influence of flooding may account for the low trap success which Williams reported for Suisun shrews in 1983 following the widespread and record high and sustained flooding that occurred during the winter of 1982-1983 in San Pablo and Suisun bays.

There is concern over whether the remaining marshes in San Pablo and Suisun bays can sustain populations of Suisun shrews because of their small size, their fragmentation, and the absence of upland refugium habitat. The marshes in Suisun Bay at Grizzly Island, Hill Slough and Peytonia Slough, and in San Pablo Bay at Fagan Marsh are thought to provide suitable marsh and upland habitats (Williams 1983).

Management Recommendations: Natural history studies on habitat relations, dispersal, factors affecting mortality, and population size, and genetic viability are needed. Genetic studies now underway are expected to resolve the systematic status of this taxon. (J. Maldonado pers. comm.). Management plans and practices for occupied tidal and non-tidal marshes administered by public and/or private agencies should be reviewed for their impacts on Suisun shrew populations. Habitat management for the Endangered salt marsh harvest mouse and California clapper rail may benefit the Suisun shrew (Shellhammer et al. 1984), but confirmation of this requires additional research. Wherever possible, tidal and brackish water marshes within the historic range of this taxon should contain a buffer zone of upland vegetation contiguous with the marsh, which is kept free of disruptive manipulations such as freshwater flushing, plowing, mowing, and/or burning.

Santa Catalina Island shrew, *Sorex ornatus willetti*

Paul W. Collins

Description: A moderately large (104-108 mm TL), dark brown shrew with a relatively long (41-43 mm), bicolored tail; pale smoke-gray ventrum; long skull and rostrum; and relatively narrow braincase (von Bloeker 1941, Collins and Martin 1985). Distinguished from sympatric *S. ornatus* of other subspecies by its slightly larger size, longer and slightly broader skull, and darker pelage (von Bloeker 1941, 1967).

Taxonomic Remarks: Von Bloeker (1941) first described the Santa Catalina Island shrew as *S. willetti*, and later relegated it to a subspecies of *S. ornatus* (von Bloeker 1967). Preliminary results from a taxonomic review of the species group indicate that *S. o. willetti* has been isolated on the order of 10,000 years, and that it is most closely related to populations in the southern part of the species' range (J. Maldonado pers. comm.).

Distribution: Santa Catalina Island shrews are known only from Santa Catalina Island (Williams 1983, Collins and Martin 1985). Based on the four specimen and four observational records, it appears to be widely distributed on the island. Single shrews were collected from Avalon Canyon on April 25, 1941 (von Bloeker 1941), from lower Cottonwood Creek 100 meters below Cottonwood Dam on January 13, 1983 (Williams 1983), from the south side of Cherry Valley Cove on March 16, 1991 (J. Maldonado pers. comm.), and from the Hancock Marine Research Station at Isthmus Cove (SBMNH-von Bloeker collection). Additional sightings of shrews are known from Middle Ranch Canyon below Thompson Dam (Williams 1983), the Bunk House at Middle Ranch, and the west end road 0.2 mi (322 m) west of the Isthmus Dump (Collins and Martin 1985). The most recent record is from Middle Canyon adjacent to the road to Ben Weston Beach on April 24, 1993 in (J. Maldonado pers. comm.). Based on these few records, the known elevational range extends from near sea level to approximately 600 ft.

Small mammal surveys of the larger islands off the coast of southern California over the past 25 years using both pitfall and live-trapping methods have failed to yield ornate shrews (Collins and Martin 1985), although the species potentially occurs there (von Bloeker 1967).

Ornate shrews were a member of the San Miguel fauna for at least 9,000 years, and may have become extinct recently (Guthrie 1993). A *Sorex* cranium was recovered in rock fissure (Walker 1980) and *Sorex ornatus* bones were recovered from column samples taken on the island (at Daisey Cave) (Guthrie 1993). Based on these skeletal materials, the ornate shrews on San Miguel Island were, like *S. o. willetti*, larger than mainland ornate shrew populations (Walker 1980, Guthrie 1993).

Life History: Little is known about the life history of the Santa Catalina Island shrew, but it is expected to be similar to that recorded for ornate shrews found on the adjacent mainland. Breeding probably occurs from late February through early June with a minor secondary breeding peak in mid-to-late September (Collins and Martin 1985). The low capture rates of intensive trapping surveys (Williams 1983, Collins and Martin 1985, J. Maldonado pers. comm.) suggests that it occurs in much lower densities than ornate shrews on the mainland (Collins and Martin 1985). Much of the potential shrew habitat on Santa Catalina Island is marginal (Williams 1983), partly or wholly because the woodland, riparian and wetland habitats have been severely degraded by more than a century of grazing by feral non-native herbivores (Collins and Martin 1985). Predation by feral cats (*Felis silvestris*), island foxes (*Urocyon littoralis*), and feral pigs (*Sus scrofa*) may also be having an adverse affect on remaining small, isolated extant populations (Collins and Martin 1985).

Habitat: The few recent captures of *S. o. willetti* occurred in riparian habitat with an overstory of cottonwood (*Populus*), willow (*Salix*), and elderberry (*Sambucus*), with a dense herbaceous understory (e.g., bulrush [*Scirpus* sp.], sedges, [*Carex* sp.] cattails [*Typha* sp.], horsetail [*Equisetum* sp.], grasses), and tangles of plant debris and tree roots, and in proximity to flowing water (Williams 1983, J. Maldonado pers. comm.). The earlier records lack detailed habitat descriptions beyond saying that shrews were in mesic habitats in major drainages on Santa Catalina Island. The available evidence indicates that this species has similar habitat requirements as ornate shrews on mainland California, namely mesic habitats with low, dense vegetation, heavy leaf litter, and soils with rich duff layers (Collins and Martin 1985). Such habitat provides cover for foraging and nesting, and protection from predators. The leaf litter and duff hold soil moisture during the dry season and provide a year-round supply of invertebrates for food (Collins and Martin 1985).

Ornate shrews on the mainland also occur seasonally or year-round in low numbers in upland woodlands such as chaparral and coastal sage scrub (Owen and Hoffman 1983, Collins and Martin 1985). It is unknown whether Santa Catalina Island shrews occur in upland chaparral, grassland, oak woodland or coastal sage scrub habitats, or in brackish and saline marshes near sea level.

Status: Class II. The Santa Catalina Island shrew is rare and locally distributed on Santa Catalina Island. Surveys in the 1980s totaling 6780 trap-nights of effort have yielded a single Santa Catalina Island shrew (Williams 1983, Collins and Martin 1985). In 1993, two shrews were captured after 350 trap-nights of effort using Sherman live-traps (J. Maldonado pers. comm.). However, additional information is needed to determine if listing as Threatened or Endangered is appropriate. The species was probably not abundant in pristine conditions due to the arid climate and restricted well developed mesic woodland habitats (Williams 1983). However, a century of grazing by a variety of introduced ungulates sheep, cattle, feral goats and wild pigs has rendered the historical riparian and wetland habitats habitat marginal for shrews.

The most important factor in the decline of this species is the fragmentation, loss and general degradation of mesic woodland, riparian and marsh habitats from more than a century of grazing by feral ungulates, and from the diversion of water for urban and agricultural uses (Williams 1983, Collins and Martin 1985). Additional factors are loss of surface water resources from groundwater pumping and water diversions and predation from feral cats (Collins and Martin 1985).

Feral herbivores directly threaten this taxon by reducing the extent of suitable mesic woodland and marsh habitat, disrupting the understory mulch and detritus layer, compacting soils, and increasing the rate of erosion (Collins and Martin 1985). These factors combine to result in a drier microclimate in remaining pockets of mesic woodland and marsh habitats that under normal pre-grazing conditions, would probably have been able to support this taxon.

Most of Santa Catalina Island is owned and managed by the Santa Catalina Island Conservancy with the primary objective to preserve and protect the island's native biota. The Conservancy also benefits from the sale of bison and from commercial hunting of wild pigs, goats, and deer. However, continuing to maintain free-roaming, feral herbivores on the island is a major threat to the island's native biota and is a source of irreconcilable conflict of management objectives (Williams 1986). Feral pigs (*Sus scrofa*) are causing the most damage to the heavy leaf litter and duff overlaying soils of wetland and streamside communities, and woodlands (Collins and Martin 1985). Although the Conservancy has been conducting feral herbivore control efforts for more than two decades, they have not been able to completely eradicate feral pigs or goats from the island. Until the Conservancy is able to eliminate these feral herbivores from Santa Catalina, mesic habitats critical to the long-term survival of Santa Catalina Island shrews will continue to be degraded.

Management Recommendations: The highest priority is to protect wetland and riparian communities on Santa Catalina Island from feral animal grazing, wild pig rooting, and groundwater pumping, especially along Middle and Cottonwood Creeks. The primary management objective for the island should be to remove or otherwise control the impact of feral herbivores and introduced plants. The land steward [Catalina Conservancy] and the Department can work together to achieve this objective by eradicating introduced game animals (i.e., wild pig and mule deer) and continuing to reduce the bison herd. If a small herd of bison is maintained on the island, it should be fenced out of sensitive riparian and wetland habitats. The full impact of present and future water diversion and drawdown projects on riparian habitats should be studied and mitigated by the Southern California Edison Company, which owns the water rights on Santa Catalina Island, in consultation with the Department. The California Coastal Commission and the Los Angeles County Planning Commission should require that any future developments proposed for Santa Catalina Island carefully evaluate their potential for impacting wetland and riparian habitats critical for the Santa Catalina Island shrew. Informed management planning will require a better understanding of the species' distribution, the extent of remaining habitat, population status, habitat associations, abundance, reproductive biology, food habits, and factors affecting mortality.

Salt marsh wandering shrew, *Sorex vagrans halicoetes*
Paul W. Collins

Description: A small to medium sized (100-110 mm TL), dark shrew, sooty seal brown to black above with a relatively long (37-41 mm), unicolored tail; dark brown ventrum; and moderately large high-domed skull (Grinnell 1913). Distinguished from upland *S. v. vagrans* by its darker dorsum and brown ventrum (silvery brown in *vagrans*), slightly larger body size, broader rostrum, and longer maxillary tooth-row (Grinnell 1913, Jackson 1928, Findley 1955). Distinguished from *S. o. sinuosus* by its slightly lighter color, larger size, browner ears, and high, dome-shaped cranium (Grinnell 1913). Weight from 3.1 to 7.2 g (males) and from 2.7 to 7.0 g (females) (Rudd 1955b). Distinguished from upland *S. v. vagrans* by darker dorsal and ventral pelage (Grinnell 1913).

Taxonomic Remarks: The salt-marsh wandering shrew was first described as *S. halicoetes* Grinnell (1913). Jackson (1928) relegated *halicoetes* to a subspecies of *S. vagrans*, a convention followed by subsequent authors (Grinnell 1933, Findley 1955, Hennings and Hoffmann 1977, Junge and Hoffmann 1981, Carraway 1990). The taxonomy of *S. vagrans* group has had a confusing history (Merriam 1895, Grinnell 1913, Jackson 1928). There is little controversy about the taxonomic status of *S. v. halicoetes*, although the karyotype from *halicoetes* was identical to *S. v. vagrans* from the northern part of the San Francisco Bay region (Brown 1974). This taxon still needs a more thorough biochemical and morphometric analysis to help clarify its phylogenetic and taxonomic relationship to other members of the *S. vagrans* complex. Carraway's (1990) morphometric analysis of the *S. vagrans* complex along the Pacific coast, which did not include *halicoetes*, resulted in the recognition of five species (*S. sonomae*, *S. bairdii*, *S. monticolus*, *S. pacificus*, and *S. vagrans*) and one new subspecies (*S. s. tenelliodus*) in the *S. vagrans* complex.

Distribution: Based on available museum specimen records, *halicoetes* occurred historically in salt marshes bordering the southern arm of the San Francisco Bay from San Pablo, south along the bay margin through Oakland, Hayward, and Alviso, then north through Palo Alto, Belmont, and South San Francisco (Grinnell, 1913, 1933, Ford 1986). Today, it is confined to small remnant stands of salt marsh found around the southern arm of the San Francisco Bay in San Mateo, Santa Clara, Alameda and Contra Costa counties (Ford 1986). The known elevational range extends from approximately 6 to 9 ft.

Life History: There are few data on the life history of *S. v. halicoetes*, although its biology is probably similar to that described for *S. vagrans* (Clothier 1955, Ingles 1960, 1961, Eisenberg 1964, Newman 1976, Hawes 1977). *S. v. halicoetes* is active all year long but tends to be most active at night with some limited nocturnal activity. Its activity pattern is probably regulated to some degree by daily and seasonal tide cycles. Based on comparisons with other salt marsh shrews (see *S. o. sinuosus* account), the diet of *halicoetes* is probably composed largely of amphipods, isopods, crustaceans, and insects that inhabit salt marshes.

Foraging probably takes place under litter and debris found on moist ground, and in moist accumulations of dead plant material (Zeiner et al. 1990). According to Johnston (1957), salt marsh wandering shrews are fairly good swimmers both above and below the surface of the water. On several occasions he observed salt marsh wandering shrews dive underwater to avoid being captured.

S. v. halicoetes breeds from February through June, with most young born during April (Johnston and Rudd 1957). Another smaller peak of breeding occurs in September, contributed to by reproduction by young of the year born in the previous spring. Gestation lasts about 20 days, and average litter size is 5.16 young (range 2-9 young). Less than half the salt marsh wandering shrews

survive to weaning. Two kinds of nests, one for breeding and the other for resting, are constructed. The breeding nest is constructed of dead plant material (*Spartina*, *Distichlis*, and *Salicornia*) by the female, and is typically located on the ground either under or in driftwood, planks, or woodblocks found along the higher tide line where they may escape flooding. Resting nests are used by both sexes and are generally placed off the ground in *Salicornia*. Of the 45 salt marsh wandering shrew nests located by Johnston (1957), only three were situated below elevations 1.8 m above mean sea level.

On average, salt marsh wandering shrews live less than 18 months, indicating high population turnover. Populations also show substantial multi-annual fluctuations. Raptors such as northern harrier (*Circus cyaneus*), white-tailed kite (*Elanus caeruleus*), and short-eared owl (*Asio flammeus*) occasionally prey on salt marsh wandering shrews (Johnston and Rudd 1957). Other likely predators are egrets, herons, feral cats (*Felis silvestris*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), and the long-tailed weasel (*Mustela frenata*). The principal causes of mortality for salt marsh wandering shrews are drowning, starvation, and exposure (Johnston and Rudd 1957).

Population density and home range size for this taxon are expected to be similar to those reported for other populations of vagrant shrews. In Washington state, *S. vagrans* have been recorded at densities ranging from 36.6 to 50.2 individuals per ha (Newman 1976). *S. vagrans* in Washington and California have home ranges from 24 to 678 m^2 and population densities of 6.1-6.9 per ha (Ingles 1961, Newman 1976).

Habitat: Salt marsh wandering shrews inhabit a narrow band of *Salicornia* marsh which is inundated daily by tidal waters (Ford 1986). According to Johnston and Rudd (1957), salt marsh wandering shrews are most frequent in salt marshes that provide dense cover, an abundant source of invertebrates for food, suitable nesting and resting sites, and continuous ground moisture. In one study, most individuals restricted their activity to middle marsh habitat, about 6 to 8 ft above sea level, and to lower-lying marsh not regularly inundated. Suitable middle marsh habitat frequented by this taxon is usually inundated only by high tides and is characterized by 30-60 cm high *Salicornia* with driftwood and other debris resting directly on the vegetation (Johnston and Rudd 1957). The surface debris provides nesting and resting sites and foraging habitat during dry periods. The high salt marsh, from 2.4 to 2.7 m in elevation, provides refuge for shrews during extremely high tides. The low marsh, dominated by *Spartina* and subjected to daily tidal floods, is used by this taxon as foraging habitat only during low tides (Johnston and Rudd 1957).

Status: Class II. *S. v. halicoetes* is currently restricted in distribution to only a few scattered, isolated remnants of tidal salt marsh around the southern arm of the San Francisco Bay (Ford 1986). Museum specimen records and the available literature, including reports from live-trapping surveys, indicate that *S. v. halicoetes* inhabited most *Salicornia* marshes between South San Francisco and San Pablo, and occurred at 54 sites in five counties (Ford 1986). Ford (1986) undertook surveys within the species' historic range and reported the following: *i)* populations were found at four marshes within its historic range (Mowry Slough, Bair Island, Dumbarton Point, and Alameda Creek Mouth); *ii)* the status of shrew populations at 31 historic locations in San Mateo and Alameda counties was unknown; *iii)* twelve historic shrew locations had been extirpated; and *iv)* fifteen additional locations contained suitable salt marsh wandering shrew habitat. Ford (1986) recommended that *S. v. halicoetes* be listed and protected under the State and Federal Endangered Species Acts. However, a more intensive range-wide population assessment of the distribution and status of extant salt marsh wandering shrew populations is needed before a decision can be made on whether to pursue this recommendation.

The salt marsh wandering shrew has been adversely affected by the degradation and loss of salt and brackish marsh habitats that occurred historically around the San Francisco Bay. When Europeans first reached the San Francisco Bay region over 200 years ago, there were more than 73,000 acres of salt and brackish marsh habitat present around the southern arm of the San Francisco Bay (Ford 1986). Approximately 91 percent (66,458 acres) of these tidal wetlands have been lost to urban, industrial and agricultural development, diking, filling, flooding, dredging, erosion, and/or conversion to other types of vegetation (Ford 1986). Today there are only about 6,546 acres of natural, undiked, tidal salt marsh remaining within the shrew's historic range (Ford 1986). The loss of this amount of marsh habitat has had a profound effect on the size and distribution of salt marsh wandering shrew populations, and is the principal reason for concern about the present status of this taxon.

Other factors affecting this taxon include widespread loss of high marsh habitat contiguous with remaining areas of low and middle marsh; construction and maintenance of dikes and levees that help to isolate shrew populations; wastewater discharges that change the composition and vigor of salt marsh shrew habitats; and infusion of heavy metals, PCBs, petroleum hydrocarbons, and pesticides that may be accumulating in the food chain on which salt marsh wandering shrews depend (Shellhammer et al. 1984, Ford 1986).

The salt and brackish marsh habitats inhabited by the salt marsh wandering shrew receive Federal and State regulatory oversight and protection because they also support populations of two Federally-listed species (the salt marsh harvest mouse [*Reithrodontomys raviventris*] and California clapper rail [*Rallus longirostris obsoletus]*). All of the marshes which have extant populations of salt marsh wandering shrews are included in the proposed critical habitat for salt marsh harvest mice (Shellhammer et al. 1984). However, this shrew uses a restricted area of salt marsh habitat, and there may be a smaller amount of suitable habitat for it than for salt marsh harvest mice. *S. v. halicoetes* may therefore be under a greater threat of extinction than the Endangered salt marsh harvest mouse.

Management Recommendations: A range-wide trapping program is needed to determine the current distribution and status of *S. v. halicoetes*, and to evaluate the extent of suitable salt marsh habitat. Such an effort should provide the basis for deciding whether to propose the listing of this taxon as Threatened or Endangered. At the same time, a better understanding of the species' life history and population biology are needed, including the population sizes needed to maintain genetically viable populations, and genetic and morphologic studies needed to understand the effect of habitat fragmentation and its relationships to other *S. vagrans* subspecies.

Some or all of the measures recommended or being implemented to protect and enhance tidal marsh habitat for the Endangered salt marsh harvest mouse and California clapper rail (Shellhammer et al. 1984) could also be benefiting salt marsh wandering shrews. Measures for habitat protection and enhancement contained in the recovery plans for these two species should be reviewed and modified where appropriate to ensure that remaining marsh habitat is enhanced for the two listed species and for the salt marsh wandering shrew. Any proposed developments, waste water discharges, dredging activities, and dike repairs within the historic range of this taxon that could modify salt marsh vegetation or change the degree of inundation of salt marsh habitats should be reviewed for their impacts on this species.

Mexican long-tongued bat, *Choeronycteris mexicana*

Elizabeth D. Pierson & William E. Rainey

Description: *Choeronycteris mexicana* can be distinguished from most other California bats by a leaf-like projection on the tip of the nose (i.e., the leaf-nose is a distinguishing trait of the Family Phyllostomidae). It can be distinguished from the other phyllostomid found in southern California, *Macrotus californicus*, by its long, narrow rostrum and small ears. In parts of its range outside California, it also co-occurs with *Leptonycteris curasoae* and *Leptonycteris nivalis*. While both these species also have a long rostrum, both lack a tail, which is present in *C. mexicana*. *C. mexicana* has a forearm of 43-48 mm, a tail length of 6-10 mm, and an adult weight of ca. 20 g (Barbour and Davis 1969).

Taxonomic Remarks: *Choeronycteris* is a monotypic genus in the Family Phyllostomidae. It was first described in 1844, from a type locality in Mexico (Tschudi 1844-1845). It has at times been considered congeneric with *Musonycteris*, but recent treatments concur that it should be considered a separate genus (Arroyo-Cabrales et al. 1987, Koopman 1993).

Distribution: *C. mexicana* reaches the northern limits of its range in the southwestern United States. The bulk of its distribution is in Mexico (including Baja California and the Tres Maria Islands), reaching as far south as El Salvador and Honduras. There are records from southern California, southern Arizona, southwestern New Mexico, and the southern tip of Texas (Hall 1981, Arroyo-Cabrales et al. 1987, Schmidly 1991), with a single specimen from southern Nevada (Constantine 1987). Maternity colonies are known from Arizona and New Mexico. With rare exceptions, this species is apparently present in Arizona only from April to October (Hoffmeister 1986).

Available museum records and recent sightings (K. Miner pers. comm.) suggest the species distribution in California is limited primarily to San Diego County. Records from the Department of Health Services indicate it could be expected over a somewhat wider area, but is confined to southern California (D. Constantine pers. comm.). The only records for San Diego County are from fall and winter, suggesting seasonal movement, perhaps from inland sites to warmer coastal areas.

Life History: *C. mexicana* has been found in groups of 40-50, but generally forms colonies of a dozen or fewer (Hoffmeister 1986). Births occur in June through early July in Arizona and New Mexico. Females give birth to single, precocial young, which may weigh as much as 30 percent of the mother's weight.

C. mexicana appears to be primarily nectivorous, although its diet also includes fruit, pollen and probably some insects (Gardner 1977). It has been observed feeding at flowers of cultivated *Agave* and columnar cacti in San Diego County (K. Miner pers. comm.).

Habitat: *C. mexicana* occurs in a wide variety of habitats from arid thorn scrub to tropical deciduous forest and mixed oak-conifer forest (Arroyo-Cabrales et al. 1987). Although Barbour and Davis (1969) state the species is found primarily in deep, moist desert canyons in southeastern Arizona and western New Mexico. It is fairly common in the Chiricahua Mountains in the early summer (P. Brown pers. comm.). Barbour and Davis (1969) also found *C. mexicana* in oak (1,600 m) and in Ponderosa pine (1,900 m) habitat.

Preferred roosting sites appear to be mines, caves and rock fissures (Huey 1954a, Banks and Parrish 1965, Barbour and Davis 1969, Hoffmeister 1986). Animals do not cluster in the roost, are alert and

wary, and tend to roost in partially lit settings. When disturbed they will fly into sunlight rather than to a darker part of the roost structure. This species has also been found in buildings, particularly in southern California (Huey 1954a, K. Miner pers. comm.).

Status: Class II. This species is being placed on the Special Concern list because it appears to have such a limited distribution in southern California, and because records of occurrence are so rare. Most of the records for this species result from an event, interpreted as a "flash invasion", which occurred in September 1946 (Olson 1947, Huey 1954a). At the time, *C. mexicana* was observed at a number of localities in San Diego County. It has not been observed again in the same numbers. Nevertheless, there are recurrent fall and winter reports of this species foraging in private gardens in San Diego County (K. Miner pers. comm.).

Since *C. mexicana* is primarily a cave dwelling species, it is, like other cave dwelling bat species, extremely vulnerable to human disturbance at its roosts. Behavioral observations suggest it is especially sensitive and wary (Barbour and Davis 1969).

Not enough is known about *C. mexicana* in California to identify threats specific to this species in southern California.

Management Recommendations: A more concerted effort needs to be made to establish the spatial and temporal distribution of *C. mexicana* in southern California. Recently identified localities should be regularly monitored to determine seasonal occurrence. The species of plants being used by the animals for foraging need to be identified. This information could then be used to search for additional localities.

California leaf-nosed bat, *Macrotus californicus*

Elizabeth D. Pierson & William E. Rainey

Description: *Macrotus californicus* is one of two phyllostomid species that occur in California. It is a medium sized bat (forearm = 46-52 mm, weight = 12-22 g), with grey pelage and long (>25 mm) ears. It can be distinguished from all other long-eared bats by the presence of a distinct nose leaf, which is erect and lanceolate (Hoffmeister 1986). The only other California species with a leaf-shaped nose projection, *Choeronycteris mexicana,* has very short ears. *Corynorhinus townsendii*, the other long-eared species with which *M. californicus* could most readily be confused, can be distinguished by the presence of bilateral nose lumps as opposed to a single nose leaf. *Antrozous pallidus* has long ears and a scroll pattern around the nostrils instead of a nose leaf. *M. californicus* has a tail which extends beyond the edge of the tail membrane by 5-10 mm.

Taxonomic Remarks: *M. californicus*, a member of the Family Phyllostomidae, has sometimes been considered a subspecies of *Macrotus waterhousii* (Anderson and Nelson 1965), but more recently, based primarily on chromosomal characters, has been treated as a separate species (Davis and Baker 1974, Greenbaum and Baker 1976, Baker 1979, Straney et al. 1979). The form now recognized as *M. californicus* was first described from a specimen collected at Old Fort Yuma, Imperial County (Baird 1859). There are currently two species recognized in the genus *Macrotus* (Koopman 1993). Only *M. californicus* occurs in the United States.

Distribution: *M. californicus* has a limited distribution which extends from northwestern Mexico (Sonora and Sinaloa) and Baja California into Arizona, southern Nevada, and southern California (Greenbaum and Baker 1976, Hall 1981).

Museum records document that earlier in the 20th century, *M. californicus* was distributed across most of southern California (specifically Imperial, Los Angeles, Riverside, and San Diego counties). It was observed in southcentral San Diego County (west of the Laguna Mountains) as recently as 20 years ago (P. Brown pers. comm.). Extensive surveys conducted over the past 30 years indicate that the species also occurs in San Bernardino County. It currently appears to be limited to the eastern portion of its former range. It is found primarily in the mountain ranges bordering the Colorado River basin, with records occurring as far west as the Eagle Mountains, Riverside County (P. Brown pers. comm.). A few individuals (males) were recently found in the Avawatz Mountains, just south of Death Valley, approximately 160 km north of the next known roost containing more than a few animals (P. Brown pers. comm.).

Life History: *M. californicus* is colonial, forming large seasonal aggregations. Females congregate in the spring and summer in maternity colonies of typically 100 to 200 bats (Barbour and Davis 1969, Vaughan 1959), although colonies of only 6-20 bats are also found. Within the larger colonies, clusters of five to 25 females will be associated with a single "harem" male that defends the cluster against intruding males (Brown and Berry 1991). Large male roosts may also form. Each female bears a single young between mid-May and early July. Maternity colonies disband once the young are independent in late summer. In September and October, males aggregate in "display" roosts, which may be separate from the maternity sites, where they are visited by females for mating (Berry and Brown 1995). Although pregnancy is initiated immediately, embryos undergo several months of "delayed development," remaining at a very early embryonic stage until development resumes in March (Bradshaw 1962). The total gestation period is almost nine months. This species also forms larger, mixed sex aggregations of up to 2,000 bats in winter. Unlike vespertilionids, phyllostomids do not hibernate. *M. californicus* has a narrow thermal-neutral zone, and appears incapable of entering torpor (Bell et al. 1986).

M. californicus is purely insectivorous, and forages low over desert wash vegetation, often within one meter of the ground (Vaughan 1959). Although the species can use echolocation, it relies preferentially on vision to localize its prey (Bell 1985, Bell and Fenton 1986), and probably uses prey-produced sounds as well. The diet is composed primarily of large moths (sphingid, noctuid, and cossid), butterflies, grasshoppers, and katydids (Anderson 1969, Huey 1925, Vaughan 1959). Since many of these taxa are either flightless or diurnal, it is presumed that *M. californicus* frequently gleans prey off surfaces (Stager 1943b, Vaughan 1959). Wings and other culled prey parts are found under night roosts.

Habitat: *M. californicus* appears to be confined to lowland Sonoran Desert habitat below 900 m (Brown et al. 1995, Brown 1996). This species also appears to be totally dependent on either caves or mines for roosting. Although it has occasionally been found night roosting in buildings or bridges (e.g., P. Brown pers. comm., Constantine 1961, Hatfield 1937), its maternity, mating, and overwintering sites are all in mines or caves (Brown et al. 1995). All except two currently known day-roost sites are in abandoned mines. Several caves used earlier in the century, some of which contained hundreds of individuals (e.g. Grinnell 1918, Howell 1920b), have either been abandoned due to human disturbance/suburban encroachment, or now contain only a few bats.

M. californicus has quite restrictive roosting requirements. Individuals remain active year round and need to find both summer and winter roosts that have temperatures of approximately 29°C. Summer roosts are generally relatively close to the roost entrance, often within the twilight zone, where temperatures in the summer in the desert exceed 30°C. In the Colorado River basin, all known winter roosts are in geothermally-heated mine workings, and may be as much as a kilometer from the entrance (P. Brown pers. comm.). Banding studies conducted over the past 30 years suggest that distances traveled between summer and winter roosts are generally no more than a few kilometers (Brown et al. 1995), and different areas of the same mine complex can be used at different seasons. While abandoned mines have long been recognized as an extremely important resource for summer and winter colonies of *M. californicus* in California, recent research has revealed that this species also uses particular sites in the fall for courtship and mating, that may be different from summer or winter sites (Berry and Brown 1995).

M. californicus also appears to require desert wash vegetation for foraging. In several radiotracking studies, Brown et al. (1993b) showed that the bats fed primarily in this habitat, generally within one to three miles (1.6-4.8 km) of the roost. Having foraging areas adjacent to the roost was more important in winter, when the bats tended to forage closer to the roost and for shorter periods than in the summer.

Status: Class I. The range of *M. californicus* has contracted during this century, and the species no longer occurs outside of desert habitats in California. The primary factors responsible for the declines are roost disturbance, renewed mining in historic districts, closure of mines for hazard abatement, and destruction of foraging habitat. The combination of limited distribution, restrictive roosting requirements, and the tendency to form large but relatively few roosting aggregations make this species especially vulnerable.

Museum records establish that this species occurred in western San Diego, northwest Los Angeles, and western Riverside counties at the turn of the century (Grinnell 1918, Howell 1920c, Krutzsch 1948). Despite extensive surveys over the past 30 years (Brown 1996), virtually no animals have been found at any of these historic localities, except for a few individuals near Lake Barrett (in 1978), and three individuals at a natural cave in the Coachella Valley, near the current city of La

Quinta (early 1990s) (P. Brown pers. comm.). The La Quinta roost, reported by Grinnell (1918) to contain at least 300 individuals in 1908, is now surrounded by golf courses and luxury estates, with only remnants of desert wash vegetation in the vicinity. The remaining known cave roosts are now subject to heavy recreational use. The complex of caves near the Salton Sea (Bat Cave Buttes) reported to have multiple colonies of up to 200 each early in the century (Howell 1920b) has been heavily vandalized and no longer contain *M. californicus*. The historic roost at Owensmouth on the Los Angeles/Ventura County line is surrounded by housing developments, and is a local party spot. The Santa Susanna roost is in the middle of a large housing tract. The Santa Margarita Ranch location is now Camp Pendleton, and the historic roosting site has not been located.

Currently, only about 20 maternity colonies, and about the same number of winter roosts are known (P. Brown pers. comm., Brown et al. 1995), although in some cases, the winter and summer roosts are in different mines within a mountain range. The largest colonies are confined to the mountain ranges along the Colorado River. The two largest roosts, with over 1,500 bats each, are in mines in extreme southeastern California. One of these mines is currently under claim to a mining company that has destroyed adjacent *M. californicus* roosts in renewed mining efforts. Bat populations in the mined areas declined by over 60% in one drainage. Another colony of 150 was totally eliminated when the mine roost was closed. The largest winter roost in California is in an area of heavy winter recreational use, and two of the three entrances were closed in 1985 for hazard abatement. This made the mine unsuitable as a maternity colony, and it is now occupied by almost 2,000 *M. californicus* only in the winter. Except for roosts in the Cargo Muchacho Mountains, none of the current roosts is threatened by renewed mining. This situation could change if mining becomes more profitable in historic districts (i.e., the price of gold increases or the cost of extraction decreases).

This species faces a number of threats in California:

Renewed mining. The primary threat to *M. californicus* populations in California is renewed mining in historic districts. Since 1977, *M. californicus* populations have been monitored in the Cargo Muchacho Mountains. In 1989, mining commenced in one drainage, and then spread out into another. In some cases bats were killed or displaced as historic mines became part of open pits. Even where mines were not directly impacted, bat populations dropped to 10% of pre-mining levels due to the removal of foraging habitat (desert wash vegetation) adjacent to the roost. The second largest winter roost in California, which is also a maternity roost, is in a drainage adjacent to the active mine (and under claim). *M. californicus* roosts at the Picacho Mine were eliminated without surveys or exclusion of roosting bats to prevent their death.

Abandoned mine closures. The largest *M. californicus* winter roost in California was almost closed for hazard abatement. Two of three entrances were closed before the Bureau of Land Management was alerted to the threat. The main shaft of the Senator Mine was covered with chain-link fence material after two Marines ignored warning signs and perished inside. Although bats continue to gain access to the mine through an alternate opening, they cannot get though the chain-link material, and the numbers in this colony have declined. With appropriate gate design, it is possible to close mines to human access and still allow use by bats and other wildlife.

Disturbance from the public. Human visitation is likely responsible for the disappearance of the colonies in Chatsworth, Owensmouth, Toro, and Salton Sea caves. There is no recent bat sign at the Owensmouth and Chatsworth roosts, which are currently surrounded by housing tracts and/or used as party sites. A combination of human disturbance and removal of foraging habitat is likely responsible for declines (from >300 to 2-3) at the La Quinta and Toro roosts. Bat Cave Buttes along the east side of the Salton Sea occasionally house a few *Tadarida brasiliensis* or *Antrozous pallidus*,

but have no evidence of *M. californicus.* These are heavily visited by OHV riders. A mine near Dulzura, which had *M. californicus* in the 1940s (Krutzsch 1948) currently receives heavy recreational use and has no bats. Recreational mine exploration and artifact collection (now a lucrative business) pose an increasing threat. P. Brown (per. comm.) reports signs of human entry (e.g., missing ore carts and an accumulation of beer cans) in deep, relatively inaccessible portions of formerly undisturbed mines.

Suburban/urban expansion. Suburban/urban expansion leads to increased recreational activity at roost sites and eliminates foraging habitat. This has been most evident in western San Diego and Los Angeles counties, as well as in the Coachella Valley near Palm Springs.

Loss of foraging habitat. The removal of desert wash vegetation, as evidenced at the American Girl mine site, has had negative impacts on *M. californicus* populations, and is particularly critical for wintering populations (Brown 1996). The largest disturbances are from active mines in the Cargo Muchachos, i.e., the Mesquite Mine at Glamis and the Picacho Mine. A new mine (Imperial) is being permitted north of the Cargos. While this will not affect any known roosts, it may remove foraging habitat. Desert wash vegetation has also been removed from large areas of the Coachella Valley, primarily due to expansion of urban areas and construction of golf courses.

Landfills. The roost in the Kaiser adit at Eagle Mountain (Riverside County) may eventually be covered by landfill. The landfill at Mesquite mine (Imperial County) will probably remove foraging habitat, although at present, the landfill site is not near an active roost.

Military activities. The Chocolate Mountain Gunnery Range has two mines with *M. californicus.* The main disturbance is troops (Navy SEALS) entering the mines. These mine entrances should be gated as soon as possible. The Twenty-nine Palms Marine Corps Training Center may have had a *M. californicus* roost (as judged by guano), but troops regularly enter the mine. A gate is planned (P. Brown pers. comm.).

Management Recommendations: Surveys of mines within range of *M. californicus* should be required before any closures occur for renewed mining or hazard abatement. Survey protocol should be standardized (Altenbach 1995, Dalton and Dalton 1995, Navo 1995, Rainey 1995).

Mines that are vulnerable to human disturbance (have evidence of recent human entry) should be gated with bat-friendly gates.

Key roosts (both gated and ungated) should be monitored annually to document population fluctuations in both winter and maternity colonies. Mines with declining populations should be most closely monitored.

Additional surveys are needed to identify the limits of current distribution of *M. californicus* in California. Surveys conducted in 1989-1994 expanded the known range to the northwest, yet many mining areas have not been be surveyed. Key populations may yet be discovered and require protection.

Preservation of desert wash vegetation within the range of *M. californicus*, especially within 5 mi (8 km) of known roosts, may be critical to survival.

Pallid bat, *Antrozous pallidus*

Elizabeth D. Pierson & William E. Rainey

Description: *Antrozous pallidus* is a large (forearm = 45-60 mm), long-eared vespertilionid bat. It can be readily distinguished from all other California bat species by a combination of large size, large eyes, large ears, light tan coloration, a pig-like snout, and a distinctive skunk-like odor. Although color varies from very light, almost blonde, in desert populations, to tan along the coast and farther north, the overall impression is of a light colored bat. No other species has fur this light. It lacks the nose-leaf found in *Macrotus californicus* and the bilateral nose lumps found in *Corynorhinus townsendii*. *Myotis evotis* is much smaller and has dark, rather than pale colored, ears. *Euderma maculatum*, which also has light ears, can be distinguished by its unique pelage coloration -- black with three large, white dorsal spots.

Pallid bats sometimes leave characteristic sign. Remains of scorpions, Jerusalem crickets, sphinx moth wings, and/or long-horned beetles in association with bat guano, indicate the presence of pallid bats. It is possible, however, to find pallid bat guano deposits that do not have culled insect parts.

Taxonomic Remarks: *A. pallidus*, a member of the Family Vespertilionidae, was first described in 1856 from a specimen collected in El Paso, Texas (LeConte 1856). The first record of *A. pallidus* for California was from Old Fort Tejon, Kern County (Merriam 1897). Based on morphometric analyses, there are six currently recognized subspecies of *A. pallidus*, with three (*A. p. pacificus*, *A. p. pallidus*, and *A. p. minor*) occurring in California (Martin and Schmidly 1982). The primary characteristic used to separate subspecies is size. Since genetic analyses have not been conducted on California populations, geographic boundaries between the subspecies have not been clearly delineated, and specimens for most localities have not been examined, we treat all California *Antrozous* as *A. pallidus*. Koopman (1993) recognizes two species of *Antrozous*, *A. pallidus* and *A. dubiaquercus*, whereas others (Engstrom and Wilson 1981, Engstrom et al. 1987) place the latter species in a separate genus, *Bauerus*.

Distribution: Pallid bats are known from Cuba, Mexico and Baja California, through the southwestern and western United States, into southern British Columbia. They occur as far east as Kansas, Oklahoma, and Texas, and throughout much of the United States west of the Rocky Mountains (Hall 1981, Martin and Schmidly 1982). In California, the species occurs throughout the state in a variety of habitats including low desert, oak woodland and coastal redwood forests, extending up to 3,000 m elevation in the Sierra Nevada.

According to Martin and Schmidly (1982), *A. p. pacificus*, the largest subspecies, occurs along the coast and in the coast ranges west of the Central Valley. *A. p. minor*, the smallest subspecies, occurs in the Colorado River basin and adjacent mountain ranges. *A. p. pallidus* occurs throughout the rest of the state (including western San Diego County, the Central Valley, all of the Sierra Nevada and areas east of the crest, and, farther north, all areas east of the coast ranges). Martin and Schmidly (1982) describe an area of intergradation in the Klamath Mountains between *A. p. pacificus* and *A. p. pallidus*. According to Hall (1981), *A. p. pallidus* is confined to the area east of the Sierra Nevada crest, south of Lake Tahoe. The subspecific status of *A. pallidus* populations in California warrants further investigation.

Life History: Pallid bats are colonial, with a typical colony containing 30-70 animals, although colonies of several hundred have been found. Colonies form in the spring (March-May), and stay together until October (Barbour and Davis 1969). These colonies can be bachelor groups, but usually consist of adult females and their young. Pallid bats mate in the fall or winter, but, as is

typical of northern hemisphere vespertilionids, the females do not actually become pregnant until the spring. They give birth to one or two young in early summer (Orr 1954). Young are born in an altricial state, dependent on their mothers for at least 6 weeks. They are deaf at birth and begin to respond to low frequency vocal communications at about 6 days of age, and have hearing equivalent to that of an adult by 12 days of age (Brown 1976, Brown et al. 1978). The young accompany their mothers when first learning to fly and forage (Brown and Grinnell 1980). Although they are weaned at 6-8 weeks, the young are not self-sufficient until the fall when colonies disperse. Recapture data from the upper Sacramento River drainage suggest that females in that part of California do not reproduce until they are two years old (Rainey and Pierson 1996). Lewis (1993) showed that reproductive success was positively correlated with temperature for a pallid bat population in Oregon. Pallid bats are not known to migrate, and are presumed to spend the winter hibernating close to their summer roosts. No wintering aggregations have been found, although hibernating individuals have been detected close to or in the same structures as the summer roosts (Barbour and Davis 1969, C. Scott pers. comm.).

Pallid bats forage primarily on large (20-70 mm) arthropods, caught on the ground or gleaned off vegetation. Prey items include flightless arthropods, such as scorpions (Vejoridae), ground crickets (Gryllacrididae), solpugids (Solpugidae), and darkling ground beetles (Tenebrionidae); largely ground-roving forms, including scarab beetles (Scarabeidae), predacious ground beetles (Carabidae), carrion beetles (Silphidae), and short-horned grasshoppers (Acrididae); and vegetation-dwelling insects, including cicadas (Cicadidae), katydids (Tettigoniidae), praying mantids (Mantidae), long-horned beetles (Cerambycidae) and sphingid moths (Sphingidae) (Hatt 1923, Borell 1942, Barbour and Davis 1969, Hermanson and O'Shea 1983).

Radiotelemetry (P. Brown pers. comm.) and the known behavior of favored prey items suggest pallid bats fly close to the ground, and land on the ground to capture prey. Light-tagging studies have also documented animals feeding on the wing, 10-20 ft (3-6 m) off the ground (pers. obs.). Discarded large arthropod remains most commonly found in pallid bat roosts in California are Jerusalem crickets, cicadas, long-horned beetles, and scorpions (D. Pierson and W. Rainey pers. obs.). Although pallid bats use echolocation to assess habitat, they apparently locate prey primarily by listening (Bell 1982). Pallid bats have also been reported as visitors to fruits and flowers (Barbour and Davis 1969, Howell 1980). Although they are presumably feeding on insects associated with these plants, they also appear to serve as pollinators of some desert plants (Herrera et al. 1993).

Habitat: Although pallid bats are frequently associated with desert areas and the Sonoran Life Zone (Barbour and Davis 1969, Hermanson and O'Shea 1983), Orr (1954), who studied this species extensively in California, described the species as occurring in a number of habitats, including coniferous forests, nonconiferous woodlands, brushy terrain, rocky canyons, open farm land, and desert. In our observations (D. Pierson and W. Rainey) in northern California, this species is associated with oak habitat, particularly lower elevation oak savannah. It is also found in association with coast redwoods, and mid- to higher elevation coniferous forest (Orr 1954, Rainey et al. 1992). It is, for example, one of the species most frequently observed in Giant Sequoia groves at ca. 2,000 m (Pierson and Heady 1996).

Pallid bats are primarily a crevice roosting species, and select daytime roosting sites where they can retreat from view. Common roost sites are rock crevices, old buildings, bridges, caves, mines, and hollow trees (Barbour and Davis 1969, Hermanson and O'Shea 1983). Recent radiotracking efforts in the west, including California, suggest that pallid bats are far more dependent on tree roosts than was previously realized. They have been located in tree cavities in oak, Ponderosa pine, coast redwood and giant Sequoia (Rainey et al. 1992, Cross and Clayton 1995, Pierson and Heady 1996).

On Santa Cruz Island, however, radio-tagged animals selected rock crevices and buildings, despite abundant oak woodland (Brown et al. 1984). Pallid bats are also one of the species most predictably associated with bridges. They sometimes roost in expansion joints by day, but more commonly are found night roosting, particularly under concrete girder structures (Lewis 1994, Pierson et al. 1996). They are also often associated with buildings, ranging from collapsing barns and historically significant sites (e.g., some of the missions) to some relatively recent structures.

Roost temperature may be a limiting factor in roost selection. Cliff-roosting pallid bats in Arizona selected crevices that remained warm and stable (ca. 30^{o} C) in the summer, and tracked ambient temperature fluctuations in spring and fall (Vaughan and O'Shea 1976). Pallid bats are intolerant of roost temperatures above 40^{o} C (Licht and Leitner 1967), and often occupy roosts that offer a varied temperature regime. In attic settings, the animals emerge from crevices to roost on open rafters when roof temperatures become excessive. Pallid bats are very sensitive to disturbance at the roost. When disturbed, they generally retreat into crevices, and with repeated disturbance, may abandon the roost. Their response time is slow, however, making them vulnerable to shooting and other forms of vandalism, and their loyalty to a chosen roost (particularly buildings, mines, bridges) is generally high.

In central coastal California, pallid bats are most frequently found foraging in open oak woodland, but also feed in forested canyons (E. Pierson and W. Rainey pers. obs.). Radiotracking studies have shown that animals generally feed within 6-8 km of their roost, and have regularly occupied feeding areas (E. Pierson and B. Rainey unpubl. data; P. Brown pers. comm.).

Status: Class II. Although the status of *A. pallidus* has not been investigated, bat biologists have noted a definite decline in populations in recent years in California (P. Brown pers. comm.; E. Pierson and W. Rainey pers. obs.). For example, in 1980, four substantial pallid bat roosts were known in Napa County, and two in southern Sonoma County. Only one of these is still occupied, and when last checked, had many fewer animals than in 1980. This decline may be due to the conversion of oak woodlands to vineyards in the Napa Valley. This species, although it will coexist with humans in rural settings, appears to be intolerant of suburban and urban development. In the San Francisco Bay area, there are museum records for pallid bats from the Stanford University campus for 1895-1951, for San Francisco in 1948-1950, and for Berkeley from 1883-1945. Available data suggest this species is extirpated from all these localities. Recent surveys of the Presidio in San Francisco found no pallid bats despite the persistence of small remnant patches of suitable oak habitat (Pierson and Rainey 1995). Although there have been numerous records of bats on the UC Berkeley campus in the past 20 years, none have been pallid bats. The species does persist in the more rural eastern portions of Alameda and Contra Costa counties, and in parts of Marin County, particularly in the vicinity of Point Reyes National Seashore and in proximity to oak woodland.

P. Brown (pers. comm.) has noted precipitous declines in populations in coastal southern California since the 1970s. Yet, at that time, only one of 12 roost sites documented by Krutzsch (1948) in the 1940s was still occupied (P. Brown pers. comm.). Destruction of buildings and urban expansion likely account for observed declines in Los Angeles, Orange, and San Diego counties.

Current timber harvest practices, particularly the selective removal of hardwoods and large Ponderosa pine snags, likely pose a serious threat to pallid bat populations in forested areas. Additionally, at lower elevations, oak habitat is being lost to suburban expansion and agricultural conversion. The rapidly growing human population of the Sierra foothills is a case in point. Because pallid bats frequently roost in buildings, they often are excluded by renovations or by the

desire of property owners to be rid of them. Because their roosting sites are often highly visible (e.g., open rafters) and the animals display considerable roost loyalty, they are often targeted by pest control operators and vandals. This species is often associated with historic buildings in which their presence is typically viewed as a hazard by property managers. Pallid bats colonies could also be impacted by bridge modifications and/or replacements, inappropriate mine/cave closures, and human induced alterations of rock features (e.g., blasting of cliffs for road construction or inundation for water impoundment).

Management Recommendations: Status surveys are necessary, particularly in areas where apparent declines have occurred or where habitat conversion is most intense. More information is needed on the habitat requirements of pallid bats, particularly in forested settings. Genetic studies, using non-lethal sampling techniques, should be conducted to resolve subspecies issues.

Townsend's big-eared bat,
Corynorhinus townsendii pallescens* and *C. t. townsendii
Elizabeth D. Pierson & William E. Rainey

Description: *Corynorhinus townsendii* is a medium sized (10-12 g) vespertilionid, with an adult forearm of 39-48 mm and ears of 30-39 mm. It shows some geographical variation in color, but generally has buffy brown dorsal fur with somewhat paler underparts (Barbour and Davis 1969, Kunz and Martin 1982). *C. townsendii* can be distinguished from all other western bat species by the combination of a two-pronged, horseshoe-shaped lump on the rostrum, and large, rabbit-like ears. Although other California species have long ears (e.g., the pallid bat, *Antrozous pallidus*, the spotted bat, *Euderma maculatum*, the California leaf-nosed bat, *Macrotus californicus*, and the long-eared myotis, *Myotis evotis*), none of these have the two-pronged nose lump, and most can be distinguished by other features (Pierson et al. 1991).

Although the ears on *C. townsendii* are obvious (erect and facing forward) when animals are alert, they can be difficult to see (curled tightly against the top of the head in the shape of a ram's horn) when animals are in torpor or hibernation. At such times, the tragus (a narrow prominence on the frontal, external opening to the ear, which is enlarged in many microchiropteran species), remains erect, and can be mistaken for short, sharply pointed ears, leading to misidentification of the species.

Taxonomic Remarks: *C. townsendii* is in the Family Vespertilionidae. There are five currently recognized subspecies of *C. townsendii* in the United States (Handley 1959); two (*C. t. townsendii* and *C. t. pallescens*) in the western U.S., two (*C. t. ingens* and *C. t. virginianus*) in the eastern part of the country, and one (*C. t. australis*) with a primarily Mexican distribution, which overlaps with *C. t. pallescens* in western Texas. Only the two western subspecies are found in California.

For most of its taxonomic history, the recognized generic name for this North American species was *Corynorhinus*. Beginning, however, with a taxonomic revision by Handley (Handley 1959) it became known as *Plecotus*. Two recent phylogenetic studies have reviewed relationships among plecotine genera (Frost and Timm 1992, Tumlison and Douglas 1992), and have recommended resurrecting the generic name of *Corynorhinus* to distinguish the North American from the Palearctic forms. Because of publication timing, these conclusions are not addressed in the most recent compilation of mammalian species (Wilson and Reeder 1993), but K. Koopman, who prepared the bat section of this volume, indicates that the name for the genus should revert to *Corynorhinus* (K. Koopman in litt.).

Distribution: *C. t. townsendii* occurs in California, Oregon, Washington, Nevada, Idaho, and possibly southwestern Montana and northwestern Utah. *C. t. pallescens* occurs in all the same states as *C. t. townsendii*, plus Arizona, Colorado, New Mexico, Texas, and Wyoming (Handley 1959). Throughout much of their range in California, Idaho, Nevada, Oregon and Washington there are extensive zones of intergradation for the two subspecies. Throughout the zone of intergradation it is frequently impossible to assign individuals to one subspecies or the other. Handley distinguishes the two subspecies based on size and color characteristics, but he also notes that the full spectrum of characteristics for both subspecies can be found within a single population. The results of preliminary mitochondrial DNA studies, using PCR techniques, failed to distinguish between these two subspecies, but this may reflect the relatively conservative region sequenced (cytochrome b) (W. Rainey). For the purposes of this document, we make no distinction between these subspecies.

In California, *C. townsendii* is found throughout most of the state, with populations concentrated in areas offering caves (commonly limestone or basaltic lava) or mines as roosting habitat. The species

is found from sea level along the coast to 1,820 m in the Sierra Nevada (Dalquest 1947, Pearson et al. 1952, Pierson and Rainey 1996a). Outside California it has been found to 2,400 m (Jones 1965, Jones and Suttkus 1972) and 2,900 m (Findley and Negus 1953).

Life History: *C. townsendii* is a colonial species, with maternity colonies in California varying in size from a dozen to several hundred animals. Maternity colonies are seasonal, and form in the spring, although the timing varies with latitude. For example, colonies begin to form in March in the desert and central coastal California, and not until June in interior northern California (G. Fellers pers. comm., E. Pierson unpubl. data). A single young is born sometime between May and July (Easterla 1973, Pearson et al. 1952, Twente 1955). *C. townsendii* pups average 2.4 g at birth, nearly 25% of the mother's postpartum mass (Kunz and Martin 1982). Young bats are capable of flight at 2.5 to 3 weeks of age and are fully weaned at 6 weeks (Pearson et al. 1952). Nursery colonies start to disperse in August about the time the young are weaned, and break up altogether in September and October (Pearson et al. 1952, Tipton 1983).

Following the typical pattern for temperate zone vespertilionids, mating generally takes place in the hibernaculum between October and February, with the females storing sperm in the uterine lining until spring, when ovulation and fertilization occur. Females are generally reproductive in their first year, whereas males do not reach sexual maturity until their second year. Gestation length varies with climatic conditions, but generally lasts from 56 to 100 days (Pearson et al. 1952).

Pearson et al. (1952) estimated annual survivorship at about 50% for young, and about 80% for adults. Band recoveries have yielded longevity records of 16 years, 5 months (Paradiso and Greenhall 1967) and 21 years, 2 months (Perkins 1995).

C. townsendii is a relatively sedentary species, for which no long-distance migrations have been reported (Barbour and Davis 1969, Humphrey and Kunz 1976, Pearson et al. 1952). The longest movement known for this species in California is 32.2 km (Pearson et al. 1952).

Although diet has not been examined in detail for any California populations, it is likely that C. *townsendii* here, as elsewhere, is a lepidopteran specialist, feeding primarily (>90% of the diet) on medium sized (6-12 mm) moths (Dalton et al. 1986, Ross 1967, Sample and Whitmore 1993, Whitaker et al. 1977, 1981). Shoemaker and Lacki (1993) determined that *P. t. virginianus* differentially selected noctuid moths, with geometrids, notodontids and sphingids also making up a significant portion of the diet. Representatives of the family Arctiidae constituted 37.5% of the available moth prey items, but were not consumed. Sample and Whitmore (1993) identified moth species from wing fragments collected at maternity caves. Of the 28 moth taxa identified, 15 were noctuids. Twenty-one species were forest dwelling, and six were associated with open, field habitats.

In addition to lepidopterans, small quantities of other insects have been detected in the diet of *C. townsendii*, particularly Coleoptera and Diptera (Dalton et al. 1986, Ross 1967, Sample and Whitmore 1993). Hemiptera, Hymenoptera, Homoptera, Neuroptera, Trichoptera, and Plecoptera have also been found sporadically (Dalton et al. 1986, Whitaker et al. 1977).

Habitat: *C. townsendii* occurs primarily in rural settings from the inland deserts to the cool, moist coastal redwood forests, in oak woodlands of the inner coast ranges and Sierra Nevada foothills, and lower to mid-elevation mixed coniferous-deciduous forests. Its distribution, however, tends to be geomorphically determined, and is strongly correlated with the availability of caves or cave-like roosting habitat. Population concentrations occur in areas with substantial surface exposures of

cavity-forming rock (e.g., limestone, sandstone, gypsum or volcanic), and in old mining districts (Genter 1986, Graham 1966, Humphrey and Kunz 1976, Kunz and Martin 1982, Perkins et al. 1994, Pierson and Rainey 1996a).

C. townsendii is primarily a cave-dwelling species, but also roosts in cave analogues, especially old mine workings (Barbour and Davis 1969, Graham 1966, Humphrey and Kunz 1976). In some areas, particularly along the Pacific coast, it has been found in old, mostly abandoned, buildings with darkened, enclosed cave-like attics and in other anthropogenic structures (e.g., water diversion tunnels and bridges)(Barbour and Davis 1969, Dalquest 1947, Howell 1920b, Kunz and Martin 1982, Pearson et al. 1952, Perkins and Levesque 1987, Brown et al. 1994, Pierson and Rainey 1996a).

This species appears to have fairly restrictive roost requirements (Humphrey and Kunz 1976, Perkins et al. 1994, Pierson et al. 1991). Roost temperature appears to be critical (Lacki et al. 1994, Pearson et al. 1952, Pierson and Rainey 1996a), and varies in maternity roosts throughout California from 19°C in the cooler regions to 30°C in the warmer southern regions (Pierson et al. 1991). Some colonies are known to change roosts during the maternity season, using cooler roosts earlier in the year (Pierson et al. 1991, P. Brown pers. comm., V. Dalton pers. comm.). Roost dimensions are also important. The majority of the roosts examined in California are fairly spacious, at least 30 m in length, with the roosting area located at least 2 m above the ground, and a roost opening at least 15 cm by 62 cm (Pierson et al. 1991). Maternity clusters are always situated on open surfaces, often in roof pockets or along the walls just inside the roost entrance, within the twilight zone.

Hibernation sites are generally caves or mines (Pearson et al. 1952, Barbour and Davis 1969), although animals are occasionally found in buildings (Dalquest 1947, E. Pierson pers. obs.). Deep mine shafts, known to provide significant hibernating sites in New Mexico (Altenbach and Milford 1991), may also be important in California (P. Brown pers. comm.). Winter roosting behavior varies with latitude. In areas with prolonged periods of non-freezing temperatures, *C. townsendii* tends to form relatively small hibernating aggregations of single to several dozen individuals (Barbour and Davis 1969, Pierson et al. 1991, Pierson and Rainey 1996a). Larger aggregations (75-460) are confined to areas which experience prolonged periods of freezing temperatures (Pierson and Rainey 1996a).

Studies in the western U.S. have shown that *C. townsendii* selects winter roosts with stable, cold temperatures, and moderate air flow (Humphrey and Kunz 1976, Kunz and Martin 1982). Individuals roost on walls or ceilings, often near entrances (Humphrey and Kunz 1976, Twente 1955). If undisturbed, individuals will frequently roost < 3 m off the ground (Perkins et al. 1994), and have been found in air pockets under boulders on cave floors (E. Pierson pers. obs.). Temperature appears to be a limiting factor in roost selection. Recorded temperatures in *C. townsendii* hibernacula range from -2.0°C to 13.0°C (Humphrey and Kunz 1976, Genter 1986, Pearson et al. 1952, Pierson et al. 1991, Twente 1955), with temperatures below 10°C being preferred (Perkins et al. 1994, Pierson and Rainey 1996a).

Recent radiotracking and light-tagging studies have found *C. townsendii* foraging in a variety of habitats. Brown et al. (1994) showed that *C. townsendii* on Santa Cruz Island in California avoided the lush introduced vegetation near their day roost, and traveled up to 5 km to feed in native oak and ironwood forest. P. Brown (pers. comm.) also documented *Corynorhinus* foraging in desert canyons with water on the west slopes of the Panamint Mountains in Inyo County. Radiotracking and light-tagging studies in northern California have found *C. townsendii* foraging within forested habitat (Rainey and Pierson 1996), within the canopy of oaks (E. Pierson and W. Rainey unpubl. data), and

along heavily vegetated stream corridors, avoiding open, grazed pasture land (G. Fellers pers. comm.). In Oklahoma, *C. t. ingens* preferred edge habitats (along intermittent streams) and open areas (pastures, crops, native grass) over wooded habitat (Clark et al. 1993). Light-tagging studies in West Virginia (V. Dalton pers. comm.) showed a bimodal foraging pattern for *C. t. virginianus*, with animals foraging over hayfields during the first part of the night, and within the forest later in the night, traveling up to 13 km from the day roost.

Status: Class I. Recent surveys conducted by Pierson and Rainey (1996a) for the Department show marked population declines for both subspecies in California, and suggest this species should be recommended for Threatened status in the state. Over the past 40 years, there has been a 52% loss in the number of maternity colonies, a 45% decline in the number of available roosts, a 54% decline in the total number of animals, and a 33% decrease in the average size of remaining colonies for the species as a whole statewide. The status of particular populations is correlated with amount of disturbance to or loss of suitable roosting sites. The populations that have shown the most marked declines are along the coast, in the Mother Lode country of the western Sierra Nevada foothills, and along the Colorado River.

A comparison of former and current population estimates for 18 historically known maternity colonies shows that six colonies (33%) appear to be extirpated; six others (33%) have decreased in size; one (6%) has remained stable; and five (28%) (four of which are protected within national parks) have increased.

A comparison of colony size for historically and currently known colonies, indicates that mean colony size has decreased from 165 (n = 18) to 111 (n = 34). The median colony size has decreased from 100 to 75. There are currently 38 known maternity colonies, occupying 55 known roost sites, with an estimated total population of about 4,300 individuals. Only three of these colonies have adequately protected roost sites.

Hibernating *C. townsendii* have been found historically or during a recent survey (Pierson and Rainey 1996a) at 44 sites (24 in mines, 19 in caves, one in a building). Most of these sites contain fewer than 20 individuals. Only three hibernating colonies number more than 100. The most significant aggregations (all those with >100) occur in the most northern part of the state, particularly Siskiyou County. In other areas, particularly the desert, smaller aggregations (5-20) are more typical, although mine shafts, found by Altenbach and Milford (1991) to house the largest aggregations, remain essentially unexplored in California. Four additional hibernating sites, not visited by Pierson and Rainey (1994) were located in 1979 (Marcot 1984), one of which contained 40-50 individuals.

Threats to *C. townsendii* include the following:

The species is roost limited. The combination of restrictive roost requirements and sedentary behavior would suggest that *C. townsendii* is roost limited, and that roost loss, through disturbance or destruction, has been primarily responsible for population declines in most areas. Although fire, winter storms, or general deterioration are sometimes responsible, in all but two of 38 documented cases, roost loss in California can be directly linked to human activity (e.g., demolition, renewed mining, entrance closure, human induced fire, renovation, or roost disturbance). Population declines are most highly correlated with roost destruction in the San Francisco Bay area, along the northern coast, and in San Diego County, and with roost disturbance in the Mother Lode country and along the Colorado River. Population declines along the Colorado River are also attributable to foraging habitat loss due to agricultural expansion.

Human Activity at Roosts. The intense recreational use of caves and mines in California provides the most likely explanation for why most otherwise suitable, historically significant roosts are currently unoccupied. It is well documented that *C. townsendii* is so sensitive to human disturbance that simple entry into a maternity roost can cause a colony to abandon or move to an alternate roost (Pearson et al. 1952; Graham 1966; Stebbings 1966; Mohr 1972; Humphrey & Kunz 1976; Stihler and Hall 1993; P. Brown pers. comm.). Inappropriate behavior on the part of well-intentioned researchers and others (i.e., entry into maternity roosts, capture of animals in roosts) could also contribute to population declines. Mark recapture studies are not without risk, since at least one wing band design causes serious injuries to *C. townsendii* (Pierson and Fellers 1994). Scientific collecting likely resulted in the extirpation of a population at Prisoner's Harbor on Santa Cruz Island (Brown et al. 1994).

Closure of Old Mines. Old mines are significant roosting habitat for a number of bat species, particularly *C. townsendii* (Altenbach and Pierson 1995, Pierson and Rainey 1991, P. Brown pers. comm.). Liability and safety concerns have led to extensive mine closure programs in western states, particularly on public lands, often without consideration for the biological values of old mines. If closures are done at the wrong time of year, or without prior biological survey (Altenbach 1995, Navo 1995, Rainey 1995), they can result in the entrapment, and thus elimination of entire bat colonies.

Renewed Mining in Historic Mining Districts. The resurgence of gold mining in the West potentially threatens cave dwelling bat species (Brown and Berry 1991, Brown et al. 1993, Brown 1995). Since open pits, created by current mining practices, are often located in historic mining districts, old mine workings are frequently demolished as part of the ore extraction process. While effective mitigation is possible (Pierson 1989, Pierson et al. 1991), there is currently no legal mandate requiring that existing populations be protected. Renewed mining is known to account for the loss of one substantial colony in the California desert (P. Brown pers. comm.).

Additionally, process water containing cyanide has caused substantial wildlife mortality at a number of mine sites in the West. Although one study found that bats constitute 33.7% of documented wildlife fatalities (Clark and Hothem 1991), they frequently are not considered in assessment of cyanide risks (Nevada Mining Assoc. et al. 1990). A *Corynorhinus* maternity colony in a mine on the west slope of the Inyo Mountains disappeared after an open cyanide pond was constructed within 2 km of the roost (P. Brown pers. comm.). Similarly, process residues in open oil sumps are another significant source of wildlife mortality (Flickinger and Bunck 1987, Esmoil and Anderson 1995).

Loss of Foraging Habitat. It is also possible that destruction or damage of foraging habitat is contributing to the declines in *C. townsendii* populations in some areas, e.g., in urbanized regions, and along the Colorado River, where the native floodplain community has been subjected to extensive agricultural conversion. Also, forest management activities, particularly timber harvest and spraying that kills non-target lepidopteran species may alter the prey base for *C. townsendii*. Perkins and Schommer (1991) suggest that *Bacillus thuringiensis* sprays may suppress Tussock moth and spruce budworm reproduction enough to suppress reproduction in resident *C. townsendii*. Although the effects of grazing have not been specifically addressed for this species, a radiotracking study at Point Reyes National Seashore indicated that telemetered bats avoided grazed pastureland (E. Pierson pers. obs.). Roosting areas adjacent to water sources may be essential for desert populations of *C. townsendii* (P. Brown pers. comm.).

Inadequate Management Policies on Public Lands. Of the 20 largest currently known colonies in California, 13 are on public lands. While the National Park Service and California Department of

Parks and Recreation have made substantial commitments to protecting known roosts, other agencies have been less willing to recognize the biological significance of cave and mine roosts, often against the advice of their own biologists.

Behavioral Ecology/ Population Biology. The tendency for *C. townsendii* to roost in highly visible clusters on open surfaces, near roost entrances, makes them highly vulnerable to disturbance. Additionally, low reproductive potential and high roost fidelity increase the risks for the species.

Management Recommendations: Given the documented population declines, the precarious status of most known roosts, the pressures on populations from mining, logging, recreational caving, and development, Threatened status under CESA may be warranted.

Steps should be taken to protect key maternity sites, particularly on public lands. In many cases adequate protection could be accomplished by excluding people from the roost site. For caves and mines this generally means gating the roost entrance, using a gate design that excludes people and allows the bats to pass through (Dalton and Dalton 1995, Pierson et al. 1991, Pierson and Brown 1992).

Key populations (based on both size and geographic distribution) should be monitored on an annual or bi-annual basis to document current population trends. Counts should be conducted early in the maternity season (before young are volant) by counting animals upon emergence from the roost, using night vision equipment.

Regulatory agencies need to be informed of the importance of both caves and anthropogenic structures, such as mines, as roosting habitat for *C. townsendii* and other bat species. Too often the biological significance of these habitat features is overlooked in environmental assessment processes.

An appropriate survey protocol needs to be established for *C. townsendii*. Since this species is rarely caught in nets or identified with an acoustic detector, it often escapes detection using standard bat survey techniques. Because roost surveys offer the only viable survey method, and roost disturbance is such a critical issue, guidelines need to be established for survey methods which do not require roost entry (e.g., electronic monitoring devices and night vision equipment) (e.g., Navo 1995, Rainey 1995), or which set standards for roost entry in those cases where access to the roost is necessary.

In light of the findings of Altenbach and Milford (1991) in New Mexico, a policy to regulate destruction of potential hibernating sites should be instituted. For example, no mines or other structures, or caves should be closed or destroyed in the winter months without prior surveys for hibernating bats. Since there appears to be some movement in and out of hibernating sites throughout the winter in most parts of California, monitoring inaccessible portions of potential hibernating sites without entry is possible. At present, however, the only accurate and cost effective way to evaluate large numbers of sites is entry (Altenbach 1995, Navo 1995).

Additional surveys are needed to explore the limits of distribution for *C. townsendii* in California. Although the surveys conducted in 1992-1994 (Pierson and Rainey 1996a) focused on areas of known historical importance, some likely important areas (e.g., some old mining districts) were not investigated at all, and other areas, like the north coast and inner coast ranges, warrant further investigation.

Studies are needed to evaluate the specific effects of roost disturbance, most importantly the impacts on colony composition and reproductive success. This is particularly critical in the Mother Lode

country.

Information gathered in recent years on the roosting and foraging requirements of *C. townsendii* (Dalton et al. 1986, Lacki et al. 1993 & 1994, Pierson et al. 1991, Fellers 1993, Brown et al. 1994) suggests the need for longitudinal studies covering a variety of habitats during different phases of the reproductive cycle.

Spotted bat, *Euderma maculatum*

Elizabeth D. Pierson & William E. Rainey

Description: *Euderma maculatum* can be distinguished from all other North American species by its unique coloration (three dorsal white spots on a background of black fur), and very large, pinkish-red ears (39-50 mm). The spots, ca. 15 mm in diameter, are located over each shoulder, and in the center of the rump. Additionally, there is a white patch at the base of each ear. It is one of the largest North American vespertilionids (forearm 48-54 mm, tail 45-50 mm, total length 107-125 mm (Watkins 1977, Woodsworth et al. 1981, Constantine 1987, Best 1988). Mean weight is 15.3 g (n=61)(Best 1988). Its wing and tail membranes, like the ears, are pinkish-red. Its ventral fur (like the dorsal spots) is white with a black base. Other North American species with very large ears (e.g., *Corynorhinus townsendii*, *Idionycteris phyllotis*, *Myotis evotis*, *Antrozous pallidus*) lack the black and white color pattern. The only other species with black fur, the silver-haired bat, *Lasionycteris noctivagans*, has short, rounded, dark ears, and its black fur, while often frosted in appearance, lacks distinct white spots.

Taxonomic Remarks: *E. maculatum* belongs to the Family Vespertilionidae. It was first described by Allen (1891) from a specimen collected in March 1890 in Ventura County in southern California. It was initially included in the genus *Histiotus* (now restricted to South American species) (Koopman 1993), and was subsequently recognized as a representative of a distinct genus, *Euderma* (Allen 1892). This genus has one species and no subspecies.

Handley (1959) viewed *Euderma* and *Plecotus* (including the taxon now recognized as *Idionycteris* [Williams et al. 1970]) as a phylogenetic unit, more closely related to one another than either is to any other genus within the Vespertilionidae. *Euderma* is placed in the tribe Plecotini (sensu Koopman and Jones 1970), which also includes *Idionycteris*, *Plecotus*, and *Barbastella*.

Relationships among plecotine genera have recently been re-examined by Frost and Timm (1992) and Tumlison and Douglas (1992). Using a similar set of morphological and karyological characters, these authors arrived at somewhat different conclusions. They concur in concluding that *Idionycteris* and *Euderma* are sister taxa, but Frost and Timm synonymize *Idionycteris* with *Euderma*, whereas as Tumlison and Douglas retain both genera. They offer differing views of the relationship between *Euderma* and the other genera. Tumlison and Douglas see *Idionycteris* and *Euderma* as the most derived taxa, and as a sister group to the Old World *Plecotus*. Frost and Timm, by contrast, treat *Euderma*, including *Idionycteris*, as the sister taxon to a clade comprised of *Barbastella*, *Corynorhinus* (= New World *Plecotus*) and *Plecotus* (= Old World species). A recent compilation of mammalian taxonomy (Koopman 1993) retains both *Idionycteris* and *Euderma*.

Distribution: This species is distributed throughout much of the western U.S. (Watkins 1977), with its range extending as far north as southern British Columbia (Woodsworth et al. 1981), and as far south as Durango, Mexico. The widely used distribution map from Hall (1981) does not reflect more recent range extensions. There are now records for western Colorado (Navo et al. 1992), Oregon (McMahon et al. 1981, Barss and Forbes 1984), and the Klamath Mountains of northwest California (Pierson et al. 1996, Pierson and Rainey in review). Within this overall range, the species' distribution appears to be patchy and geomorphically determined, limited to areas with appropriate roosting habitat.

The type specimen for this species is from Castaic Creek, Ventura County, California (Allen 1891). Prior to 1990, the majority of California records (mostly single, dead or moribund animals) came from low elevation, xeric settings (e.g., Red Rock Canyon State Park in Kern County, Mecca in

Riverside County, and several from the Owens Valley, Inyo County) (Grinnell 1910, Hall 1939, Constantine et al. 1979, Bleich and Pauli 1988). Additionally there were two records from Yosemite Valley (Ashcraft 1932, Parker 1952). The most northern record was from a single specimen picked up alive in Palo Cedro, Shasta County (Bleich and Pauli 1988).

More recent surveys (Pierson and Rainey in review) have detected the species (using its echolocation call which is audible to most humans) at several sites in the mountains of Shasta and Siskiyou counties and shown it is more widely distributed than previously realized in the Sierra Nevada. Most Sierran localities are mid-elevation (ca. 1,200-1,400 m), but one or more individuals have been predictably encountered at several high elevation sites (up to 2,880 m). P. Brown (pers. comm.) reports recent auditory detections at Mount Palomar in San Diego County; at Coso Peak, near China Lake, Inyo County; and north of Bishop, Inyo County. A roost in the Owen's Gorge, Mono County, was recently discovered (P. Brown pers. comm., E. Pierson and W. Rainey pers. obs.).

Life History: Little is known about the population biology of spotted bats, although available data suggest that females roost singly, and give birth to a single young (Findley and Jones 1965, Watkins 1977), with births occurring in June or early July. A female about to give birth was caught at Fort Pierce Wash in Utah on June 20 (Poché 1975). Woodsworth et al. (1981) collected a pregnant female on June 16, 1980 in British Columbia. A pregnant female, captured on June 11, 1969, in a mist net in Big Bend National Park in western Texas gave birth to a single young, which weighed 4 g (25% mother's weight)(Easterla 1971). Lactating females have been caught as early as June 12 in Texas (Easterla 1973) and as late as mid-August at 2,300 m in Utah (Easterla 1965), and on the Kaibab Plateau in Arizona (Berna 1990). Lactating females were caught in early September in Yosemite National Park (Pierson and Rainey 1996b, c).

E. maculatum appears to be a dietary specialist (Ross 1961, Easterla 1965, Easterla and Whitaker 1972), feeding primarily on moths (most likely noctuids) 5-12 mm in length. In two studies it was found to feed entirely on moths; in one study, the stomach contents of two individuals were 10-30 % by volume June beetles (Scarabaeidae)(Easterla and Whitaker 1972). Most observations suggest spotted bats forage alone (Wong and Fenton 1982, Wai-Ping and Fenton 1989), sometimes maintaining exclusive feeding areas (Leonard and Fenton 1983), and other times using a "trapline" strategy (Woodsworth et al. 1981). Individuals generally forage 5-15 m off the ground in large elliptical paths, with axes of 200-300 m (Wai-Ping and Fenton 1989, Navo et al. 1992). Unlike many species, spotted bats do not appear to night-roost, and are active all night, traveling one way distances from the roost site of 6-10 km each night (Wai-Ping and Fenton 1989).

Little is known of seasonal patterns for this species. It is not known whether the species migrates. Since other plecotine bats (i.e., *Corynorhinus*) are known to be relatively sedentary, however, long distance migration seems unlikely. On the east side of the Sierra, it has been detected frequently at Owens Lake in the spring and fall, but rarely in the summer (P. Brown pers. comm.). It has been found hibernating in the colder portions of its range (e.g., Hardy 1941), yet is present and periodically active throughout the winter in southwestern Utah (Ruffner et al. 1979, Poché 1981), and in the upper Sacramento River drainage of northern California (R. Miller pers. comm.). The presence of foraging animals in Yosemite Valley in both midsummer and in early November (E. Pierson and W. Rainey pers. obs.) suggests that Sierra Nevada populations do not migrate long distances.

Habitat: *E. maculatum* is found from 57 m below sea level (Grinnell 1910) to 3,230 m above sea level (Reynolds 1981), in habitats ranging from desert scrub to montane coniferous forest (Findley and Jones 1965, Best 1988). It has been collected most often in dry, rough desert terrain. Wherever

the species is found, there are substantial rock cliffs nearby (Parker 1952, Medeiros and Heckmann 1971, Easterla 1973, O'Farrell 1981, Berna 1990, Navo et al. 1992, Pierson and Rainey in review), suggesting that the distribution of spotted bats may be limited by the availability of suitable roosting habitat. Also, at all sites where resident populations have been identified, there is water in the area (O'Farrell 1981).

In California, *E. maculatum* has been found in extremely arid areas, such as the Salton Sea (Grinnell 1910) and Red Rock Canyon (Hall 1939). There are past and current records from the Owens Valley (Bleich and Pauli 1988, P. Brown pers. comm., J. Szewczak pers. comm.) which is dominated by sagebrush (*Artemisia tridentata*), saltbush (*Atriplex* spp.), greasewood (*Sarcobatus vermiculatus*), and rabbitbrush (*Chrysothamnus nauseosus*). A number of authors report the species from areas dominated by Ponderosa pine (Handley 1959, Findley and Jones 1965, Watkins 1977, Woodsworth et al. 1981, Berna 1990, Navo et al. 1992, Pierson and Rainey in review), although there is no evidence the species roosts in trees, nor forages within forests. Typically the bats are detected in meadows or open areas surrounded by Ponderosa pine. They have also been observed in oak savannah (*Quercus* spp.) (Bleich and Pauli 1988), or mixed oak/conifer woodland (Pierson and Rainey in review). Pierson and Rainey (in review) have found spotted bats associated with cliffs and wet, montane meadows (from 1,200 to 2,900 m) in the Sierra Nevada.

Limited information is available on the specific roosting requirements of *E. maculatum*. Available data suggest, however, that the species roosts predominantly in small crevices in cliff faces (Easterla 1970, Easterla 1973, Poché 1975, Poché and Ruffner 1975) of varied lithology (including granite, basalt, limestone, sandstone, and other sedimentary rock). In the few cases in which it has been possible to locate released animals, they were in narrow cracks, one 3 cm wide (Poché and Ruffner 1975), another with an interior opening 10 cm wide, and the bat hanging by its feet 1.5 m from the base of the hole (Poché 1975). Radiotracking studies, conducted in the Okanagan Valley in British Columbia (Leonard and Fenton 1983, Taylor and Wai-Ping 1987), suggest that individual spotted bats roost singly in high cliffs, and are loyal to roosts.

Although spotted bats are not generally viewed as cave dwelling, there are several records of this species roosting in caves and mines. Hardy (1941) reports the finding of four spotted bats hibernating in February on the walls of a wet cave in Utah. There are additional records of a spotted bat found in a natural cave in Nevada in April (Soulages 1966), and in Wyoming (WDFG 1994). A spotted bat was also found in a mine in Sonora, Mexico (Vorhies 1935), and in a wet "cave dug into the side of a hill" in March, 1948 in San Bernardino County, California (Parker 1952).

Although spotted bats have been reported from in or around buildings, these have generally been considered aberrant records, and not indicative of normal behavior (O'Farrell 1981). For example, a spotted bat found at a fish hatchery in Fresno County, California proved to be rabid (Medeiros and Heckmann 1971). Others were found in odd circumstances (e.g., hanging from a second story window sill [August and Dingman 1973] or on the sides of buildings [Ashcraft 1932, Benson 1954, Easterla 1965]).

Status: Class II. Although recent investigations have identified several new localities for *E. maculatum* in California, and have expanded the known range (Pierson and Rainey submitted), the species was detected at only one out of nine historic localities surveyed (Pierson and Rainey 1996b, c). The only historic locality at which *E. maculatum* was found was Yosemite Valley. It was also not detected at 70 other localities, which offered apparently suitable roosting habitat. The conclusions drawn from this survey were that the species' distribution was very patchy, and, in the areas where it occurred, it was relatively rare. K. Miner (pers. comm.) reported detection in 1996

and 1997 of spotted bats at Red Rock Canyon, an historic locality. The recent reappearance of *E. maculatum* at this locality may be related to restoration of a flowing creek following tamarisk removal.

There are a number of potential threats to the roosting and foraging habitat of *E. maculatum* which are discussed in detail in Pierson and Rainey (1996b, c). The following is a summary.

Recreational Climbing. There has been an extraordinary increase in recreational rock climbing in the west in recent years, and improving technical aids have made previously unclimbable areas accessible. A recent informal survey by personnel at Yosemite National Park has documented 3,000 new climbing routes within the park, some employing unsanctioned alterations or attachments (Dept. of Resource Management, Yosemite National Park, pers. comm.). Popular sites, such as El Capitan in Yosemite Valley, experience climbing traffic jams, with multiple parties on a route at one time. Similarly, limited areas of columnar basalt cliffs along the western base of the Sierra Nevada have experienced increasingly heavy use since about 1990. Although no information is available regarding what proportion of the crevices used by climbers offers suitable roosting sites for *E. maculatum*, it is reasonable to presume that hands or temporary climbing aids inserted into a roost crevice would be cause for disturbance and possible abandonment of a site. Also, climbers actively alter cliff habitat, dislodging unstable rock and clearing ledges.

Water reservoirs. The same canyons which offer suitable cliff habitat for *E. maculatum* also provide basins for storage reservoirs, and other water projects. Almost every river which drains the west side of the Sierra Nevada range in California has one or more such reservoirs. It is almost certain that roosting habitat has been lost for these species as a result of these projects. For example, *E. maculatum* is known to occur in the Hetch Hetchy area of Yosemite National Park (Pierson and Rainey 1993). The meadows, riparian woodland, and lower cliff faces of the valley are now submerged. Although *E. maculatum* still occurs there, it is likely that both its roosting and foraging habitat were reduced by this project. The population which once likely foraged in the valley directly below the cliffs, now must travel several miles downstream to find a suitable foraging area (Pierson and Rainey in review).

Highway Projects. River drainages, because they frequently offer the easiest routes through mountain ranges, are also favored corridors for highway construction. Such construction commonly entails blasting of cliff faces, either for initial highway construction or later improvements (i.e., widening and straightening). Since bats are frequently overlooked in the environmental assessment process, cliff roosting species, such as *E. maculatum*, are at risk of both direct impacts from blasting, and long-term loss of roosting habitat from cliff modifications. In some settings, it is possible that soil removal and blasting may expose rock and create habitat, but this is not generally the case since fractured, potentially unstable rock is often removed.

Grazing/Meadow Management. Whereas a number of bat species appear to forage predominantly over water, or along vegetation boundaries (e.g., riparian zones, forest edges), *E. maculatum* frequently forages in open areas, particularly over meadows. To the extent that intensive grazing and trampling of meadows by livestock alters the insect productivity (particularly for lepidopterans), it may impact the foraging habitat of *E. maculatum*, and could adversely affect local populations.

Pesticide Spraying and Environmental Contaminants. Pesticides have been shown to have detrimental effects on bat populations (Clark et al. 1978, Clark 1981, Clark et al. 1983). Persistent chlorinated hydrocarbons are now banned. While the shorter half-life organophosphates, now in wide use, are known to have negative impacts on raptors (Wilson et al. 1991), their effect on bats has

not been investigated. Short-term neurotoxic insecticides could be lethal or impair maneuverability, leading to reduced foraging efficiency and increased vulnerability to predators. Lepidopteran-specific agents like *Bacillus thuringensis* result in significant, if short-term, reduction in the prey base for lepidopteran specialists like *E. maculatum* (Sample et al. 1993).

Recreational Caving. Although *E. maculatum* is not generally considered a cave roosting species, it has been found in caves on several occasions. Though dates are not always available for these records, there is the suggestion that this species is more likely to use caves for hibernation. Disturbance of cave-dwelling bats at roosting sites has been a major cause for population declines for a number of species in the eastern United States, and could potentially have similar impacts on *E. maculatum.*

Closure of Abandoned Mines. Aggressive mine closure programs for hazard abatement have been underway for ten or more years in a number of western states. Until very recently, most closures were undertaken without any prior biological assessment. To the extent that *E. maculatum* may use abandoned mines, they would be at risk from these practices.

Mining and Quarry Operations. Mining and quarry operations which impact cliff habitat could potentially remove roosting habitat. Additionally, the noise generated by active mining and quarry operations could disturb roosting bats, although quarries may in some circumstances create cliff habitat.

Management Recommendations: The combination of small population size and patchy distribution place individual populations of *E. maculatum* at risk of local extirpation from anthropogenic and stochastic causes. Wherever populations are identified, special measures should be taken to protect them.

Recent surveys, which expanded the known range of *E. maculatum*, suggest that additional surveys should be conducted, particularly in the Coast Ranges, at higher altitudes in the Sierra Nevada, and on the east side of the Sierra Nevada.

More information is needed on the spatial and temporal distribution of populations. It is not known how loyal individuals are to particular roost sites, and thus whether single roost sites, or roosting areas need to be monitored and protected. Studies need to be conducted to assess the impact of certain human activities, particularly recreational climbing, in the vicinity of roost sites.

Red bat, *Lasiurus blossevillii*

Elizabeth D. Pierson & William E. Rainey

Description: *Lasiurus blossevillii* is a medium sized bat with a short rostrum, short rounded ears, and a heavily furred interfemoral membrane (Barbour and Davis 1969, Shump and Shump 1982). It can generally be distinguished by the brick-red color of its fur. The color, however, can vary from intense red to yellow-brown. It can, nevertheless, be distinguished from the other *Lasiurus* species with which it could be most readily confused based on size. *L. blossevillii* has a forearm of 35-45 mm. *Lasiurus xanthinus*, which generally has more yellow fur, is larger, with a forearm of 45-48 mm. *Lasiurus cinereus* is considerably larger, with a forearm of 46-58 mm. The pelage of *L. cinereus* is generally dark grey, with frosted white tips, a yellow face, and ears rimmed in black. Although *L. blossevillii* can appear somewhat frosted and have a yellowish tinge to its fur, it is never as dark, nor as frosted, as *L. cinereus*.

Taxonomic Remarks: The red bat is generally included in the genus *Lasiurus* (Family Vespertilionidae) as *L. borealis* (Koopman 1993). Hall (1981), who reverted to an earlier generic name, *Nycteris*, mapped the distribution of six subspecies, with all California animals referred to *N. borealis teliotis*. Genetic studies (Baker et al. 1988, Morales and Bickham 1995) support the separation of red bats into four separate species, with all animals in the western United States, Mexico, Central America, and South America referable to *L. blossevillii*.

Distribution: *L. blossevillii* has a very broad distribution reaching from southern British Columbia, through much of the western United States, through Mexico and Central America, reaching as far south in South America as Argentina and Chile (Hall 1981, Shump and Shump 1982).

In California, the majority of records are from the coastal areas from the San Francisco Bay area south, plus the Central Valley and surrounding foothills, with a limited number of records from southern California, extending as far east as western Riverside and central San Diego counties. Red bats have been captured or seen on three occasions on Santa Cruz Island (P. Brown pers. comm.). There are no records from the lower desert, from higher elevations in any of the mountain ranges, nor from the east side of the Sierra Nevada. Red bats have been captured in Nevada, however, just a mile east of California and the White Mountains (J. Szewczak pers.comm.). Currently, the most northern locality in California is from the upper Sacramento River near Dunsmuir, Siskiyou County (Rainey and Pierson 1996).

There are multiple records for red bats in the San Francisco Bay area in the spring, fall, and winter months, including records from Golden Gate Park in San Francisco (Grinnell 1918, Orr 1950, Constantine 1959). Although reproductive females and young do occur in coastal California in the summer (Constantine 1959, C. Scott and P. Winters pers. comm.), they are more likely to be located inland, particularly in the Central Valley, where they can find the desired summer temperatures of 80-95°F (Constantine 1959). Immature animals from several localities in eastern Contra Costa County have been turned in to rehabilitation facilities during June and July in recent years (C. Scott pers. comm.).

Life History: Reproductive patterns in red bats are summarized by Shump and Shump (1982). Whereas most vespertilionid bats have a single young per year, red bats have litters of up to five. No information is available on *L. blossevillii*, but *L. borealis* has a mean litter size of 3.2 young (Shump and Shump 1982). In the midwest, *L. borealis* are born around the middle of June. In California, two young about 2 weeks old were found in Contra Costa County on July 1 (C. Scott pers. comm.). Young are born at about 0.5 g. each, and can fly at 3-6 weeks of age. This species mates in the late

summer or early fall. Females become pregnant in spring and have a pregnancy of 80-90 days.

Red bats forage on a number of insect taxa, flying at both canopy height and low over the ground (Shump and Shump 1982). The limited dietary information has all come from *L.borealis* in the eastern U.S. No information is available on the diet of *L. blossevillii* in California. In a study conducted in Indiana, Whitaker (1972) found that red bats ate 26% moths. Other studies (summarized in Shump and Shump 1982) have also found Homoptera, Coleoptera, Hymenoptera, and Diptera in the diet.

Red bats are migratory, and there are records of them on the east coast being found a considerable distance out to sea (Norton 1921, Carter 1950). The most striking account of migration comes from Mearns (1898), who describes "great flights of them the whole day."

Habitat: *L. blossevillii* roosts in the foliage of trees and shrubs, predominantly in edge habitats adjacent to streams and open fields (Shump and Shump 1982). Constantine (1959) found the species roosting in fruit trees (apricot and orange) in the Central Valley of California. An analysis of these roost sites by Constantine (1959) suggested the bats selected trees that were well-pruned and 4.5-6.0 m in height, with roost sites typically located 2.6 m above the ground. The trees had rigid branches and short stems which resisted the wind, a spreading canopy, and lacked lower limbs that might provide perches for predatory birds. The roosting site was usually dark, well sheltered from above, with open exposure for free flight below. Dalquest (1945) noted daytime roosting sites for *L. blossevillii* in tamarisk windbreaks along irrigation ditches in California's Central Valley. Although *L. borealis* has been reported roosting in caves in Kentucky and Missouri (Quay and Miller 1955, Myers 1960), this behavior has never been seen in *L. blossevillii*.

Although they have been observed foraging around lights in urban areas (e.g., Shump and Shump 1982), Constantine (1959) found red bats primarily in areas distant from human habitation. In Canada, Furlonger et al. (1987) found they foraged around lights in towns and rural areas, more than in urban areas. The animals studied by Orr (1950) in Golden Gate Park in San Francisco were roosting in *Sparmannia africana*, a large-leafed, exotic, evergreen plant commonly planted in gardens in the Bay area. On Santa Cruz Island, red bats were observed foraging among native oaks and ironwood trees (Brown et al. 1994). Winter behavior of this species is not well understood. Saugey et al. (1994) recently documented, through a radiotracking study in Arkansas, that when temperatures dropped, some individuals moved from trees to hibernate in the leaf litter. Red bats apparently arouse from hibernation on warm days to feed (Shump and Shump 1982), and Orr's observations suggest that this species forages periodically during the winter in the San Francisco Bay area (Orr 1950).

Status: Class II. The status of this species in California is not currently known, although it occurs relatively rarely in net captures, in Department of Health Services records, and at rehabilitation facilities (D. Constantine pers. comm., C. Scott pers. comm., W. Rainey and E. Pierson unpubl. records)

Given what is known of the distribution and habitat needs of this species in California, it is possible to identify a number of threats, and hypothesize population declines and extirpations in certain areas, as follows:

Predation: Predation, other than human disturbance, is rarely an issue for bat species which seek cryptic and protected diurnal retreats (e.g., crevices). It can, however, be a factor for the foliage dwelling lasiurines. There are a number of reports in the literature of red bats being attacked and

killed by birds, particularly jays (Allan 1947, Downing and Baldwin 1961, Wilks and Laughlin 1961, Elwell 1962, Hoffmeister and Downes 1964, Horsley 1991). There is also a record of red bats being eaten by an opossum (*Didelphis virginiana*) (Sperry 1933). Since both jays and opossums thrive as commensals with humans, it is likely that predation from these species has increased for red bats. Additionally, a significant proportion of the red bats turned in to rehabilitation facilities has been retrieved from domestic cats.

Agricultural Conversion of Riparian Zones: Past records have shown a close association between red bats and riparian corridors. Particularly important are those associated with the major river systems that drain the Sierra Nevada. Agricultural conversion has led to significant loss of riparian corridors in the Central Valley, and thus has reduced both roosting and foraging habitat for *L. blossevillii*.

Storage Reservoirs: Storage reservoirs occur on most of the major rivers draining the Sierra Nevada, and are particularly prevalent at lower elevations, at ca. 200-600 m. A significant amount of riparian vegetation has been submerged by these reservoirs. Mist netting surveys in the Los Banos Creek drainage, at the site of a proposed reservoir, documented an association between *L. blossevillii* and the large stand of mature sycamores in that drainage. Additionally, the changes in downstream flooding regimes resulting from dam construction lead to altered riparian vegetation.

Pesticides: Constantine (1959) documented that *L. blossevillii* roosts in fruit trees in the Central Valley. Many fruit orchards are subjected to particularly intense pesticide treatments. Although the effects of aerially sprayed organophosphates on *L. blossevillii* have not been specifically examined, documentation of negative impacts on raptors (Wilson et al. 1991) suggests potential problems for bats.

Fire: The finding of Saugey et al. (1994) that red bats may move down to the leaf litter when temperatures drop raises questions regarding potential impacts from fire, particularly controlled burns which are conducted in either the spring or fall.

Management Recommendations: Given the high association of this species with agricultural and riparian areas, a status review, particularly in the Central Valley and surrounding foothills, is urgently needed. Radiotracking should be conducted to characterize roost sites and foraging habitat. It is likely that the species would benefit from any reduction in pesticide use, and restoration of riparian habitat.

Western yellow bat, *Lasiurus xanthinus*

Elizabeth D. Pierson & William E. Rainey

Description: *Lasiurus xanthinus* is a medium-sized bat with a short rostrum and short, rounded ears. The proximal one-third to one-half of its uropatagium has its dorsal surface densely furred. It can be distinguished from other California bats by the combination of yellow coloration, size, and short ears. It could be confused with *L. blossevillii*, but is larger (forearm = 45-50 mm versus 35-45 mm) and has more yellow fur. In coloration it is most similar to *Antrozous pallidus* (which has large ears) and *Pipistrellus hesperus* (which is much smaller and has a black mask).

Taxonomic Remarks: *L. xanthinus* (Family Vespertilionidae) was first described as *Dasypterus ega xanthinus* from a locality in Baja California (Thomas 1897), and recognized as belonging in the genus *Lasiurus* by Hall and Jones (1961). Recent genetic work argues strongly that the species formerly considered to be *Lasiurus ega* should be treated as two species: the southern yellow bat, *Lasiurus ega*, and the western yellow bat, *Lasiurus xanthinus* (Baker et al. 1988, Morales and Bickham 1995). Only *L. xanthinus* occurs in California.

Distribution: *L. xanthinus* has a primarily Mexican and Central American distribution, with a range that extends only into the southern portions of California, Arizona, New Mexico and possibly southwestern Texas (Hall 1981, Schmidly 1991, Dixon 1997). Yellow bats are found in a variety of habitats throughout their range, from dry tropical forest to semi-tropical wet forests (Kurta and Lehr 1995).

The first record for California was from Palm Springs in 1945 (Constantine 1946). It has since been found in a number of localities (P. Brown pers. comm., D. Constantine pers. comm., K. Miner pers. comm., D. Simons pers. comm.) and could be expected in appropriate habitat south and east of the San Bernardino Mountains.

Life History: Life history characteristics for *L. ega*, including *L. ega xanthinus* (here treated as *L. xanthinus*) are summarized by Kurta and Lehr (1995). This species is thought to be non-colonial, although aggregations of up to 15 have been found in the same roost site. Individuals usually roost in trees, hanging from the underside of a leaf. They are commonly found in the southwestern U.S. roosting in the skirt of dead fronds in both native and non-native palm trees. At least some individuals or populations may be migratory, although some individuals appear to be present year-round, even in the northernmost portion of the range. Yellow bats probably do not hibernate; activity has been observed year-round in both the southern and northern portions of the range. Yellow bats are insectivorous. Very limited diet data from Mexico suggest the primary prey is beetles, but almost no information is available from the southwestern United States. K. Miner (pers. comm.) reports juvenile yellow bats taking ichneumonids (Hymenoptera) based on finding insect parts embedded in tail membranes of two juveniles. Capture sites are often associated with water features (e.g., stock tanks, ponds, streams, and rivers) in open grassy areas and scrub, as well as canyon and riparian situations. Captures are also reported over swimming pools, lawns in residential areas, and orchards. In northern areas, seasonal segregation between the sexes during parturition may occur, as males are scarce from April through June. In the U.S., pregnant females are known from late April through June, with lactation occurring during June and July. The number of embryos carried by pregnant females ranges from one to four, with no apparent geographic trend. Reported predators include barn owls, domestic dogs and domestic cats.

Habitat: Yellow bats are associated with dry, thorny vegetation on the Mexican Plateau, and are found in desert regions of the southwestern United States, where they show a particular association

with palms. They are known to occur in a number of palm oases, but are also believed to be expanding their range with the increased usage of ornamental palms in landscaping. *L. xanthinus* occurs up to approximately 2,000 m in the mountains in Arizona. In California, this foliage-roosting species appears to roost exclusively in the skirts of palm trees, and to be limited in its distribution by the availability of palm habitat.

Status: Class II. This species is being placed on the Special Concern list due to its limited distribution and apparently restrictive habitat requirements. Although there is evidence that the species is expanding its range in response to the availability of ornamental palms (D. Constantine pers. comm.), and most of the significant palm oases in southern California are on public land (e.g., Joshua Tree National Monument and Anza Borrego State Park), this species is at risk from certain management practices regarding palms -- the cosmetic removal of dead fronds in suburban settings, and the burning of fronds by vandals (Mirowsky 1997). Additionally, burning of fronds was used as a management practice at Joshua Tree National Monument in the 1970s and early 1980s. The use of pesticides in date-palm and other orchards may also constitute a threat to both roosting bats and the insects upon which they forage. Domestic cats, whether pets or feral, may be a significant source of predation, as they are for many lizards, songbirds, and rodents.

Management Recommendations: More survey work in needed in southern California, focusing on palm habitat, to delineate more clearly the distribution and habitat needs of this species. Information is also needed regarding daily activity patterns, dietary requirements, and seasonal movement patterns.

Arizona myotis, *Myotis occultus*

Elizabeth D. Pierson & William E. Rainey

Description: *Myotis occultus* is a medium sized *Myotis*, which could be confused with other *Myotis* species, particularly *M. lucifugus*, *M. volans*, *M. velifer*, and *M. yumanensis*. It has a forearm length of 36-41 mm and weighs 6.2-7.7 g (Hayward 1963, Barbour and Davis 1969). It lacks the fringed interfemoral membrane of *M. thysanodes*, and the keeled calcar of *M. volans*. Its ears are shorter than those found in *M. thysanodes* or *M. evotis*. *M. velifer* is larger (forearm 40-43 mm), and has a bare patch between the scapulae. *M. yumanensis* (forearm 33-36 mm) is smaller than *M. occultus*, and has lighter colored ears. It is most difficult to distinguish from *M. lucifugus* (Hoffmeister 1986), but the two forms do not co-occur in California. Whereas *Myotis* species generally have two premolars, *M. occultus* is frequently missing the second premolar (Stager 1943, Mumford 1963). This trait is variable, however, and thus cannot be relied upon as diagnostic.

Taxonomic Remarks: *M. occultus* is in the family Vespertilionidae. *M. occultus* was first described in 1909 from a specimen collected along the Colorado River, near Needles, California (Hollister 1909). Findley and Jones (1967) concluded that *M. occultus* should be a subspecies of *M. lucifugus*. Although this is accepted by Hall (1981) and Koopman (1993), Hoffmeister (1986) argues, based on a principal components analysis of 25 cranial measurements, that *M. occultus* should retain specific status.

Distribution: *M. occultus* has a relatively limited distribution from the southwestern United States (southeastern California, Arizona, New Mexico, western Texas) to central Mexico (Hall 1981, Hoffmeister 1986). In California, it is known from only a few localities along the Colorado River between Needles (type locality) in San Bernardino County and Yuma in Imperial County. The only substantial California colony was located near Blythe, Riverside County (Stager 1943).

Life History: *M. occultus* forms maternity roosts of up to 800 females. Although males have been found associated with colonies in late summer, they are not present when the females are rearing young (Stager 1943). Limited data suggests that in New Mexico, females give birth to a single young in June (Mumford 1957, Hayward 1963).

Although the species is reported to forage close to water and riparian vegetation, no information is available on its diet.

Habitat: Outside California, the species appears to be primarily associated with relatively high elevation (2,000-3,000 m) conifer forests, particularly fir, spruce, and ponderosa pine (Barbour and Davis 1969). In 1966, Barbour and Davis (1969) found it to be the most common of four *Myotis* species at higher elevations in New Mexico. It has also been found in low desert, particularly in association with permanent water and riparian forest (cottonwoods, sycamores, and willows) (Hayward 1963). The known habitat in California is desert riparian.

Most of the few known *M. occultus* summer roosts are in anthropogenic structures, including bridges and attics of buildings (Barbour and Davis 1969). Individual animals were found in several mines in the Riverside Mountains (D. Constantine pers. comm., Stager 1943). A recent radiotracking study in Arizona identified eight *M. occultus* roosts, including three maternity roosts (Lutch and Miller 1996). One was in a building, two were in large ponderosa pine snags, with one colony of 322 bats living in a crevice created by lightning.

Status: Class I, likely extirpated. Although there are scattered records for this species along the

Colorado River between 1905 and 1945, only one colony was ever identified in California (Stager 1943). When discovered in a highway bridge near Blythe in 1939, it contained about 800 female *M. occultus*, and remains the largest maternity roost known. The colony was present in 1945 (D. Constantine pers. comm.), but the bridge was subsequently demolished, and the colony was never located again. K. Stager (pers. comm.) reports the capture and release of a single *M. occultus* from a mine in the Riverside Mountain in the summer of 1969. Other than that, the species has not been seen in California since 1945, despite repeated bat surveys along the Colorado river corridor over the past 30 years (P. Brown pers. comm., P. Leitner pers. comm.). Surveys on the Arizona side of the river have apparently yielded few (perhaps no) 20th century specimens of this species (Castner et al. 1994, 1995a, 1995b; Cockrum et al. 1996, Hoffmeister 1986), leaving the impression that the lower Colorado population was concentrated on the California side of the river and perhaps isolated from higher elevation central Arizona populations. Winter sites for the lower Colorado population were never identified.

Although the disappearance of the only known colony in California is attributable to the demolition of the roost site (possibly with the bats present), both riparian habitat and water quality in lower Colorado River are also heavily altered, affecting a number of wildlife species. Observations of foraging bats of this species (Grinnell 1914, Hollister 1909, Stager 1943) in California are largely from stands of cottonwoods and willows, a habitat that is now much reduced.

Management Recommendations: Monitoring and netting in remnant lower Colorado riparian woodland could indicate whether this species persists. Radiotracking of captured bats would permit identification of roost sites and evaluation of the need for site protection.

Fringed myotis, *Myotis thysanodes*

Elizabeth D. Pierson & William E. Rainey

Description: *Myotis thysanodes* is one of the larger *Myotis* species, with a forearm length of 40-47 mm, and an adult weight of 5.3-7.6 g. It can be distinguished from all other California bat species by a well-developed fringe of hair on the posterior edge of the tail membrane. It has relatively large ears, and can most readily be confused with the long-eared myotis, *Myotis evotis*. *M. evotis* is smaller (forearm = 36-41 mm), with longer ears (22-25 mm in *M. evotis* vs. 16-20 mm in *M. thysanodes*). Although *M. evotis* sometimes has a scant fringe of hairs on its tail membrane, it is never as distinct as that in *M. thysanodes*. *M. thysanodes* varies in color from yellowish brown to a cinnamon brown, with more northern populations tending to have darker coloration.

Taxonomic Remarks: *M. thysanodes* is in the Family Vespertilionidae. The type locality for *M. thysanodes* is Old Fort Tejon (at Tejon Pass) in the Tehachapi Mountains, Kern County, California (Miller 1897). Four subspecies are recognized (Hall 1981, Manning and Jones 1988), *M. t. aztecus*, *M. t. thysanodes*, *M. t. pahasapensis*, and *M. t. vespertinus*. Most *M. thysanodes* in California are referable to *M. t. thysanodes*; populations in the northwestern part of the state (Humboldt, Siskiyou and Shasta counties) have recently been placed in the new subspecies, *M. t. vespertinus* (Manning and Jones 1988), although relatively few specimens have been examined and the boundary between subspecies has not been clearly delineated. Recent investigation of evolutionary affinities among long-eared *Myotis* of the southwestern U.S. (Reduker et al. 1983) suggest they form a monophyletic clade, and that *M. thysanodes* shared a common ancestor with *M. evotis*, after the divergence of *Myotis auriculus* (a species not currently known from California.

Distribution: *M. thysanodes* is widely distributed across the western third of the United States, is found in most of Mexico, and reaches into southern British Columbia. Three subspecies have very limited distributions, *M. t. pahasapensis* in western South Dakota, western Nebraska and eastern Wyoming, *M. t. aztecus* in southern Mexico (Hall 1981), and *M. t. vespertinus* in southwestern Washington, western Oregon, and northwestern California (Manning and Jones 1988). *M. t. thysanodes*, the primary subspecies found in California, ranges from 51'54^{o} N. lat. in southern British Columbia (Rasheed et al. 1995) to Michoacán in southern Mexico (Hall 1981).

In California, the species is found the length of the state, from the coast (including Santa Cruz Island) to >1,800 m in the Sierra Nevada. Records exist for the high desert and east of the Sierra Nevada (e.g., lactating females were captured in 1997 by P. Brown near Coleville on the eastern slope of the Sierra Nevada). However, the majority of known localities are on the west side of the Sierra Nevada.

Life History: *M. thysanodes* is a colonial species. Although Barbour and Davis (1969) state that nursery colonies of several hundred are not uncommon, and the colony studied by O'Farrell and Studier (1975) contained 1,000-2,000 individuals, colonies observed in California in recent years more typically contain 10-20 adults (E. Pierson and W. Rainey unpubl. data), although one colony of > 200 was known from the San Bernardino Mountains (P. Brown pers. comm.).

The reproductive cycle in *M. thysanodes* has been most thoroughly investigated at a colony in northeastern New Mexico by O'Farrell and Studier (1973). Like other North American vespertilionids, *M. thysanodes* appears to mate in the fall after the maternity colony has disbanded. Ovulation, fertilization and implantation occur in the spring and are followed by a pregnancy of 50-60 days. Females give birth to a single young per year. In the New Mexico colony, parturition occurred between 25 June and 7 July. Available evidence suggests that births take place much earlier

in California. In Napa County, females in late stage pregnancy have been observed in early May, and young 10-14 days old by the third week in May (Pierson and Rainey unpubl. data). Farther north, in Shasta County, females in late pregnancy or with newly born young were observed in late May and early June for three consecutive years from 1992-1994 (Rainey and Pierson unpubl. data).

Prenatal and postnatal growth has been described by O'Farrell and Studier (1973). Young are born unfurred, with their eyes open, at about 22% adult weight. They are capable of limited flight by 16.5 days of age, and full flight at 20.5 days.

Only limited information is available on diet in *M. thysanodes*. In a study conducted in New Mexico, Black (1974) concluded the species appeared to be a beetle strategist. In western Oregon (Whitaker et al. 1977), the dominant prey item in the diet of three out of four animals examined was lepidopterans (moths). The diet also included phalangids (harvestmen), gryllids (crickets), tipulids (crane flies), and araneids (spiders). The feces of one individual captured on the upper Sacramento River in California contained predominantly coleopterans (beetles) and hemipterans (bugs) (Rainey and Pierson 1996). Relatively heavy tooth wear on animals examined in a five year study on the Sacramento River would suggest that in this area the species feeds primarily on heavy bodied insects, such as coleopterans and hemipterans. The presence of non-flying taxa in the diet of the Oregon animals suggests a foraging style which relies at least partially on gleaning.

Winter behavior is even more poorly understood than summer behavior. Scattered winter records suggest, however, that the species is not migratory, and like many species in the more temperate parts of California, may be intermittently active throughout the winter. The species has been found hibernating in buildings and mine tunnels along the coast in the San Francisco Bay area and in the coast range north of San Francisco.

Habitat: *M. thysanodes* occurs in a wide range of habitats, from desert scrub to high elevation conifer forest (O'Farrell and Studier 1980). Barbour and Davis (1969) found it to be one of the more common species in oak forest at 1,500-1,800 m elevation in the Chiricahua Mountains. In a study in the Mogollon Mountains of New Mexico and Arizona, Jones (1965) found *M. thysanodes* occurred almost exclusively in evergreen forest (>2,000 m elevation), and was the fourth most common species in this habitat. In a long- term study in western New Mexico (Jones and Suttkus 1972), *M. thysanodes* was found predominantly at the highest elevation sampled (2,600 m), and was the ninth most common bat species in this habitat.

A paucity of records makes it difficult to assess habitat preferences for this species in California. The earliest records for the state (Grinnell 1933) are all between 360 and 900 m elevation. Orr (1956) in reviewing specimens held at the California Academy of Sciences, notes two localities from the coastal region (Carmel in Monterey County and Woodside in San Mateo County). P. Brown (pers. comm.) reports finding a colony in 1991 at Big Bear in the San Bernardino Mountains. More recently, records have accumulated from the upper Sacramento River (Rainey and Pierson 1996), and the Sierra Nevada (Pierson and Rainey unpubl. data). Although nowhere common, the species occurs as one of the rarer taxa in netting records from the central coast to at least 1,950 m in the Sierra Nevada. It has been found in mixed deciduous/coniferous forest and in both redwood and giant sequoia habitat (Pierson and Rainey unpubl. data).

Most known roosts for *M. thysanodes* are in caves, buildings, or mines (O'Farrell and Studier 1980). Although outside of California maternity colonies have been found in caves (e.g. Baker 1962, Easterla 1966, Judd 1967), the only cave in California for which there are multiple records is Clough Cave in Sequoia National Park. The majority of roost sites documented in California have been

found in buildings (e.g., Orr 1956), including the type locality at Old Fort Tejon (Miller 1897). Although mines are mentioned as roost sites by several authors (Cahalane 1939, Cockrum and Musgrove 1964, Barbour and Davis 1969), there are no published records of maternity roosts in mines. Since 1987, we have located two small maternity roosts in mines (ca. 10 adult females each) in the coast range north of San Francisco. P. Brown (pers. comm.) in 1992 also located a maternity colony of ca. 50 in a mine in the southern Sierra foothills, and in 1991 captured lactating females entering a mine in the Castle Mountains, in the eastern Mojave Desert. Five roosts in the Laguna Mountains, San Diego County, located by radiotelemetry in the summer of 1996, were in rock crevices on cliff faces (Miner et al. 1996). Research within the past few years in Oregon and Arizona has also documented that *M. thysanodes* roosts in tree hollows, particularly in large conifer snags (Cross and Clayton 1995, Chung-MacCoubrey 1996). In California, a small colony was also located in a hollow redwood tree in the Carmel Valley (Pierson and Rainey unpubl. obs.). Tree-roosting behavior is consistent with an observed association between *M. thysanodes* and heavily forested environments in the northern part of its range (M. Brigham pers. comm., Cross et al. 1976, E. Pierson and W. Rainey pers. obs.).

One issue needing further investigation for this species is its preferred roost temperature. Work by Studier and O'Farrell (1972) on a colony in New Mexico suggested that *M. thysanodes* could fly at lower ambient temperature than many species, and sought cooler roosting conditions than did *M. lucifugus* with which it shared an attic roost. The two mine roosts which were identified recently in California were both relatively cool and damp (one mine had standing water). In contrast, a mine used as a nursery roost in the southern Sierra Nevada is dry and moderately warm (P. Brown pers. comm.).

Barbour and Davis (1969) noted that this species was readily captured at the entrances to night roosts in buildings, mines and caves. In a five year study on the upper Sacramento River, we observed that *M. thysanodes*, though one of the least commonly encountered bats, was more readily detected at bridge night roosts than in netting surveys conducted over water (Pierson et al. 1996).

Status: Class II. The status of this species has not been systematically investigated. Museum records suggest that while *M. thysanodes* is widely distributed in California, it is everywhere rare. Our personal experience is that although this species occurs in netting and night roost surveys in a number of localities, it is always one of the rarest taxa (Pierson et al. 1996).

Available museum records offer documentation for only six maternity sites: two in Kern County (including the type locality at Old Fort Tejon), and one each in Marin, Napa, Tuolumne, and Tulare counties. Investigation of four of these sites since 1990 has shown that while the roosts are still available this species is no longer present at any of these sites.

The limited data available suggest serious population declines. Maternity colonies identified between 1891 (Old Fort Tejon) and the early 1970s (Point Reyes National Seashore, Marin County) were likely considerably larger than any colonies known today. Forty-two animals were collected at the Fort Tejon site (five different collections between 1891 and 1945), 58 at Point Reyes National Seashore between 1973 and 1974, 40 in one year from a site in Napa County, 20 from a Tuolumne County site, and 14 from a Kern County site. Although, in the context of surveys not targeting this species, we have identified six new maternity sites in northern California, none of these contains more than 10-30 females. One site in Napa County was described by Dalquest (1947) as having about 50 animals in July 1945. Forty animals were collected at that time. In June 1987 the site contained 10-15 animals, and in August 1988, none. The grounds around this building had been considerably modified in 1988 for a new winery installation, and the building which housed the bats

was experiencing more human activity and scheduled for renovation. P. Brown (pers. comm.) observed two somewhat larger colonies (40-50 animals) in southern California, although one was in a house from which it has since been excluded. This species appears to be extremely sensitive to disturbance at roost sites and to human handling. While some species of *Myotis*, like *Myotis yumanensis*, seem tolerant of human incursions into their roosting space, *M. thysanodes* is not.

A cave in Sequoia National Park was documented in 1951 as being a *M. thysanodes* maternity site. Sixteen animals were collected at that time. Additionally, this cave has experienced very heavy recreational use for many years. Repeated attempts by the Park Service to gate the cave have been thwarted by vandalism. Although *M. thysanodes* has been mist-netted in the vicinity of this cave, it has not apparently been observed roosting there recently.

A comparison of historic and current records indicates limited recolonization at sites from which it has been extirpated. What may have been the largest documented colony in California occupied a barn at Point Reyes National Seashore. Fifty-eight animals were collected from this site in 1973 and 1974. Monitoring of this site since 1979 showed annual reoccupation by a *Myotis yumanensis* maternity colony, but *M. thysanodes* was not detected until 1996. The site has been protected by the Park Service for at least ten years, with no known human incursions into the roosting space. This suggests that the distribution of *M. thysanodes* is patchy and its dispersal capabilities limited.

Closure of old mines for hazard abatement and renewed mining in historic districts both pose considerable risks to this and other cavern dwelling bat species (Belwood and Waugh 1991, Brown and Berry 1991, Altenbach and Pierson 1995, Riddle 1995). One of the two *M. thysanodes* mine nursery sites we (E. Pierson and W. Rainey) have found since 1987 was destroyed by renewed mining. The colony persists by default, now occupying the lower level of a mine gated as a mitigation site for *Corynorhinus townsendii* (Pierson et al. 1991).

Restoration of historic buildings may also pose a threat to this species. One historic roost site (Old Fort Tejon) and two current roost sites are located in historic buildings owned by the California Department of Parks and Recreation. Another is located in a utility building on a State wildlife refuge. The tendency for bats to occupy historic buildings creates potential conflicts between the goals of historic preservation, access for public education, and wildlife protection. Although these conflicts are generally resolvable, and bat populations can almost always be accommodated in buildings without damaging historic values, this is frequently not appreciated.

In some forested settings, *M. thysanodes* appears to rely heavily on tree cavities as roost sites, and may be threatened by current timber harvest practices. For example, Chung-MacCoubrey (1996) in Arizona found that this species prefers large diameter (45-65 cm DBH) conifer snags, the size tree which is preferentially harvested under “shelterwood removal” regimes.

Although the species is protected from over-collection under current Department permitting practices, there is no doubt that scientific collection contributed to or accounted for the extirpation of the colony at Point Reyes National Seashore, and possibly the colony at Old Fort Tejon. While these museum records are invaluable in providing the only historic data we have, historic collecting practices appear to have harmed some populations.

Management Recommendations: Distributional surveys are needed, particularly in the Sierra Nevada and Coast Range. These mountain ranges offer the opportunity to evaluate distribution in relationship to latitude, altitude, and habitat type. It is particularly important to investigate the association between this species and late successional forest. This can be accomplished partly by

netting and night roost (e.g., mine, building, and bridge) surveys. Identification of tree roosts would, however, require radiotracking. Given the apparent sensitivity of this species to disturbance, radiotracking studies should be undertaken with the greatest caution. Until the tolerance of the species for radiotracking can be evaluated, studies should be limited to males and post-lactating females. Also, studies should be conducted in a setting which offers the opportunity to recapture the animals to assess transmitter impacts and remove the transmitter package. To minimize disturbance of day roosting sites, and maximize chances of recapture, animals selected for radiotracking should be captured only at night roosting sites.

Although extensive mine surveys have been conducted by P. Brown and others in the desert regions of southern California in the past 20 years, only limited surveys have been conducted in the Sierra Nevada foothills and other areas of central and northern California. Since mine use by bats appears to vary regionally, more extensive mine surveys need to be conducted in northern and eastern California.

Two of the currently known roost sites occupy historic buildings in state parks. Park personnel in these two parks have been very responsive to protecting the bats, and have been able to accommodate them within the historic structures. Although there is no inherent conflict between wildlife protection and historic preservation, local management is not consistently supportive of wildlife protection goals. Thus, policies need to be changed within appropriate agencies at both the Federal and State level to recognize the potential importance of anthropogenic features to bats and other wildlife.

The extent to which *M. thysanodes* uses caves is not well documented in California. Since it is known to use caves quite extensively elsewhere in its range, and has been considered a cave-dwelling bat (Barbour and Davis 1969), it should be considered along with other bat species in cave management plans. The reluctance of land management agencies to manage caves for wildlife rather than for human recreation poses one of the most significant threats to bat populations in California. Revised management practices which restrict human access to bat caves would make a significant difference for a number of bat species, likely including *M. thysanodes*.

Cave myotis, *Myotis velifer*

Elizabeth D. Pierson & William E. Rainey

Description: *Myotis velifer* is a large *Myotis*, with a forearm of 37-47 mm, and an adult weight of ca. 12 g. The subspecies found in California has a forearm of 40-45 mm (Stager 1939). This species has a large skull with a pronounced sagittal crest, a conspicuous bare patch on the back between the scapulae, large feet, and medium length ears (Fitch et al. 1981, Hoffmeister 1986). It can be distinguished from most other *Myotis* species on the basis of size. The only other *Myotis* in the same size range are *M. thysanodes* and *M. volans*. *M. thysanodes* has a fringe of hair on the interfemoral membrane, and *M. volans* has a distinct keel on the calcar.

Taxonomic Remarks: *M. velifer* is in the Family Vespertilionidae. This species was first described as *Vespertilio velifer* from a specimen collected in Guadalajara, Mexico (Allen 1890). The first use of the current name combination was by Miller (1897). Vaughan (1954) argued that the form found in southeastern California and Arizona belonged in a separate subspecies, which he named *M. v. brevis*. This subspecies is retained by Hall (1981). Hayward (1970) and Fitch et al. (1981) synonymize *M. v. brevis* with *M. v. velifer*, and recognize a total of three subspecies, *M. v. grandis*, *M. v. incautus*, and *M. v. velifer*. Under this arrangement, all *M. velifer* in California would be *M. v. velifer*. The first collection in California was on 16 July 1909 at Needles, San Bernardino County (Grinnell 1918).

Distribution: *M. velifer* is distributed across the southwestern quarter of the United States, from Kansas, Oklahoma and western Texas to southern Nevada and southeastern California, and south through Mexico, reaching its southern limit in Honduras (Fitch et al. 1981). Within the U.S., it is most widely distributed in Arizona.

In California, its distribution is limited to the Colorado River basin, primarily the Whipple, Mule, and Riverside mountains. Although the California Department of Health Services has received isolated specimens from farther to the west (D. Constantine pers. comm.), the only known roost sites are found in the mountain ranges within the Colorado River basin. The species is present in California primarily during the maternity season, from early April through September. A few individuals of both sexes were seen in a mine along the Colorado River in December 1993 (P. Brown pers. comm.), and there is one unverified winter record from Parker Dam (Royal Ontario Museum record).

Life History: *M. velifer* is highly colonial, typically forming maternity colonies of 2,000 to 5,000 (Barbour and Davis 1969, Fitch et al. 1981). A colony of 20,000 was located in a mine in Arizona in 1991 (V. Dalton pers. comm.). Maternity colonies form in the spring (in early May in California [Stager 1939]), and disband in late summer. Copulations take place in the fall or winter, and females give birth to a single young in early summer. Young are born at ca. 26% adult weight (Fitch et al. 1981), and attain adult weight by week 9 to 10. They begin to fly at about 3 weeks of age, and begin to forage at about 4 weeks (Kunz 1974).

This species appears to be opportunistic in its feeding habits. In some localities small moths (Lepidoptera) appear to be dominant in the diet, and in other settings beetles are the most common food item (Coleoptera) (Kunz 1974, Fitch et al. 1981). Vaughan (1980) reported this species feeding opportunistically and selectively on a swarm of flying ants near a roosting area.

Habitat: This species is found primarily at lower elevations (the Sonoran and Transition life zones) of the arid southwest, in areas dominated by creosote bush, palo verde, brittlebush, and cactus.

M. velifer roosts primarily in caves and mines, but has also been found in buildings, and under bridges (Stager 1939, Constantine 1958, Davis and Cockrum 1963, Barbour and Davis 1969, Fitch et al. 1981, Hoffmeister 1986). It appears to tolerate summer roost temperatures as high as 37°C (Constantine 1958). It has also been found on repeated occasions, particularly in the non-reproductive season, in swallow nests (Fitch et. al. 1981). Although the first record for California was from an old warehouse in Needles, most records are from abandoned mines in the Riverside Mountains. This population, with multiple colonies numbering in the thousands, was studied intensively by Stager (1939) in the 1930s and Vaughan (1959) in the 1950s. This species was present in the mines from early April through August, with almost no animals left by October 1. Where the majority of the California population goes in the winter is unknown. In southern Arizona, this species has been found in the winter occupying wet mine tunnels above 6,000 ft (1,830 m), where roost temperatures are 8° to 11° C.

Foraging habitat for the California population is predominantly the floodplain of the Colorado River. Both Stager (1939) and Vaughan (1959) report on *M. velifer* foraging low (2-4 m above the ground) over dense vegetation in this area. Stager (1939) describes the foraging habitat as consisting primarily of cottonwood (*Populus)* and arrowweed *(Pluchea*). Vaughan (1959) observed that the linear stands of screw bean (*Prosopsis pubescens*), tamarisk (*Tamarix* spp.), catsclaw (*Acacia greggii*), and mesquite (*Prosopsis* spp.) that border the oxbow ponds along the river were the favored foraging habitat. Less frequently the species was observed foraging in drier washes -- dominated by mesquite, catclaw and palo verde (*Cercidium floridum*).

Status: Class I. The distribution of this species within historic time in California has likely always been limited, as the species reaches the northwestern limits of its range along the Colorado River in southeastern California and southern Nevada. Extensive studies of this species in the 1930s and 1950s document very large California colonies numbering many thousands of individuals. Although both Stager and Vaughan collected animals for scientific purposes, these collection activities were not extensive enough to have adversely impacted the population. Extensive survey work has been conducted in this region over the past 25-30 years (P. Brown pers. comm., D. Constantine pers. comm., P. Leitner pers. comm.). Currently there are only two known maternity roosts for *M. velifer* along the Colorado River, one with approximately 300 animals, and the other about 200 (P. Brown pers. comm.). The mines that once housed the very large colonies no longer have any *M. velifer*. P. Brown (pers. comm.) has located two previously unknown mines with large deposits of *M. velifer* guano, one in the Cargo Muchacho Mountains and the other in the Riverside Mountains. When surveyed in 1993, the Cargo Muchacho mine had no bats, and the other had a few males. Based on this information, we must conclude that the status of this species in California is currently very precarious.

The most likely explanation for the dramatic declines in *M. velifer* populations along the Colorado River is loss of foraging habitat through the conversion of the floodplain to agriculture. The loss of native vegetation has almost certainly altered the invertebrate community. Also, the entire area is subjected to extremely heavy aerial spraying with pesticides, which could both reduce the prey base and directly poison the bats (e.g., Clark and Stafford 1981, Clark et al. 1983). The riparian habitat is mostly gone in the vicinity of the smaller maternity colony, and is rapidly being lost to river front homes and trailer parks near the other colony (P. Brown pers. comm.).

Cave and mine dwelling bats are very vulnerable to disturbance in their roost sites, particularly if they form large exposed aggregations as does *M. velifer*. Human disturbance is not likely to be a significant factor in this setting, however. The mines along the Colorado receive considerable

recreational use in the cool, non-summer months, but very little during the extremely hot summer (= bat reproductive) season.

Another threat to mine dwelling bats in California is the renewal of mining activity in historic districts (Brown and Berry 1991, Brown 1995).

Management Recommendations: The two remaining *M. velifer* populations should be systematically monitored. Although P. Brown (pers. comm.) has examined these colonies sporadically, she has not had the opportunity to monitor them on a regular basis. Also, radiotracking studies to investigate foraging habitat should be conducted.

Steps need to be taken to protect the two remaining populations, both on BLM land. One site is currently protected by having no claimant and being unknown to all but a few researchers; the other might have an active claim. Renewed mining should be avoided at both sites.

The last forty years has seen a dramatic decline in bat abundance and diversity along the Colorado River. The situation is particularly acute for *M. velifer* because this species occurs nowhere else in California. This situation is, however, symptomatic of a larger issue, which is the loss of the native habitat in the Colorado River floodplain. State and Federal agencies should identify areas of ecological importance along the river, and undertake projects to restore the floodplain ecosystem.

Long-legged myotis, *Myotis volans*

Elizabeth D. Pierson & William E. Rainey

Description: *Myotis volans* is a large *Myotis*, with a forearm of 37-41 mm. It can be distinguished from other large *Myotis* species by the presence of a well-developed keel on the calcar and fur on the underside of the wing membrane, extending from the body to a line between the elbow and the knee. It also has notably short, rounded, thick-rimmed ears that barely reach the nostrils when laid forward, and a short rostrum with a high forehead (Warner and Czaplewski 1984, Hoffmeister 1986). The only other California *Myotis* species with a keeled calcar (*M. californicus* and *M. ciliolabrum*) are much smaller. Other species may have some fur on the underside of the wing, but it is not as extensive as in *M. volans*. *Myotis thysanodes*, which is comparable in size, has longer ears and a fringe of hair (usually well developed) on the edge of the interfemoral membrane that is lacking in *M. volans*. *Myotis velifer*, which is also comparable is size, has a distinguishing bare spot on its back between the scapulae.

Taxonomic Remarks: *M. volans* is in the Family Vespertilionidae, and was first described as *Vespertilio volans* in 1866 from a type locality in Baja California (Allen 1866). Four subspecies are currently recognized (Hall 1981, Warner and Czaplewski 1984), *M. v.volans*, *M. v. amotus*, *M. v. interior*, and *M. v. longicrus*. *M. v. interior* and *M. v. longicrus* both occur in California. The type locality for *M. v. longicrus* (originally *Vespertilio longicrus* True 1886) was Puget Sound, Washington, and for *M. v. interior*, was Taos County, New Mexico. The earliest California records for *M. v. longicrus* are from Fort Reading, Shasta County (Townsend 1887) and Nicasio, Marin County (Miller 1897), and for *M. v. interior*, San Emigdio, Kern County and Owens Lake, Inyo County (Grinnell 1918).

Distribution: *M. volans* is widely distributed across the western third of the United States, reaching the northern limits of its range in northern British Columbia and the southern limits in central Mexico (Hall 1981, Warner and Czaplewski 1984). *M. v. amotus* is confined to central Mexico, and *M. v. volans* to Baja California. *M. v. longicrus* is distributed from northwestern British Columbia across central Alberta, across much of Washington, western Oregon and western California. *M. v. interior* is found throughout much of the western United States from north central North Dakota south to central Texas and west to California, eastern Oregon and eastern Washington. The boundary between the two subspecies in California runs from Mount Shasta to the coast just east of Santa Barbara, with *M. v. longicrus* occurring along the coast and in the coast ranges, and *M. v. interior* east of the Central Valley and to the coast from Ventura County south. Since there are no known ecological differences between the two subspecies, they are treated as a single unit in this document.

In California, *M. volans* occurs in a variety of habitats throughout most of the state, and has been found from the coast, to high elevation in the Sierra Nevada and White Mountains. Records are absent for the low desert areas of southeastern California, but occur in the mountains of the Mojave Desert, central San Diego County, the Coast Range, and the transverse ranges between the Los Angeles basin and the Central Valley. A notable percentage of the records (from California and elsewhere in the range) are from relatively high elevations.

Life History: Like all North American vespertilionids, *M. volans* mate in the fall and/or winter. The females store sperm over winter, and ovulate in the spring. They generally give birth to a single young in the late spring or early summer, although considerable variation has been noted in time of birth across the species' range, with pregnant females being found from mid-April until mid-August (Warner and Czaplewski 1984). In California, Dalquest and Ramage (1946) noted that all females

collected from a maternity colony in Kern County on June 4 had near term fetuses. In northern California, lactating females have been captured in Monterey County in early July (unpubl. data), in Sonoma County in mid-July (D. Constantine pers. comm.), and along the upper Sacramento River from mid-July through mid-August. Post-lactating females have been captured at the Sacramento River localities as early as mid-July (Rainey and Pierson 1996). This species is described by Barbour and Davis (1969) as forming large maternity colonies of several hundred females.

M. volans feeds primarily on moths (Lepidoptera), although it has also been documented eating a variety of soft-bodied invertebrates and small beetles (Warner and Czaplewski 1984). It is known to feed on spruce budworm moths in southern Oregon (M. Perkins pers. comm.).

Habitat: This species is found primarily in coniferous montane forests, and is likely the most forest-dependent of any of the California *Myotis* species. Although it occurs from sea level to 3,200 m, it is usually found between 2,000 and 3,000 m. In southern Oregon it is found primarily in the Ponderosa pine habitat (Cross et al. 1976), and in Colorado is the most common species in high elevation spruce-fir forests (K. Navo pers. comm.). It was the second most common bat found in high elevation evergreen forests in the Mogollon Mountains of New Mexico and Arizona (Jones 1965), and at 2,600 m in western New Mexico (Jones and Suttkus 1972). In California, we (E. Pierson and W. Rainey) have found it in the high desert (e.g., Providence Mountains), in redwood forest along the central coast, in giant sequoia forest in the Sierra Nevada, in mixed conifer forest in the upper Sacramento River drainage, and at lower elevations in the Sierra Nevada (the higher elevations have not been surveyed). In recent surveys in the White Mountains *M. volans* was captured at Owens Lake, and was the most abundant species in summer net captures at 2,700 m (Szewczak et al. In Press, Szewczak unpubl. data). P. Brown (pers. comm.) reported netting pregnant females around Owens Lake in April and May, but captured none during the summer months. Since there are museum records for the summer months from elevations higher than Lone Pine, this species probably migrates altitudinally.

Although this species has been found roosting in abandoned buildings, mines, and rock crevices (Barbour and Davis 1969, Warner and Czaplewski 1984), recent research suggests it roosts primarily in trees, particularly large diameter conifer snags, or live trees with lightning scars. Colonies of up to 200 have been found in live and dead ponderosa pine in New Mexico (Chung-MacCoubrey 1996). Radio-tagged females have also been found in ponderosa pine snags in South Dakota (Cryan 1996), and in large snags and hollow incense cedar trees in the Central Oregon Cascades (Ormsbee 1996). Ormsbee (1996) found that females used multiple day roosts within a single area. Along the upper Sacramento River in California, a post-lactating female *M. volans* was radiotracked to a large diameter conifer snag (Rainey and Pierson 1996).

Barbour and Davis (1969) described *M. volans* as foraging 10-15 ft (3-5.4 m) over water and in openings in the forest. Fenton and Bell (1979) found that in wooded areas *M. volans* foraged along the forest edge, primarily above the canopy, and was never observed gleaning. In recent light-tagging studies, Saunders and Barclay (1992) observed *M. volans* foraging high above the ground, in open areas and high along cliff walls. A single individual radio-tagged in the Upper Sacramento River drainage appeared to forage above the canopy along the river and tributary stream corridors (Rainey and Pierson 1996).

Status: Class II. There are relatively few records for *M. volans* in California. In museum collections, there are series of reproductive females from only five localities, all pre-dating 1955. In June 1945, Old Fort Tejon in Kern County had a maternity colony of approximately 500 females which is now gone (Dalquest and Ramage 1946). In July 1954, D. Constantine (pers. comm.) collected

approximately 40 animals, including 16 mature females from a colony of >100 in Sonoma County. He returned to this site in September 1968 and found approximately 25 *M. volans* in another structure at the site. The original building in which the bats were found has been renovated and whether *M. volans* still occurs in this area is unknown. Seventy two specimens were collected in Nicasio, Marin County in the late 1800s (Miller 1897). The original site and current status of that colony are unknown, although extensive netting at Point Reyes National Seashore in recent years has yielded only a single male *M. volans* (G. Fellers pers. comm.). Individual reproductive females have been identified at a number of localities, including the Laguna Mountains in southern San Diego County (Miner et al. 1996), but no maternity roosts for this species have been located in the past 40 years. P. Brown (pers. comm.) found a group of pregnant females in a building at Coso Hot Springs in Inyo County in April of 1980 and 1984, but the animals departed prior to parturition. This site has not been visited recently.

Although this species is reported to be currently common at high elevations in the Rocky Mountains (K. Navo pers. comm.), was known to be common 25-30 years ago at higher elevations in Arizona and New Mexico (Jones 1965, Jones and Suttkus 1972), and has been found at some of high elevation sites in California (e.g., in the White Mountains and Mount Whitney in the Sierra Nevada), its current status in California is largely unknown. Most of the higher elevation areas of California have never been surveyed for any bat species.

The most serious threat to *M. volans* populations is likely to be timber harvest practices which favor selective removal of large diameter trees and have inadequate snag retention/snag recruitment guidelines. State forestry regulations in particular are inadequate (see California Forest Practice Rules 919.1, 939.1, 959.1) in that they make special allowances for the removal of merchantable snags and snags within 100 ft (30 m) of ridge tops. Recent research on tree roosting habits of many bat species suggests the bats generally select early stage (i.e., merchantable) snags, and often selectively seek roosts near ridge tops that offer maximum solar exposure (e.g., Barclay and Brigham 1996).

Another potentially serious risk to *M.volans* and other forest species is aerial spraying of pesticides. Henny et al. (1982) showed that the carcasses of *M. volans* and four other bat species showed post-spraying residues of DDT metabolites following a single DDT spray application for the Douglas fir tussock moth (*Orgyia pseudotsugata*) in northeastern Oregon, eastern Washington and northern Idaho in 1974. These residues were still detectable in tissue three years post-spray. Although the impact on bat populations (e.g, survivorship or reproductive success) were not assessed in this study, other studies have related bat population declines to application of pesticides (e.g., Geluso et al. 1976, Clark et al. 1978). While pesticides in use today are less persistent, their effects on bats have not been investigated. Short-term neurotoxic insecticides could be lethal or impair maneuverability, leading to reduced foraging efficiency and increased vulnerability to predators. Lepidopteran-specific agents like *Bacillus thuringensis* result in significant, if short-term, reduction in the prey base for lepidopteran specialists like *M. volans* (Sample et al. 1993).

Management Recommendations: What is most urgently needed is research exploring the breeding range of this species, both latitudinally and altitudinally in California, with a focus on the higher elevations of the Sierra Nevada, White Mountains, and northern Coast Range. Additionally, radiotracking studies are needed to identify roost sites and foraging areas. Since limited available data suggest an association with late successional forest, research should focus especially on areas subjected to timber harvest. Ormsbee (1996) recommended management or protection of a 240 m buffer zone around more permanent tree roosts for *M. volans*. Whether this would be appropriate for *M. volans* in California forests needs to be assessed. An additional unresolved issue is the location

of winter range or refugia.

Western mastiff bat, *Eumops perotis*

Elizabeth D. Pierson & William E. Rainey

Description: *Eumops perotis* is one of four molossids which occurs in California. The molossids are distinguished from all other bat species by the presence of a "free-tail," which extends visibly beyond the edge of the interfemoral (=tail) membrane. *E. perotis* is distinguished from the other molossids on the basis of size. It is by far the largest bat species found in California. It has a wingspan of 53 to 56 cm, a forearm of 75-83 mm, and an adult weight of 60-72 g. The species with which it could most readily be confused is *Nyctinomops macrotis*, another molossid, with a forearm of 58-64 mm. Both have large bonnet-like ears, which extend forward over the eyes and are connected at the midline.

Taxonomic Remarks: *E. perotis* is in the family Molossidae. The California form of *E. perotis* was first described by Merriam (1890), and has been recognized as the subspecies *E. p. californicus* since 1932 (Sanborn 1932). The type locality is Alhambra, Los Angeles County. There are nine species currently recognized in the genus *Eumops* (*auripendulus*, *bonariensis*, *dabbenei*, *glaucinus*, *hansae*, *maurus*, *perotis*, *trumbulli*, and *underwoodi*), and two subspecies of *E. perotis* (*californicus* and *perotis*)(Eger 1977). Most species have their centers of distribution in Mexico, Central and/or South America; three (*glaucinus*, *underwoodi*, and *perotis*) occur in the southern United States; only *E. perotis californicus* occurs in California, with the other subspecies, *E. p. perotis*, being confined to South America.

Distribution: *E. p. californicus* ranges from central Mexico across the southwestern United States (parts of California, southern Nevada, southwestern Arizona, southern New Mexico and western Texas) (Bradley and O'Farrell 1967, Eger 1977, Hall 1981). Recent distributional information for California is summarized below (from Pierson and Rainey 1996b, c).

Historically, *E. perotis* was known to be broadly distributed in southern California, from the Colorado River to the coast, with records concentrated in the Los Angeles basin and San Diego County (Cockrum 1960, Eger 1977). The most northern records for which specimens were available was a single animal from the San Francisco Bay area (Hayward, Alameda County) (Sanborn 1932) and several records from Yosemite Valley in Yosemite National Park (Natural History Museum, Yosemite National Park). There were also observations of several *E. perotis* at Hetch Hetchy Reservoir in Yosemite National Park (Vaughan 1959), and of a single animal (specimen not available), presumed to be a vagrant, found in 1973 in Butte County, near Oroville (A. Beck pers. comm., Eger 1977).

Although *E. perotis* is a colonial species, it is striking how few of the available records represent colony sites. Most colony records are from southern California. Early in this century, Howell (1920a, 1920b) located several in buildings in the Los Angeles basin (e.g., in Azusa, Colton, and Covina). In the 1940s, Krutzsch (1943, 1945, 1948, 1955) identified two colonies in San Diego County. Additional significant locality records were contributed by Vaughan (1959) who monitored 22 sites, including eight colonies, located primarily in southern California. Leitner (1966) also focused his research on a colony located in a building at Citrus Junior college in Azusa in the Los Angeles basin. D. Constantine (pers. comm.) knew of a colony in a church in Highland in the 1960s. K. Stager (pers. comm.) reported a very large colony eliminated by an exterminator from a house in downtown Los Angeles in the early 1950s. Historically there were only three records of colonial roost sites north of the Los Angeles basin, all located in the 1940s and 1950s by researchers associated with the Museum of Vertebrate Zoology at the University of California, Berkeley -- a colony on the west side of the Central Valley in San Benito County (Dalquest 1946), one in Kern

County near McKittrick (Krutzsch 1955), and one in the Kern River drainage east of Bakersfield (Koford 1948, Krutzsch 1955).

Recent surveys (Pierson and Rainey 1996b, c) have changed the distributional picture for *E. perotis*. It is now apparent that the species is more widely distributed than was previously realized, and significant populations occur in areas for which only single or scattered records were previously available. This species is now known to have a range that extends almost to the Oregon border, with a number of new localities in the western Sierra Nevada foothills and eastern Trinity Alps. Although there were very few records for the Coast Range prior to the 1990s, multiple animals, suggesting resident populations, have now been detected at several localities in the Coast Range south of San Francisco. Historically the only indication that *E. perotis* occurred in the Sierra Nevada was several lower elevation records (Koford 1948, Vaughan 1959). It is now known that significant populations of *E. perotis* occur in many of the Sierra Nevada river drainages, particularly in the central and southern Sierra, i.e., the Stanislaus, Tuolumne, Merced (North and South Forks), San Joaquin, Kaweah, Tule, and Kern rivers. Substantial populations and roost sites have been located in basaltic table formations in the western Sierra foothills, particularly on the lower San Joaquin and Stanislaus Rivers (W. Philpott, T. Rickman, D. York pers. Comm..). Although the largest populations appear to occur at lower elevations, animals have been detected in the warm season as high as 2,600 m elevation in Yosemite National Park (Pierson and Rainey 1996c), and at 2,000 m in Giant Forest (Pierson and Heady 1996). There are no historic records east of the Sierra Nevada crest, but recent (albeit infrequent) acoustic detections at several localities suggest that this species occurs in some of the Mojave Desert mountain ranges (e.g., Coso, Granite and Panamint Mountains) (P. Brown pers. comm.). Also, the species was heard once in Bishop, during the summer of 1996 (P. Brown pers. comm.).

Unlike some molossid species (e.g., *Tadarida brasiliensis*) which undergo long distance seasonal migrations, *E. perotis* appears to move relatively short distances seasonally. Like other molossids, it does not undergo prolonged hibernation, and appears to be periodically active all winter. Although in southern California local populations may change roost sites, they likely remain in an area year-round (Howell 1920a, Krutzsch 1948 and 1955, Leitner 1966, Barbour and Davis 1969). On the western side of the Sierra Nevada, the species likely moves down the river drainages as the weather cools, concentrating during the winter in areas which experience prolonged periods of above freezing temperatures (below 300 m). For example, winter surveys on the Kern River revealed that animals were not occupying a summer roost site at 580 m, but were concentrated near the mouth of the canyon at ca. 245 m (Pierson and Rainey 1996b). Reliable observers have documented that populations are present throughout the winter at three basaltic table mountain formations (near Oroville, Jamestown and Fresno) (B. McMurtry, W. Philpott, T. Rickman, D. York pers. comm.).

Life History: Unlike vespertilionids which mate in the fall, North American molossids, including *E. perotis*, appear to mate in the spring and give birth to a single young in early- to mid-summer. Available data suggest, however, that although most *E. perotis* young are born by early July (Krutzsch 1955), parturition dates vary extensively (Barbour and Davis 1969), and births are not synchronous, even within colonies (Cockrum 1960). Juveniles with open epiphyses were captured in mid-August in Yosemite National Park, and in the Coast Range in mid-September (Pierson and Rainey 1996b). An individual, still identifiable as a juvenile, was also captured in the Coast Range in late November (L. Thompson pers. comm.). A lactating female was caught in Anza Borrego Desert State Park in early July, and a series of lactating females in Yosemite Valley in early September (Pierson and Rainey 1996b, c). In a different year, a post-lactating female was caught in Wawona, Yosemite National Park in mid-August (Pierson and Rainey 1995). A series of animals killed by the San Bernardino County Health Department on August 20, 1992, included five

post-lactating females, and three juveniles with open epiphyses (P. Brown pers. comm.).

E. perotis is colonial, but colony size is generally small (fewer than 100 animals) (Barbour and Davis 1969). Howell (1920a) considered even 20 to be a large roost. Although maternity roosts for most bat species contain only adult females and their young, *E. perotis* colonies contain adult males and females at all times of year (Krutzsch 1955).

E. perotis emerges after dark, and its audible call can be heard flying every hour of the night. The animals are strong, fast fliers, with a likely extensive foraging range. The species has been heard in open desert, at least 15 mi (24 km) from the nearest possible roosting site (Vaughan 1959). Given the frequency with which multiple animals are detected together or in rapid succession, it is possible this species sometimes travels or forages in groups. Generally they move through an area fairly rapidly. An interval of intense acoustic activity will frequently be followed by silence, and foraging will not predictably reoccur at the same site on sequential nights.

The diet appears to be primarily moths (Lepidoptera). Ross (1967) reports that a sample of eight *E. perotis* from Arizona had eaten only large Lepidoptera (up to 60 mm) and a few Homoptera. Easterla and Whitaker (1972) found that in 18 specimens, almost 80% of the diet was Lepidoptera, and the rest predominantly Gryllidae and Tettigoniidae. At one locality in Arizona, 58% of the diet consisted of small (about 8 mm) hymenopterous insects (Ross 1961). In California, it appears that *E. perotis* feeds predominantly on moths (Lepidoptera), but also includes beetles (Coleoptera) and crickets (Gryllidae) in its diet (Whitaker et al. in prep.)

Habitat: The distribution of *E. perotis* is likely geomorphically determined, with the species being present only where there are significant rock features offering suitable roosting habitat. It is found in a variety of habitats, from desert scrub to chaparral to oak woodland and into the ponderosa pine belt.

E. perotis is primarily a crevice dwelling species. Natural roosts are often found under large exfoliating slabs of granite, sandstone slabs or in columnar basalt, on cliff faces or in large boulders (Dalquest 1946, Krutzsch 1955, Vaughan 1959). A number of roosts have also been located in appropriately proportioned cracks in buildings (Howell 1920a, Barbour and Davis 1969). Roosts are generally high above the ground, usually allowing a clear vertical drop of at least 10 ft (3 m) below the entrance for flight (Vaughan 1959, Barbour and Davis 1969). Roosts recently located in California were in exfoliating granite, sandstone, or columnar basalt (Pierson and Rainey 1996b). In all cases the bats are in a crevice at least 3.5 m above the ground.

Due to its audible echolocation call, *E. perotis* can be readily detected in foraging areas. In California, it is most frequently encountered in broad open areas. Its foraging habitat includes dry desert washes, flood plains, chaparral, coastal sage scrub, oak woodland, open ponderosa pine forest, grassland, and agricultural areas.

Status: Class II. Recent surveys have shown that *E. perotis* is more widely distributed, particularly in the Sierra Nevada foothills, than was previously realized (Pierson and Rainey 1996b). The discovery of a number of new localities was likely due to improved detection techniques (i.e., monitoring distinctive audible echolocation), rather than an expanding geographic range. Although researchers had made reference to the audible calls of *E. perotis* (e.g., Vaughan 1959), this characteristic had not been previously used as a survey tool.

Assessing the status of *E. perotis* populations presents certain challenges. Unlike many species

which exhibit great roost fidelity, and whose status can be tracked by monitoring colony size at roost sites (e.g., *Corynorhinus townsendii* and several *Myotis* species [Stihler and Hall 1993, Pierson and Rainey 1996a]), *E. perotis* may occupy roost sites in an unpredictable fashion. Krutzsch (1948) followed the Barrett Junction roost over a period of 11 years, and the population varied from 10 to 60 at comparable times of year. Certain roost sites, or series of roost sites, may be critical to particular populations, but not enough is known about the roosting ecology of this species to determine roosting patterns.

An absence of historical records makes it impossible to assess current trends for this species in most areas. In the recent surveys, a paucity of detection events along the north rim of the Los Angeles basin, in an area relatively rich in historic records, does suggest population declines. Although there was a very large colony (200-300 animals) in Azusa in the 1960s, there was no evidence acoustically that the species still occurs in Azusa, nor in the adjacent drainage leading into the San Bernardino Mountains. Likewise, no bats were detected in repeated acoustic surveys in Altadena and Pasadena. A roost in Highland, which had 40-50 adults in 1969 (D. Constantine pers. comm.), had only three bats in September 1992. With the exception of the north rim of the Los Angeles basin, *E. perotis* was detected in most sampled areas for which there were historic records.

There are a number of potential threats to the roosting and foraging habitat of *E. perotis*, which are discussed in detail in Pierson and Rainey (1996b). The following is a summary:

Urban/suburban Expansion. The loss of foraging habitat in the Los Angeles basin is likely primarily responsible for what appears to be a decline in *E. perotis* populations in this area. The numerous creek drainages flowing into the Los Angeles basin from the San Bernardino and San Gabriel mountains provided the kind of floodplain, desert wash vegetation, which appears in other settings to be ideal foraging habitat for this species. Most of that habitat has now been lost to urban/suburban development and associated watercourse channelization.

In San Diego County, for example, where houses are situated among boulder jumbles, people can be brought into close contact with these bats, which due to their size and loud vocalizations, are evident when present. Thus colonies in close proximity to human dwellings become vulnerable to disturbance and vandalism of their roosts.

Pest Control Operations. Extermination of colonies by pest control operators and public health departments has also been responsible for the elimination of many *E. perotis* in the Los Angeles basin. In this area, where building roosts are relatively more common, these large and noisy bats are very vulnerable to the hysteria which often surrounds bat colonies. K. Stager (pers. comm.) described a situation in a building near the Los Angeles County Museum in which "3 wash tubs full" of *E. perotis* were killed by exterminators in the 1950s. The only two recent colonies known for the Los Angeles basin (a school in Rancho Cucamonga and the Norco City Hall) came to our attention because both colonies were eliminated by public health officials.

Water Storage and Development. The same canyons which offer suitable cliff habitat for *E. perotis* also provide basins for storage reservoirs and other water projects. Almost every river which drains the west side of the Sierra Nevada has one or more such reservoirs. It is almost certain that roosting and foraging habitat has been lost at many of these sites (e.g., Hetch Hetchy Reservoir), and is threatened at others (e.g., Los Banos Creek). *E. perotis* has also frequently been detected foraging in the vicinity of reservoirs (e.g., Tulloch Lake, Lake Kaweah, Lake Success), so it is also possible that reservoirs create foraging habitat. The situation needs further evaluation.

Highway Projects. For obvious reasons, substantial cliffs generally occur where they have been carved by river systems. River drainages, because they frequently offer the easiest routes through mountain ranges, are also favored corridors for highway construction. Such construction commonly entails blasting of cliff faces, either for initial highway construction or later improvements (i.e., widening and straightening). Since bats are frequently overlooked in the environmental assessment process, cliff roosting species, such as *E. perotis*, are at risk of both direct impacts from blasting, and long-term loss of roosting habitat from cliff modifications.

Recreational Climbing. There has been an exponential increase in recreational rock climbing in the west in recent years. A recent informal survey by personnel at Yosemite National Park has documented 3,000 new climbing routes within the park, where the unsanctioned use of various technical aids has made previously unclimbable areas accessible (Dept. of Resource Management, Yosemite National Park, pers. comm.). The popular sites, such as El Capitan in Yosemite Valley, literally experience climbing traffic jams, with 20-30 climbers on the face at once. Similarly, columnar basalt cliffs, which occur along the western base of the Sierra Nevada, until recently considered too hot and unpleasant for climbing, have experienced increasingly heavy use since about 1990. Although no information is available regarding what proportion of the crevices used by climbers offer suitable roosting sites for *E. perotis*, it is reasonable to presume that hands or temporary climbing aids inserted into a roost crevice would be cause for disturbance and possible abandonment of a site. If climbers camp overnight on ledges beneath roosts, noise and light could potentially disturb nursery sites. Also, climbers may alter cliff habitat, dislodging unstable rock and clearing ledges.

Mining and Quarry Operations. Mining and quarry operations which impact cliff habitat could potentially remove roosting habitat for *E. perotis*. Additionally, the noise generated by active mining and quarry operations could disturb roosting bats. Quarries may create cliffs, however. One of the colony sites monitored by Vaughan (1959) was in a quarry west of Riverside.

Grazing/Meadow Management. Whereas a number of bat species appear to forage predominantly over water, or along vegetation edges (e.g., riparian zones, forest edges), *E. perotis* frequently forages in open areas, including meadows. To the extent that excessive grazing and trampling of meadows by livestock alters the insect productivity (particularly for lepidopterans), it may impact the foraging habitat of *E. perotis*, and could adversely affect local populations.

Pesticide Spraying and Environmental Contaminants. Pesticides have been shown to have detrimental effects on bat populations (Clark 1981, Clark et al. 1978, 1983). Persistent chlorinated hydrocarbons are now banned. While the shorter half-life organophosphates, now in wide use, are known to have negative impacts on raptors (Wilson et al. 1991), their effect on bats has not been investigated. Short-term neurotoxic insecticides could be lethal or impair maneuverability, leading to reduced foraging efficiency and increased vulnerability to predators. Lepidopteran-specific agents like *Bacillus thuringensis* result in significant, if short-term, reduction in the prey base for species like *E. perotis* that rely heavily on moths (Sample et al. 1993).

Sensitivity to Human Disturbance. No data are available on the sensitivity of *E. perotis* to human disturbance. Most bat species, however, are sensitive to human intrusion into roost sites, particularly during the maternity season.

Management Recommendations: Recent surveys expanded the known range of *E. perotis*, and suggest that additional surveys should be conducted, particularly in the Coast Range, at higher altitudes in the Sierra Nevada, and on the east side of the Sierra Nevada.

More information is needed on the spatial and temporal distribution of populations. It is not known how loyal colonies are to particular roost sites, and thus whether single roost sites, or roosting areas need to be monitored and protected. Studies need to be conducted to assess the impact of certain human activities, particularly recreational climbing, in the vicinity of roost sites.

Recent surveys identified a number of significant populations. Methods need to be developed for assessment and ongoing monitoring of population size.

Pocketed free-tailed bat, *Nyctinomops femorosaccus*

Elizabeth D. Pierson & William E. Rainey

Description: *Nyctinomops femorosaccus*, like all molossids, has a free tail which extends beyond the edge of the interfemoral membrane. It can generally be distinguished from the other three molossids which occur in California based on size or forearm length. This species, with a forearm length of 45-49 mm, and a weight of 10-14 g, is larger than *Tadarida brasiliensis* (forearm 36-46 mm, weight 11-15 g), and smaller than *Nyctinomops macrotis* (forearm 58-64 mm, weight 22-30 g) or *Eumops perotis* (forearm 75-83 mm, weight ca. 65 g) (Barbour and Davis 1969, Kumirai and Jones 1990, Schmidly 1991). It is closest in size to *T. brasiliensis*, and there is some overlap in forearm length between the two species. *N. femorosaccus* differs from *T. brasiliensis* in having its ears joined at the midline (a character which is common to all *Nyctinomops* species and *E. perotis*) (Constantine 1958). The ears meet, but are not joined, in *T. brasiliensis* (Constantine 1958, Barbour and Davis 1969). A shallow fold of skin on the uropatagium, near the knee (thus the name "pocketed free-tail bat") is frequently difficult to find, and should not be relied upon as a distinguishing characteristic.

Taxonomic Remarks: *N. femorosaccus* is in the Family Molossidae. *N. femorosaccus* was first described by Merriam (1889) from a specimen found in Palm Springs, California. Although it was for many years known as *Tadarida femorosacca* (Barbour and Davis 1969), it was named *Nyctinomops femorosaccus* by Miller (1902), and that name has recently been reinstated (Freeman 1981, Koopman 1993). It is a monotypic species.

Distribution: This species ranges from southwestern Mexico through southwestern Texas, southern New Mexico, southcentral Arizona, and southern California (Hall 1981, Kumirai and Jones 1990).

This species is known historically from very few localities in California. The type specimen was from Palm Springs in Riverside County. Other localities were Borrego Palm Canyon, San Diego County (Neil 1940), and the vicinity of Suncrest, San Diego County (Krutzsch 1944a). Although colonies had been observed, there was no information on whether these colonies consisted of females and young. Thus it was not known based on these records whether the California populations were reproductive.

Recent surveys in California (Pierson and Rainey 1996b, c) suggest that while *N. femorosaccus* is likely confined to the southern third of the state, and is relatively uncommon, it is nevertheless more widespread in that region than was previously realized. In these recent surveys, positive identification of *N. femorosaccus*, via net captures, was obtained for two localities in San Diego County. Reproductive females were captured in Anza Borrego Desert State Park. Young, with partially open epiphyses, were captured in November 1994 at another site in San Diego County, providing evidence that the species raises young in southern California (K. Miner pers. comm.). An additional population, based on visual observations and acoustic records, was located in Painted Canyon, north of Mecca, Riverside County in August 1992. P. Brown (pers. comm.) in 1992 reported a *Nyctinomops* colony (most likely *femorosaccus*) in a large boulder near Lake Mathews, and possibly a colony in a canyon on Camp Pendleton. K. Miner (pers. comm.) has located additional roost sites in western San Diego County. *Nyctinomops* has been detected acoustically near the Chocolate and Cargo Muchacho mountains in Imperial County (P. Brown pers. comm.). Records obtained by the California Department of Health Services suggest *N. femorosaccus* could be expected anywhere in southern California south of the San Bernardino Mountains (D. Constantine pers. comm.).

Life History: Although very little is known specifically about the reproductive biology of *N.*

femorosaccus, it appears to follow the molossid pattern of breeding in the spring, with females giving birth to a single young in June and July (Kumirai and Jones 1990). Capture of young with only partially closed epiphyses in late November in San Diego County suggests that some young may be born as late as September (Pierson and Rainey 1996b, c).

Limited data are available on the diet of this species. Easterla and Whitaker (1972) in an examination of 13 stomachs, found the species to feed primarily on large moths (probably Sphingidae), but to include a number of flying insects in their diet, e.g., crickets (Gryllidae), grasshoppers (Tettigoniidae), flying ants (Formicidae), froghoppers (Cercopidae), and leafhoppers (Cicadellidae). The digestive tract of one *N. femorosaccus* from Arizona contained only Macrolepidoptera (probably hawk moths), and another from the same locality contained 85% Microlepidoptera and 15% Coleoptera (Ross 1967).

Habitat: This species appears to be confined primarily to arid lowland areas (Barbour and Davis, 1969, Schmidly 1991). In Big Bend National Park in Texas, it has been found only in desert shrub and river floodplain arroyo (Easterla 1973). It has been detected as high as 2,160 m elevation in pine-oak forest in Mexico (Kumirai and Jones 1990). In California it has been located only in the Lower and Upper Sonoran life zones (Krutzsch 1948), associated primarily with creosote bush and chaparral habitats. It is found primarily in association with prominent rock features -- very large boulder jumbles or rocky canyons.

N. femorosaccus is a crevice dwelling species, usually associated with high cliffs and rugged rock outcroppings (Barbour and Davis 1969), although it has also been found in caves (Dalquest and Hall 1947), and in buildings, e.g., a colony living under roof tiles in a building at the University of Arizona, Tucson (Gould 1961). Colony size may be relatively small. Krutzsch (1944b) reported 50-60 animals in a colony in Borrego Palm Canyon, Anza Borrego Desert State Park, San Diego County, although a colony of >100 has been located in San Diego County by K. Miner (pers. comm.).

Two roost sites were described by Krutzsch for California. The roost in Borrego Palm Canyon (Krutzsch 1944b, 1948) was in several crevices, on a southwest facing slope, about 3.6 m above the base of a cliff. One crevice was ca. 5 cm wide, and formed an irregular horizontal opening several feet long. At the Suncrest site (Krutzsch 1945, 1948) the bats were in a vertical crevice in a large granite boulder. The crack varied in width from 2.5 to 7.5 cm. *N. femorosaccus* inhabited the higher, narrower portion of the crack, and *E. perotis* was in the lower, wider portion.

Recently located roosts have all been in rock crevices (Pierson and Rainey 1996b, c). At one site the animals were in several vertical cracks, on a rock wall in a narrow canyon, about 4-5 m above the ground. Although they shared one crack with a nursery roost of *E. perotis*, they appeared to be roosting separately. At another site they were in a dry, narrow, rocky canyon, in a large horizontal crack, beneath an overhang, ca. 5 m above the ground. At a San Diego County site, animals presumed to be *N. femorosaccus* emerged from a number of cracks on the cliff face (K. Miner pers. comm.). P. Brown (pers. comm.) located a roost under an exfoliating slab in a large granite boulder. The slope was such that the roost was at least 4 m above the ground.

This species frequently makes audible calls in and around the roost at emergence (Krutzsch 1944, 1948, Pierson and Rainey 1996b, c; K. Miner pers. comm.). At several sites animals have been observed at emergence swooping back and forth, calling to each other with a characteristic intense "chatter" for a number of minutes, before leaving the roost area. The literature indicates that this species leaves the roost well after dark (Gould 1961). In California, animals have been observed

leaving the roost after dark in the summer, but well before dark in November.

Although there are not enough records for this species from California to document seasonal patterns, the species likely occurs year round. Krutzsch (1948) has records from March, May, July and August. Recent records from San Diego County from late November suggests the species overwinters there (Pierson and Rainey 1996b, c). The species is present year-round in southern Arizona (Gould 1961, Hoffmeister 1986).

Status: Class II. Recent surveys concluded the species has a restricted distribution in southern California, and is rare to uncommon, but breeding populations do exist within the state.

Alterations or disturbance of cliff habitat (i.e., water impoundment projects, highway projects, and recreational climbing) could potentially affect this species. Two roosts in San Diego County are in close proximity to reservoirs. Not enough is known regarding the habitat requirements of this species to identify other potential threats, particularly those which might affect foraging habitat.

Management Recommendations: Additional surveys for this species (which could be conducted in the context of surveys for other species) are urgently needed, especially in the canyon areas of southern California (San Diego, Imperial and Riverside counties) to determine both spatial and temporal distribution, and to determine habitat requirements. Acoustic sampling may be the most efficient and effective method of detecting the presence of this species in an area. Like other molossids, however, this species has a variable vocal repertoire, and more extensive investigation of call characteristics needs to be conducted before a protocol can be established for distinguishing this species from *N. macrotis* and *T. brasiliensis*. Attempts should be made to identify more maternity sites, and to ensure that key maternity sites are protected.

Big free-tailed bat, *Nyctinomops macrotis*

Elizabeth D. Pierson & William E. Rainey

Description: *Nyctinomops macrotis*, like all molossids, has a free tail tip which extends beyond the edge of the interfemoral membrane. It can be distinguished from the other three molossids which occur in California based on its size or forearm length. This species, with a forearm length of 58-64 mm, is larger than *Nyctinomops femorosaccus* (forearm 45-49 mm) or *Tadarida brasiliensis* (forearm 36-46 mm), and smaller than *Eumops perotis* (forearm 75-83 mm) (Barbour and Davis 1969, Milner et al. 1990). It has large, broad ears which are joined at the midline of the forehead, and extend beyond the tip of the nose when laid forward (Schmidly 1991). It weighs 22-30 g (Schmidly 1991).

Taxonomic Remarks: *N. macrotis* is in the family Molossidae. *N. macrotis* was first described from a specimen found in a tree hollow in Cuba (Gray 1839). The California form was described by Allen (1893). Although in the past it has been called *Tadarida macrotis* or *Tadarida molossa*, the currently accepted nomenclature is *Nyctinomops macrotis* (Freeman 1981, Koopman 1993). It is a monotypic species.

Distribution: *N. macrotis* is distributed from Uruguay and northern Argentina, northward through South America, mostly east of the Andes, through central America and Mexico into the southwestern United States, with records also from the Greater Antilles (Milner et al. 1990). In temperate North America, there are also individual records from eastern Kansas, Iowa, South Carolina and British Columbia (Hall 1981, Di Salvo et al. 1992, Nagorsen and Brigham 1993). Records are more common for Texas, Arizona, New Mexico, and Utah than for California.

There are very few records for this species in California. The type specimen for a form originally described as *Nyctinomops macrotis nevadensis* was most likely collected in California, although the exact locality is not known (Allen 1893, Allen 1894). There are several records from San Diego County (Huey 1932, 1954, August and Dingman 1973), one from Alameda County (Museum of Vertebrate Zoology, UC Berkeley, 1916), and a number from scattered locations in California, with a concentration in southern California (D. Constantine pers. comm.).

Surveys conducted in 1993-1995 (Pierson and Rainey 1996b, c) identified two possible localities for this species. A moribund specimen was found below a cliff face in San Diego County in April, 1991 (P. Brown pers. comm.). Acoustic and visual observations in November 1994 and May 1995 suggested that other individuals of *N. macrotis* were roosting at this locality (Pierson and Rainey 1996b, c). Recordings of echolocation calls possibly attributable to *N. macrotis* were also made at Barker Dam in Joshua Tree National Park on August 30, 1992 (Pierson and Rainey 1996b, c).

Recent records collected by the California Department of Health Services, although all of isolated and dead individuals, suggest that, though this species is rare, it has a scattered distribution throughout much of the state, and could be expected almost anywhere (D. Constantine pers. comm.).

Life History: Available information on the population biology of this species, although limited, suggests that adult females form nursery colonies, and give birth to a single young in June or July, with lactating females having been taken as late as mid-September (Barbour and Davis 1969, Constantine 1961).

Very little is known about the foraging ecology of *N. macrotis*. Ross (1967) found only macrolepidoperans (probably hawk moths) in the stomach of one individual. Easterla and Whitaker

(1972) examined 60 stomachs, and found that the most important food was large moths. Also occasionally included in the diet were crickets (Gryllidae), grasshoppers (Tettigoniidae), and flying ants (Formicidae).

Habitat: In the southwestern U.S., *N. macrotis* is primarily associated with arid, high relief landscapes, i.e., Big Bend National Monument in Texas or the canyonlands of southern Utah (Barbour and Davis 1969, Easterla 1973, Milner et al. 1990, D. Rogers pers. comm.). Easterla (1973) documented it in four plant communities -- arroyo, shrub desert, woodland, and moist Chisos woodland -- although the majority of animals were in the floodplain-arroyo association. Although it has been found at about 2,440 m elevation in New Mexico (Jones 1965), it is more typically detected below 1,800 m (Milner et al. 1990).

Relatively few roosts of *N. macrotis* are known. A colony of about 130 was discovered by Borell (1939) in the Chisos Mountains of Texas. The animals were in a horizontal rock crevice (ca. 15 cm wide and 6 m long), located about 12 m above a talus slope in a narrow, rocky canyon. Although animals have been detected in buildings and caves (Milner et al. 1990) -- two specimens from San Diego County were in buildings (Huey 1932, 1954b) -- the few colonies of this species that have been located in the southwestern U.S. have been in rock crevices in canyon settings (Milner et al. 1990). In Cuba, the species appears to roost in small groups and has been found in tree hollows (Silva Taboada 1979).

Status: Class II. Acoustic surveys were conducted from 1993-1995 at a number of localities throughout California (Pierson and Rainey 1996b, c). These yielded possible records of *N. macrotis* at one site in San Diego County and at Joshua Tree National Park, Riverside County. Thus, although this species may occur almost anywhere in the state, it is likely very rare. Also, since no reproductive females or juveniles have been identified in any of the published records, it still is not known whether this species breeds in California.

Alterations or disturbance of cliff habitat (i.e., water impoundment projects, highway projects, and recreational climbing) could potentially affect this species. Not enough is known regarding the habitat requirements of this species to identify other potential threats.

Management Recommendations: Additional surveys for this species (which could be conducted in the context of surveys for other species) are urgently needed, especially in the canyon areas of southern California (San Diego, Imperial, and Riverside counties). Acoustic sampling may be the most efficient and effective method detecting the presence of this species in an area. While molossids are generally readily detectable acoustically, they also display a large variability in their echolocation calls (Simmons et al. 1978). This interpretation of acoustic data should be undertaken with caution until the range of variation within potentially similar species is adequately characterized.

Pygmy rabbit, *Brachylagus idahoensis*

Paul W. Collins

Description: A small (230-295 mm TL) "peppery," grayish brown rabbit with short hind legs; hirsute short (67-76 mm) hindfeet; short (35-52 mm), rounded ears covered with silky pelage, both inside and out; and a short, unicolored tail (15-20 mm) which is dusky colored above and below (Orr 1940, Green and Flinders 1980a, 1980b). Pygmy rabbits have the smallest body mass of North America lagomorphs; adult females in California average 397.8 g (246-458 g) and males average 409.3 g (375-435 g) (Orr 1940). There is a single annual molt in August and September (Grinnell et al. 1930); the new pelage described as long, almost silky, and buffy gray on dorsal surfaces and white tinged with cinnamon buff on ventral surfaces (Green and Flinders 1980a, 1980b; Dobler and Dixon 1990). As a result of wear, this taxon undergoes a fairly substantial change in dorsal pelt color during the course of the year being pinkish-drab in the fall, silvery-gray in the winter, brownish-gray in the spring, and "burnt" grayish-brown in the summer (Grinnell et al. 1930). Pygmy rabbits are distinguished from *Sylvilagus* species by their smaller size (generally under 300 mm in total length), short hairy ears, and short, nearly unicolored tail, which is grayish both above and below (white below in other species of *Sylvilagus*) (Orr 1940, Ingles 1965, Jameson and Peeters 1988).

Taxonomic Remarks: Grinnell et al. (1930) placed the pygmy rabbit in the genus *Sylvilagus*, a decision followed by (Orr 1940), Hall and Kelson (1959), and Hall (1981). Green and Flinders (1980a, 1980b) placed them in the genus *Brachylagus*, a convention supported by morphologic (Kenner 1965) and genetic (Johnson and Wicks 1964, Johnson 1968, Robinson et al. 1984) analyses, and accepted by Wilson and Reeder (1993). In our view, the available data warrant being classified in the monotypic genus *Brachylagus*.

Distribution: Pygmy rabbits are confined to sagebrush dominated habitats in the Great Basin and contiguous intermountain areas of the western United States (Green and Flinders 1980a, 1980b). They range from southeastern Washington south through eastern Oregon and northeastern California to southern Mono County, California, eastward through central Nevada, western Utah to western Wyoming, and north to southwestern Montana and southern Idaho (Dobler and Dixon 1990). In California, they occur in eastern Modoc, Lassen, and Mono counties (Orr 1940, Severaid 1950, Jones 1957). The southern limit of their distribution in California is from the vicinity of Lake Crowley in southern Mono County (Jones 1957). Their known elevational range in California extends from approximately 4,800 ft at Goose Lake, Modoc County (USNM 13087; Grinnell 1933) to 8,374 ft at Bodie, Mono County (MVZ 109446; Severaid 1950). Pygmy rabbits are apparently not ubiquitous across their range, but instead exhibit a disjunct, spotty distribution (Dobler and Dixon 1990). They have declined in some areas of their historic range such as eastern Washington (Lyman 1991), Oregon (Weiss and Verts 1984), and California (Williams 1986).

Life History: California populations of the pygmy rabbit have not been well-studied. Information on their natural history is based on studies of populations outside of California (Green and Flinders 1980a, 1980b; Dobler and Dixon 1990). The pygmy rabbit is a shy, elusive species, spending much of the time under dense protective shrub cover or in burrows which it excavates. They are rarely seen more than a few feet from such refuge, rarely cross large areas of open ground (Bradfield 1975, Weiss and Verts 1984). Pygmy rabbits are active year round and are considered to be crepuscular; however, they can be found above ground any time of day (Dobler and Dixon 1990). This species is unique among rabbits in western North America in that it excavates its own burrow (Green and Flinders 1980a, 1980b). Burrows usually have a number of entrances, are constructed into a north or east facing slope (Wilde 1978), often located at the base of sagebrush patches (Green and Flinders

1980a, 1980b). In California, their burrows are generally less than 1 m long and up to 1.5 m deep (Grinnell et al. 1930, Orr 1940). Burrows are an important element of an individual's home range because they provide protection from predation and temperature extremes, and are probably used as nesting sites. Breeding occurs from late February to early May; litters of 5-8 young are born from March through August (Dobler and Dixon 1990).

Pygmy rabbit populations fluctuate, but there is no indication they show the multi-annual cycles like snowshoe hares. Annual adult mortality is high (88% for one study), with the majority of this occurring during the winter (Wilde 1978). Juvenile mortality is initially high with 50% of juveniles disappearing within five weeks of emergence (Wilde 1978). Pygmy rabbits have been reported at densities of 0.7-1.4 per ha in Utah (Janson 1946), and up to 45 per ha in prime habitat in Idaho (Green 1978). Home range characteristics have not been reported. This species apparently does not range far from its burrow entrance; most feeding activity is within 50 m of the burrow in the winter and slightly further in the spring (Janson 1946, Orr 1940). The maximum distance reported is 2.6 km (Green and Flinders 1981). Big sagebrush (*Artemisia tridentata*) is the dominant food source year-round (Green and Flinders 1980a, 1980b). The relative proportion of sagebrush consumed varies with season, with more consumed during the winter (comprising up to 99% of their diet) than summer (Green and Flinders 1980a, 1980b). Grasses constitute 30-40% of the mid-summer to fall diet along with a variety of forbs (Dobler and Dixon 1990). Predators of pygmy rabbits include bobcat (*Lynx rufus*), coyote (*Canis latrans*), weasel (*Mustela frenata*), badger (*Taxidea taxus*), red fox (*Vulpes vulpes*), owls and hawks (Green and Flinders 1980a, 1980b).

Habitat: Pygmy rabbits typically occur in dense, tall sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus* sp.), and bitterbrush (*Purshia tridentata*), in deep, friable soils (Orr 1940, Green and Flinders 1980a, 1980b, Dobler and Dixon 1990). At Mono Lake, they have been reported in willow (*Salix* spp.) and buffaloberry (*Shepherdia* sp.) thickets (Harris 1982). Dense stands of sagebrush along intermittent stream channels, fence lines, and in borrow ditches next to roads may serve as avenues for dispersal (Green and Flinders 1980a, 1980b). Suitable habitat for this species includes dense, tall sagebrush, deep soil suitable for burrowing, and good grass and forb cover for summer forage (Dobler and Dixon 1990). Characteristics of habitats inhabited by pygmy rabbits in Oregon and Idaho include high shrub height (56 to 84 cm), high shrub cover density (28.8 to 46%), and deep soils (Green and Flinders 1980a, 1980b; Weiss and Verts 1984). The depth and strength of soil were physical properties of soil that were associated with sites occupied by pygmy rabbits, and were probably related to excavation of burrows (Weiss and Verts 1984).

Status: Class II. Pygmy rabbits may be common at a few locations in the state, but have a restricted, spotty distribution, and tend to be uncommon throughout most of their California range. Pygmy rabbits require dense sagebrush, for both food and cover, and soft soils for burrowing (Chapman et al. 1990). They are vulnerable in California because of their restricted distribution, narrow habitat requirements, limited dispersal capabilities, small home ranges, and small, fragmented populations. The primary threat to this species comes from loss, degradation and fragmentation of sagebrush rangeland from overgrazing, agricultural conversions, sagebrush removal for range improvement, and wildfires (Dobler and Dixon 1990, Chapman et al. 1990). Populations situated on the edge of the species range, such as those in California, and populations which are small and/or fragmented, are particularly vulnerable to local extinctions resulting from demographic or genetically related stochastic events.

Large areas of the species historic range in California have been altered by intensive livestock grazing, dryland farming and irrigated agriculture. The removal of sagebrush to improve rangelands for livestock grazing has rendered many areas of sagebrush rangeland unsuitable for pygmy rabbits.

Chapman et al. (1990) state that cattle grazing "is incompatible with the conservation of pygmy rabbit habitat, except in areas that have become so open that grazing is likely to increase the sagebrush density." Heavy livestock grazing is known to increase the density of big sagebrush and reduce perennial grasses and forbs available to pygmy rabbits (Ellison 1960). Because cattle are known to congregate in tall stands of sagebrush during the summer seeking shade, protection from wind, and relief from insects, they tend to damage the structure of tall stands of sagebrush by trampling the understory, breaking off branches and opening the canopy, which in turn opens up the understory and results in a reduction in food and shelter for pygmy rabbits. Wildfires and brush clearing on rangelands also adversely affect sagebrush habitat for pygmy rabbits. Because of these alterations to the sagebrush community in California, pygmy rabbits are restricted in distribution. Weiss and Verts (1984) suggested that pygmy rabbit populations are susceptible to rapid declines and local extirpations, and that the fragmentation of sagebrush communities poses a threat to extant populations because of this susceptibility.

Pygmy rabbits are currently designated as a resident small game species in California. They can be hunted from July 1 through the last Sunday in January, with a bag limit of 10 per day in Lassen and Modoc counties, and five per day in Mono County. Although there is no estimate of the number of pygmy rabbits that are harvested annually as a result of this hunting season, the effect of hunting on pygmy rabbit populations in California is probably not significant. This is because hunters probably kill relatively few pygmy rabbits due in part to the rabbit's secretive habits, localized distribution, and tendency to rarely venture away from dense brush. Accurate data on the annual harvest of this species in California is needed, however, so that the Department can evaluate whether the current hunting program is adversely affecting remaining populations.

Management Recommendations: The first priority for this taxon is to gather more detailed data on its current distribution, abundance, population status, and precise habitat requirements in California. This should be followed by studies on its basic biology including breeding biology, demographics, and especially dispersal capabilities. Basic life history data specific to California pygmy rabbit populations are needed to help evaluate whether grazing and other types of habitat disturbances are adversely affecting extant populations. Research on the basic biology of the pygmy rabbit will provide information to develop appropriate long-term conservation and management measures. More detailed information on the ecology and biology of the pygmy rabbit will also help to more accurately determine the level of hunting that small, fragmented pygmy rabbit populations can sustain. An understanding of genetic variation present in fragmented populations of this taxon in California is needed to plan for the size and configuration of habitat patches required for maintaining genetically and demographically viable populations. Finally, State and Federal land and resource management agencies should consider the habitat requirements of *Brachylagus idahoensis* when evaluating activities such as grazing, brush clearing, and controlled burns proposed for lands within its the range. Protecting the densest deep soil sagebrush areas and surrounding buffer zones of several hectares is probably the most important element to ensure the survival of viable populations of the pygmy rabbit in California.

Sierra Nevada snowshoe hare, *Lepus americanus tahoensis*

Paul W. Collins

Description: A medium-sized (363-400 mm, TL) cinnamon-brown (summer pelage) rabbit with relatively short ears (76-99 mm); large, hirsute hindfeet (112-132 mm); and a short tail (25-40 mm) (Orr 1933, 1940, 1949). This is the smallest subspecies of snowshoe hare in western North America. The pelage is long, thick, and soft; there are two annual molts. In winter, individuals are more or less uniformly white (Orr 1940). Summer pelage is cinnamon-brown to brownish-black above and white beneath (Orr 1940, Hall 1946). The species is distinguished from *L. townsendii* by its smaller ears (less than 100 mm; slightly longer than the head), and smaller hindfeet (less than 138 mm) (Jameson and Peeters 1988). It is distinguished from *L. a. klamathensis* by its overall darker dorsal summer pelage with a contrasting blackish rump, other details of coloration, and skull proportions (see Orr 1933, 1940).

Taxonomic Remarks: The Sierra Nevada snowshoe hare was first described as a subspecies of *L. washingtonii* (Orr 1933) and later as a subspecies of *L. americanus* by Dalquest (1942).

Distribution: Sierra Nevada showshoe hares inhabit the mid-elevations of the northern and central Sierra Nevada from approximately Mount Lassen in southeastern Shasta County south through Yosemite National Park to Mono and Mariposa counties. They have also been recorded from Nevada in the general vicinity of Lake Tahoe (Hall 1946, Richardson 1954). The southern locality is north of Mammoth (Mono County: CSUH 2593). The elevational range is from 4,800 ft at Mineral (Tehema County: MVZ 35017) to approximately 7,000 ft near Donner Summit (Placer County: MVZ 20860). *L. t. tahoensis* typically occurs below 8,000 ft; however, its upper elevational limits are unknown. There are a number of apparent sightings from Yosemite National Park (NPS unpubl. data) at localities above 8,000 ft, although these have not been verified.

Life History: There is some anecdotal information on the natural history of the Sierra Nevada snowshoe hare (Grinnell et al. 1930, Orr 1940), but most of the information presented here is based on the literature of *Lepus americanus* (Keith 1981, Bittner and Rongstad 1982, Flux and Angermann 1990). Snowshoe hares are secretive, and usually observed when flushed. They typically spend the day in forms under evergreen bushes, dense thickets of willows, logs, or jumbled piles of fallen trees or shrubs (Bailey 1936). Snowshoe hares are active year-round and are most active at night and early morning, moving via runways to reach feeding areas (Flux and Angermann 1990). They seldom venture into open spaces or mature closed canopy conifer forests. Breeding occurs from early spring to late summer; litter size ranges from two to seven young, with an average of approximately three (Orr 1940, Zeiner et al. 1990). Two litters are produced annually, sometimes three (Keith 1981), usually in the female's second summer. Grinnell et al. (1930) and Orr (1940) reported embryo counts from three to five in Sierra Nevada snowshoe hares. Snowshoe hares in the southern range have smaller litters than those in the northern range (Keith et al. 1966). Pregnant females of *L. a. tahoensis* have been reported between May 7 and July 22; young have been observed from mid-June through mid-July (Grinnell et al. 1930, Orr 1940).

Snowshoe hares can show dramatic population fluctuations with a cycle of eight to ten years (Keith 1981). However, populations that occupy fragmented habitat in mountainous terrain such as *L. a. tahoensis* may not show dramatic population fluctuations (Keith 1981, Wolff 1981). Wolff (1981) attributed this to the high mortality of dispersing hares from preferred habitat into suboptimal and marginal habitats.

Densities range from 0.1 per ha to 11-23 per ha (Keith and Windberg 1978). Snowshoe hares spend

their lives in relatively small home ranges. Home ranges of snowshoe hares vary from 9.9 to 24.7 acres (4.0 to 10.0 ha) averaging 12.3 to 14.8 acres (5 to 6 ha) (O'Farrell 1965).

In the summer, snowshoe hares feed on various green succulent plants, grasses, sedges, ferns, and forbs (Bittner and Rongstad 1982). In the winter, their diet changes to bark and twigs of conifers, evergreen shrubs, and deciduous trees such as aspen (*Populus*), alder (*Alnus*), and willow (*Salix*) (Orr 1940, Ingles 1965). Primary predators of hares in the western United States are bobcats (*Lynx rufus*), red foxes (*Vulpes vulpes*), coyotes (*Canis latrans*), and several species of hawks and owls (Wolff 1981). Predators of *L. a. tahoensis* probably include bobcats (*Lynx rufus*), pine martens (*Martes americana*), long-tailed weasels (*Mustela frenata*), red foxes (*Vulpes vulpes*), coyotes (*Canis latrans*), mountain lions (*Felis concolor*) and great horned owls (*Bubo virginianus*). Hunting by humans is an additional mortality factor.

Habitat: In California, snowshoe hares are generally found above the Yellow Pine zone in Canadian and Hudsonian associations (Grinnell 1933), in an ecologic niche within the boreal life zone which is the high mountain counterpart to the riparian/brush community inhabited at lower elevations by the brush rabbit (Orr 1940). The Sierra Nevada snowshoe hare occurs in riparian communities characterized by thickets of deciduous trees and shrubs such as willows and alders (Grinnell 1933, Orr 1940, Williams 1986). In the vicinity of Lake Tahoe, it was reported in dense deciduous streamside vegetation, forest undergrowth, dense thickets of young conifers, especially firs where the branches droop to the ground, and patches of chaparral composed of *Ceanothus* and manzanita (*Arctostaphylos*) (Orr 1940, 1949; Hall 1946). During the summer, snowshoe hares in the Lake Tahoe area are associated with brush situated close to meadows or deciduous riparian vegetation rather than on ridgetops or brush-covered upper slopes (Orr 1940). In the Mount Lassen region, Grinnell et al. (1930) reported that snowshoe hares were uncommon, being infrequently encountered "among snow-brush thickets and small firs and in or near thickets of alders or willows in meadows."

Status: Class II. The population status of the Sierra Nevada snowshoe hare is poorly known. Its distribution is patchy, with populations common in some areas of the Sierra Nevada, especially in willow/alder riparian habitat. The subspecies is vulnerable to loss and degradation of riparian habitat due to logging activities, grazing, wildfires, conversion for agricultural, recreational or urban uses, and any other activities that remove or alter areas of brushy cover. It is a small game species and hunted from July 1 through the last Sunday in January with a bag limit of five per day or five in possession. Some are probably taken by hunters out of season because they are difficult to distinguish from white-tailed jackrabbits (which have no season or bag limit in California). The overall effect of hunting on fragmented populations of *L. a. tahoensis* in California is unknown, but is probably not a significant factor contributing to mortality rates in this taxon. The principal threats to the Sierra Nevada snowshoe hare come from destruction or alteration of habitat from logging activities, human settlements, and grazing activities.

Management Recommendations: The highest priority is for field studies on its current distribution, abundance, population status, habitat requirements, and numbers being harvested annually by hunters in California. The natural history of *L. a. tahoensis* is not well-known, especially its breeding biology, demographics, dispersal capabilities, and food habits. These data would improve the evaluation of current hunting quotas, and are essential to the development of long-term conservation and management measures. Finally, State and Federal resource management agencies in California should consider the habitat requirements of *L. a. tahoensis* in evaluating grazing, timber harvest, and controlled burns proposed for lands that they manage. Protection of brush and alder/willow riparian habitats within the range of the Sierra Nevada snowshoe hare is probably the most important element to ensuring their survival.

Point Arena mountain beaver, *Aplodontia rufa nigra*

Paul W. Collins

Description: A medium-sized (300-465 mm TL; 265-333 mm BL), stout, cylindrical muskrat-sized rodent with coarse pelage; furred, short (20-35 mm), cylindrical tail; small eyes; small round ears; short limbs of about equal length; forefeet with functionally opposed thumbs; long stiff rostral vibrissae; and a broad, massive, triangular shaped, laterally compressed skull which lacks postorbital processes. Weight (adult) from 900 to 1,100 g (Taylor 1918, Ingles 1965, Hall 1981, Jameson and Peeters 1988, Steele 1989, Steele and Litman 1994). The pelage is uniformly dark grizzled blackish-brown dorsally and ventrally with a white spot below each ear (Ingles 1965, Carraway and Verts 1993). Both sexes have similar coarse-textured, dull pelage with thick underfur and sparse guard hairs (Carraway and Verts 1993). Coastal individuals of this species tend to be darker than inland animals (Taylor 1918). This is the most strikingly marked subspecies of mountain beaver. It is distinguished from most other mountain beavers by its dark black and gray dorsal coloration and small size (Taylor 1918). It is distinguished from the Point Reyes mountain beaver (*A. r. phaea*), its closest living relative, by its slightly larger size, darker coloration, and cranial characters such as width of interpterygoid fossa, and outline and breadth of nasal bones (Taylor 1914, 1918).

Taxonomic Remarks: Mountain beavers (*Aplodontia rufa*) are a monotypic genus and species in the family Aplodontidae, order Rodentia, suborder Sciurognathi (Wilson and Reeder 1993). Taylor (1914) first described the Point Arena mountain beaver as a full species (*A. nigra*) based on its distinctive black coloration and geographic isolation. Later studies showing wide morphological variability and overlapping cranial characters with *A. r. humboldtiana* and *A. r. phaea* resulted in relegating it as a subspecies of *Aplodontia rufa* (Taylor 1918), a conclusion adopted by subsequent workers (Grinnell, 1933, Hall and Kelson 1959, Hall 1981).

Distribution: Based on 11 museum records and data from Camp (1918) and Taylor (1918), *A. r. nigra* is known from a 24 mi^2 area in the vicinity of Point Arena, Mendocino County. Colonies historically extended 6.8 mi (10.9 km) along the central Mendocino County coast from the town of Point Arena north to Alder Creek (Camp 1918). Museum specimens document its occurrence at Point Arena, Alder Creek, and Christiansen Ranch (Steele, 1989). Collection of two specimens at Christiansen Ranch in 1951 extended the known range of this taxon 5 mi (8 km) further north (Pfeiffer, 1954). Surveys in 1981 (Steele 1982), 1986 (Steele 1986a, 1986b), 1989 (Steele 1989), and 1991 (Horton and Franzreb 1991) located individuals at Mallo Pass Creek, Irish Creek, Alder Creek, Manchester State Beach (four sites), Lagoon Lake, Minor Hole Road, and Point Arena. These 10 populations were all located within the 12 mi (19 km) long stretch of Mendocino County coast line that the taxon was originally reported to inhabit. Only one (Alder Creek) of the four historic locales was found to still support a population of mountain beavers during the 1980s. Although Grinnell (1933) lists the elevational range of this taxon as below 500 ft (153 m), examination of recent and historic locality records reveal a slightly more restricted elevational range (e.g., from about sea level (13.7 m) at Manchester State Beach to 85.3 m at Christainsen Ranch) (Steele 1986b).

Life History: There are few life history data for the Point Arena mountain beaver. The following summary is based largely on data from other subspecies of *A. rufa* (Godin 1964), Feldhamer and Rochelle 1982, Steele 1986a, 1989, Zeiner et al. 1990, Carraway and Verts 1993). The principal sources used to construct the following life history account of the Point Arena mountain beaver were Steele (1986a, 1986b, 1989) and Horton and Franzreb (1991).

Home ranges of adults vary from 0.01 to 0.08 acres (Horton and Franzreb 1991) with no significant

difference between males and females (Martin 1971). While there is some overlap in mountain beaver home ranges, individuals vigorously defend their nests and burrows except during the breeding season (Steele 1986a, 1989). Underground tunnels are constructed within the home range, usually 6-12 in (15-30 cm) below the surface with numerous openings (Steele 1989). Portions of these tunnels are enlarged to accommodate nests and food storage areas (Camp 1918). The direction and extent of runways and the location of entrances, exits and nests are determined by local topography such as fallen logs, rocks, soil factors, the slope of a bank, and the location of food plants (Voth 1968). Nests are generally located at sites with good drainage, often under mounds, logs, uprooted stumps, or dense thickets (Steele 1989). An average of one or two individuals is found within a single burrow system (Steele 1986b).

The breeding season is limited. Parturition occurs in late February and March. Litter size is usually two to three, infrequently four or five, young per year following a 28-30 day gestation (Pfeiffer 1958). Females are monoestrous and all ovulate synchronously within a population during a 5-7 week period in mid-to-late winter (Pfeiffer 1958). Females reach sexual maturity in their second year (Pfeiffer 1958).

Mountain beavers require substantial daily amounts of drinking water and thermoregulate within a narrow range of mild ambient temperatures between 6 and 16^{o} C and reach their upper thermal tolerance limit at 30^{o} C (Johnson 1971, Kinney 1971). They are apparently unable to enhance evaporative water loss when heat-stressed (Goslow 1964, Johnson 1971, Kinney 1971). When surface temperatures are too warm, mountain beavers thermoregulate either by seeking refuge in their burrow or by orienting their body to maximize passive loss of body heat. Mountain beaver nests and burrow systems temper daily and seasonal changes in temperature and humidity. These osmotic and thermoregulatory limitations restrict mountain beavers to cool, moist areas and limit their surface activity to moderate temperature days and cool night-time hours (Dolph et al. 1962, House et al. 1963, Nungesser and Pfeiffer 1965, Schmidt-Nielson and Pfeiffer 1970, Johnson 1971, Kinney 1971, Steele 1986a, Horton and Franzreb 1991).

Another limiting factor for mountain beaver populations is the availability of protein for growth (Voth 1968). Steele (1989:26) suggests that this requirement for high protein content "may explain why mountain beaver growth pattern is usually slow and age of first reproduction is late." While mountain beavers are known to use virtually any green plants in their habitat for food and nesting material (Scheffer 1929), their preferred food is succulent herbaceous plant material and deciduous tree bark and leaves (Steele 1982, 1986a, Voth 1968). According to Voth (1968), mountain beavers utilize an uncontested niche by foraging on plant species normally toxic to many other vertebrates such as lupine (*Lupinus* sp.), larkspur (*Delphinium* sp.), foxglove (*Digitalis* sp.), thistle (*Cirsium* sp.), and nettle (*Urtica* sp.). *A. r. nigra* utilizes most of the understory plants in its habitat, but prefers succulent herbaceous vegetation such as sword fern (*Polystichum munitum*), cow parsnip (*Heracleum*), salal (*Gaultheria shallon*), nettle, and salmonberry (*Rubus spectabilis*) (Camp 1918, Steele 1982, 1986b, 1989). The Point Arena mountain beaver forages nocturnally (Steele 1986b).

There are no data available on population densities of the Point Arena mountain beaver. Population densities for other mountain beaver subspecies range from 1.4 to 2.2 per acre (Neal and Borrecco 1981, Lovejoy and Black 1979) and up to 9 animals per acre (Voth 1968). Based on surveys conducted between 1981 and 1991, Steele (1989:7) reports that the Point Arena mountain beaver "exists as small disjunct populations occupying relatively small areas." Steele (1986b, 1989) estimated that the number of individual Point Arena mountain beavers per site ranged from 3 to 10 or more, for an overall population estimate of 100 individuals (Horton and Franzreb 1991). He estimated that *A. r. nigra* occupied roughly 24 acres of approximately 100 acres of available habitat

and that sites varied in size from 3.7 to 19.8 acres (Steele 1986b, 1989, Horton and Franzreb 1991).

Habitat: Mountain beavers occur in densely vegetated areas along the Pacific Coast and Sierra Nevada which receive heavy rainfall (Feldhamer and Rochelle 1982, Steele 1986a). According to Grinnell (1933:195), the Point Arena mountain beaver "inhabits wet ravine sides heavily clothed with thimble-berry and associated plants." *A. r. nigra* populations occur on steep, north-facing slopes of ridges and gullies near the coast in the vicinity of Point Arena (Camp 1918, Steele 1986b). Consistent features of Point Arena mountain beaver habitat included an abundant supply of food plants which usually formed an impenetrable thicket, and moderately deep, firm, well drained soil (Steele 1989). The ten extant Point Arena mountain beaver populations were found in four types of habitat including coastal scrub, stabilized dunes (coastal strand), coniferous forest, and riparian (Horton and Franzreb 1991). Coastal scrub was the characteristic habitat utilized by mountain beaver populations at Point Arena, Minor Hole Road, Alder Creek, Lagoon Lake, and Mallo Pass Creek (Steele 1986b). The Irish Creek site was vegetated with a coniferous overstory composed of Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*) and Bishop pine (*Pinus muricata*), and an herbaceous understory consisting of elements from both riparian and coastal scrub habitats (Steele 1986b). Of the four mountain beaver populations at Manchester State Beach, two were situated in coastal scrub and two were in an area of stabilized dunes (Steele 1986b). The two populations in coastal strand were less sheltered than other *A. r. nigra* populations; however, strong winds and a persistent marine influence did prevent drastic fluctuations in temperature at these two sites (Steele, 1986b).

Status: Class I. Since 1986, the Department has listed this taxon as a highest priority Species of Special Concern (Williams 1986). Because of its "limited distribution (i.e., 10 sites), narrow physiological habitat tolerances, small overall population number (100 individuals), and threats of habitat loss from urban development, pesticide application, predation by feral animals as well as house pets, and human disturbance" the USFWS listed *A. r. nigra* as an Endangered species (Horton and Franzreb 1991:64721). Given these threats and the fact that only about 100 Point Arena mountain beavers remain on about 100 acres of habitat at 10 small (3 to 20 individuals per site), disjunct sites, this taxon is facing imminent extinction and appears to meet the criteria for State-listing as Endangered.

The most important threat to the species is existing and ongoing loss and fragmentation of habitat to urban and agricultural uses. This loss of habitat is the direct result of construction of roads, new homes, and facilities, as well as loss and degradation of habitat from brush clearing, and livestock grazing (Horton and Franzreb 1991). Roughly half of the ten remaining Point Arena mountain beaver populations occur on California Department of Parks and Recreation lands. All extant populations are threatened with inbreeding depression that could threaten long-term survival. Natural catastrophic events such as wildfires (see also species account for *A. r. phaea*), floods, disease, drought, or earthquakes could eliminate all individuals from a number of these already depressed populations to the point where this taxon could not recover.

The Point Arena mountain beaver is also being adversely affected by the following factors: reduction in the quality and quantity of its native habitats as a result of the uncontrolled expansion of exotic plants such as gorse (*Ulex europaeus*), pampas grass (*Cortaderia selloana*), and broom (*Cytisus* spp.); loss of individuals due to road kills, rodent control trapping and poisoning, and predation by feral and non-feral house pets; decline in habitat quality at a number of the remaining *A. r. nigra* populations from dumping of trash and human disturbance; and habitat fragmentation that eliminates the opportunity for populations to expand into unoccupied favorable habitats or for genetic exchange to occur between neighboring population sites (Steele 1986b, Horton and Franzreb 1991).

Management Recommendations: Detailed field surveys should be conducted of all extant populations and remaining adjacent suitable habitats, and of other potential habitat along the central Mendocino County coastline. Because a significant portion of the range of this taxon is under private ownership, opportunities of purchasing habitat or protecting it through conservation easements should be explored. Also, a habitat enhancement program should be initiated to protect remaining habitat from grazing pressure and future urban and agricultural developments, including the establishment of habitat buffers around known populations. A biochemical study of all extant populations of this taxon is needed to better define the genetic distinctiveness of *A. r. nigra* and to evaluate the genetic health of remaining populations. Steele (in review) recommended that *i*) long-term monitoring of existing populations be undertaken, and *ii*) recovery plans be prepared and implemented, that include consideration of translocation of individuals to maintain existing populations or create new populations in unoccupied habitat within its historic range.

Point Reyes mountain beaver, *Aplodontia rufa phaea*

Paul W. Collins

Description: This is a medium-sized (300-465 mm TL), stout, compact, cylindrical muskrat-sized burrowing rodent with coarse textured pelage; a well-furred, short (20-35 mm), cylindrical tail; small eyes; small round ears; short limbs of about equal length; forefeet with functionally opposed thumbs; digits with long curved claws; long stiff rostral vibrissae; and a relatively broad, massive, triangular shaped, laterally compressed skull which lacks postorbital processes (Taylor 1918, Ingles 1965, Hall 1981, Jameson and Peeters 1988, Steele 1989). Pelage is uniformly dark grizzled blackish-brown both dorsally and ventrally with a white spot below each ear (Ingles 1965, Carraway and Verts 1993). Both sexes have similar coarse-textured, dull pelage with thick underfur and sparse guard hairs (Carraway and Verts 1993). Coastal individuals of this species tend to be darker than inland animals (Taylor 1918). The Point Reyes mountain beaver is the smallest subspecies of mountain beaver known and is the lightest colored of the races found along the Pacific Coast (Merriam 1899a, Taylor 1918). Point Reyes mountain beavers average 308 mm (range 280-344 mm) in total length (Taylor 1918). *A. r. phaea* can be distinguished from the Point Arena mountain beaver (*A. r. nigra*), its likely closest relative, by its slightly smaller size, and lighter grizzled brown coloration (Taylor 1918). Cranial features such as a short incisive foramina, a narrow interpterygoid fossa, and the outline and breadth of its nasal bones are characters which distinguish the Point Reyes mountain beaver from other mountain beaver subspecies except for *A. r. nigra*, which it resembles cranially (Merriam 1899a, Taylor 1918).

Taxonomic Remarks: General taxonomic remarks made for *A. r. nigra* also apply to this taxon. Citing its small size, Merriam (1899a) described the Point Reyes mountain beaver as a species (*A. nigra*). Taylor (1918) placed it as a subspecies of *A. rufa*, a conclusion followed by subsequent authors (Grinnell 1933, Hall and Kelson 1959, Hall 1981). The karyotype of *A. r. phaea* (2n = 46, six pairs of metacentric and 16 pairs of submetacentric autosomes, and a submetacentric Y-chromosome) is the same reported for *A. r. californica* (McMillin and Sutton 1972). No genetic studies were available at the time of this review.

Distribution: Point Reyes is the southernmost location along the coast which supports mountain beavers. Based on museum specimens, the elevational range of *A. r. phaea* is from ca. 40 ft at Limantour Bay to approximately 1,000 ft at Mount Wittenberg. Historically, this taxon was distributed within an area of approximately 110 mi^2 (285 km^2) in western Marin County (Camp 1918, Taylor 1918), extending from approximately 6 mi (9.6 km) west of Inverness east to Lagunitas and south to four mi (6.4 km) south of Olema (Grinnell 1933, Steele 1989). A local trapper from Inverness reported in 1918 to Camp (unpubl. field notes) that mountain beavers were in every gulch west of Inverness Ridge between Brions and Division Ranchos south to Bolinas Bay, and were less common east of Inverness Ridge (Steele 1989). Museum specimens (n=109) are known from 16 localities in western Marin County: eight locations between 0.75 and 6 mi (1.2 and 9.6 km) W of Inverness (Murphy and Heims Ranches), Marshall Ranch, Point Reyes (21 specimens from unspecified locations), 3 mi (4.8) NE of Point Reyes, Limantour Bay, Lagunitas, three locations from just W to 9 mi (14.4 km) W of Olema (Bear Valley and Tevis Ranches, and Mount Wittenberg), and 4 mi (6.4 km) S of Olema (Williams 1986, Steele 1989). With the exception of Lagunitas, all of the specimen-vouchered localities for this taxon are currently under the jurisdiction of the Point Reyes National Seashore.

All known extant populations of this taxon occur on lands administered by the Point Reyes National Seashore. Currently there are no known extant populations of this taxon situated off the peninsula on privately held lands east of Inverness Ridge. Four extant populations which Steele (1989)

reported finding in 1981 include: a north-facing slope above Rogers Ranch and the Sir Francis Drake Highway, just off the road to Mount Vision, on a north-facing slope above Home Ranch Creek, and on a steep south-facing slope above Glenbrook Creek (Steele 1989). Although Steele (1989) reported finding several old mountain beaver burrows in the Five Brooks area, he did not find any active colonies on the Point Reyes peninsula south of Glenbrook Creek. Based on sighting and field survey data contained in files at the Point Reyes National Seashore headquarters, Evens (1988) reported populations occur on moist fern-covered slopes from "Tomales Point south along the northeast facing slopes of Inverness Ridge to Arroyo Hondo at Palomarin". Dense colonies of this taxon occur in the vicinity of Mount Vison, Point Reyes Hill, Laguna Canyon and Chute Gulch, with incidental observations from Spring Valley, in the Ledum Swamp drainage system, and on the northeast slope of Point Reyes Hill. Evens (1988) also reports "an extensive colony in Devils Canyon is nearly continuous with the Home Ranch colony along Home Ranch Creek." Based on data presented in Evens (1988) and on more extensive surveys of the Point Reyes National Seashore (G. Fellers pers. comm.), it appears that the Point Reyes mountain beaver has a larger geographic range and is more common on the Point Reyes peninsula than reported by Williams (1986) or Steele (1989).

Life History: The life history of the Point Reyes mountain beavers is similar to that of the Point Arena mountain beaver (Camp 1918, Pfeiffer 1958, Steele 1989). Breeding occurs during a short 5-7 week period in mid- to late winter. A single litter is produced in late February following a gestation of 28-30 days. Based on uterine scars, the average liter size is 2.4-2.8 young (Pfeiffer 1958).

Like the Point Arena mountain beaver, Point Reyes mountain beavers are restricted to cool, moist areas which have a year-round supply of water, and tend to limit their surface activity to moderate temperature days and cool nighttime hours. The burrow system excavated by *A. r. phaea* is elaborate and contains a large number of burrow entrances connected to one another by passages by from 6-18 in (15-46 cm) underground, several food storage chambers and a nest chamber (Camp 1918). *A. r. phaea* is active year-round (Camp 1918), and is largely nocturnal, although it is known to occasionally forage during daylight (Camp 1918, Steele 1989). Individuals generally take short foraging trips and return to the burrow with clipped vegetation (Steele 1989). The Point Reyes mountain beaver eats various succulent herbaceous vegetation including: salal (*Gaultheria shallon*), cow parsnip (*Heracleum*), sword fern (*Polystichum munitum*), and stinging nettle (*Urtica*), which make up a major part of their diet; and bracken fern (*Pteridium aquilinum*), thimbleberry (*Rubus parviflorus*), salmonberry (*Rubus spectabilis*), poison oak (*Toxicodendron diversilobum*), Oregon grape (*Berberis*), mint roots, red alder (*Alnus rubra*) and willows (*Salix*), which play a lesser role in their diet (Camp 1918, Steele 1989). In areas of dense coastal sage scrub, considerable time is spent foraging in low trees and shrubs to clip new growth (Steele 1989).

Densities are expected to be similar to those recorded for other mountain beaver subspecies (1.4-2.2 individuals per acre). Based on burrow counts of four populations, Steele (1989) estimated that the number of mountain beavers per site ranged from 0.1 to 3.0 individuals per acre (0.3 to 7.5 per ha) for an overall population estimate of 31-38 or more individuals. It is likely that the population estimate for this subspecies is probably much higher than the 31-38 individuals that Steele (1989) estimated were present during field surveys in 1981.

Habitat: According to Grinnell (1933:195), the Point Reyes mountain beaver inhabits "hillside seepage areas overgrown to sword fern and thimble-berry." Camp (1918) mentioned the apparent association of this taxon with north-facing slopes. Hooper (1944) noted that *A. r. phaea* was found on cool moist slopes with rich humus soils with extensive and continuous heavy chaparral or clumps

of sword fern. According to Evens (1988), favorable habitat includes "moist, sloped soils with dense clumps of sword fern growing in easily excavated, humus-rich soil." Four extant populations were located in sheltered gulches or on steep, north-facing slopes with well drained easily excavated soils vegetated with dense stands of vegetation (Steele 1989). Three of the extant sites were located adjacent to perennial streams and were vegetated with coastal scrub dominated by an overstory of salmonberry, coyote brush (*Baccharis* sp.), poison oak (*Toxicodendron diversilobum*), and cow parsnips (Steele 1989). The fourth extant population was located along the northwest slope of Mount Vison within a Bishop pine forest (Steele 1989). This population was situated within a break in the forest canopy which supported a denser understory growth of sword fern, elderberry (*Sambucus*), salal, and stinging nettle (Steele 1989). Thus the characteristic habitat of the Point Reyes mountain beaver includes moist, well drained, north-facing slopes vegetated with an overstory tangle of shrubs, and a dense understory of sword fern, bracken fern (*Pteridium aquilinum*), salal, stinging nettle and other low plants characteristic of the coastal scrub community.

Status: Class I. The Point Reyes mountain beaver has a very restricted range, has lost a portion of its historically occupied habitat to urban and agricultural developments, and lost approximately 60% of its known populations to the 1995 Mount Vison Fire. Today, much of its 110 mi^2 (285 km^2) historic range is no longer suitable habitat. Although extant populations are afforded some protection as a result of occurring on lands administered by Point Reyes National Seashore, not all of the private lands on the Point Reyes Peninsula are administered by the Federal Government, and feral and exotic herbivores such as axis and fallow deer and cattle continue to degrade mountain beaver habitat within the Seashore. Since Europeans settled the Point Reyes area, native habitats have been extensively modified. Bishop pine and Douglas-fir forests have been intensively harvested for timber, large expanses of coastal brush have been burned and cleared by ranchers to provide grassy fields for livestock grazing and agricultural planting, and native perennial grasslands have been replaced with introduced annual grasslands as a result of intensive livestock grazing (Evens 1988). Suitable coastal scrub habitat for *A. r. phaea* is reduced and fragmented (Steele 1989). Habitat east of Inverness Ridge continues to be heavily impacted from development of private residences, and from intensive grazing by dairy cattle. As a result, there are currently no known extant colonies of Point Reyes mountain beavers east of the Inverness Ridge. It is unknown whether the National Park Service's current management practices for feral and exotic herbivores are having a positive or negative effect on this taxon. Also, there are currently no management plans address the conservation needs of this species at the Point Reyes National Seashore, the Samuel P. Taylor and Tomales Bay State Parks, or the Golden Gate National Recreation Area. This taxon continues to be threatened by degradation of its coastal scrub habitat from feral and exotic herbivore grazing, and from habitat conversion to urban and agricultural uses.

In October 1995, the Mount Vison fire burned more than 12,300 acres of the Point Reyes peninsula (Stallcup 1995). This fire destroyed 40% of the known habitat of the Point Reyes mountain beaver as well as about 60% of the known populations (G. Fellers pers. comm.). Although recent surveys of the burn area revealed that mountain beavers were more widespread than previously thought, no mountain beavers have been found within the burn area (G. Fellers pers. comm.). Until the Mount Vison fire, it appeared that within the Seashore, the trend of reduction in *A. r. phaea* habitat from feral herbivore grazing had been reversed. However, the recent wildfire demonstrates the susceptibility of Point Reyes mountain beavers to catastrophic events such as fire. Due to the decline in available habitat and to the loss of a substantial portion of the known populations of this taxon to fire, the Point Reyes mountain beaver could be threatened with possible extinction in the future, if special protection and management efforts are not implemented to help protect remaining populations.

Management Recommendations: A management plan for the Point Reyes mountain beaver should be prepared and implemented by the National Park Service. Steele (in review) recommended that *i*) long-term monitoring of existing populations be undertaken, and *ii*) a recovery plan should be prepared and implemented, and should consider artificial movement of individuals to maintain existing populations or create new populations in unoccupied habitat within its historic range. Until an area-wide survey for the species is completed, remaining areas of suitable north-facing coastal scrub habitat in the Point Reyes area should be protected or preserved to ensure this taxon's survival. Impact analyses of all proposed developments or changes in land use should be prepared that analyze adverse affects on the species and their consistency with the recovery plan. The effects of feral and exotic herbivore grazing (cattle, fallow and axis deer) on habitat should also be assessed. If feral herbivore grazing is found to be detrimental, grazing should be eliminated from areas that currently contain restricted populations of this taxon. A biochemical study of extant populations of *A. r. phaea* should be undertaken to investigate the evolutionary relationship of this taxon with other coastal mountain beaver populations, and to evaluate the potential problem of inbreeding of remaining populations.

San Bernardino flying squirrel, *Glaucomys sabrinus californicus*
Philip V. Brylski

Description: This is a medium-sized squirrel; TL about 260 mm. Maximum weights observed in one study of *G. s. californicus* were 140 g for females and 158 g for males (Butler et al. unpubl. report). Flying squirrels are nocturnal and secretive and therefore rarely observed, but are easily distinguished from other sympatric arboreal squirrels (*Sciurus* and *Tamiasciurus*) by the presence of a furred patagium connecting the fore and hind limbs from ankle to wrist.

Taxonomic Remarks: The San Bernardino flying squirrel was described by Rhoads (1897) based on specimens collected near Squirrel Inn, San Bernardino Mountains at 1585 m. Recent studies based on mitochondrial DNA indicate that populations of *sabrinus* on the west coast (based on samples from populations in southern California and coastal Oregon and Washington) are genetically distinct from *sabrinus* east of the Rocky Mountains and may warrant status as a separate species (Arbergast unpubl. manuscript). Additional genetic studies of California *sabrinus*, including *s. californicus* are planned (P. Weigl pers. comm.).

Distribution: The San Bernardino flying squirrel historically occurred as three isolated populations at the southern edge of the range of *sabrinus* in the forests of the San Gabriel, San Bernardino, and San Jacinto mountains. Museum records are restricted to several localities in the San Bernardino Mountains and a single locality (Idyllwild) in the San Jacinto Mountains. Vaughan (1954a) reported *sabrinus californicus* from the San Gabriel Mountains, but there apparently are no museum records for that locality. The movement of individuals among populations is interrupted by the Cajon Pass (between the San Gabriel and San Bernardino mountains) and the San Gorgonio Pass (between the San Bernardino and San Jacinto mountains). Its nearest conspecific population is 265 km to the north in the Sierra Nevada. There is no current information on the San Gabriel and San Jacinto mountains populations. Flying squirrel surveys in the San Bernardino National Forest, based on live-traps and identification of flying squirrel remains in pellets collected from nest sites of California spotted owl (*Strix occidentalis occidentalis*), indicate that flying squirrels are found in forests between approximately 1,200 and 2,500 m elevation. The distribution is fragmented by natural variation in vegetation cover (e.g., along the Santa Ana River wash), an apparent preference for high elevation habitats, and barriers such as forest cover loss resulting from ski developments and the 1978 Big Bear fire.

Life History: There have been few studies on the San Bernardino flying squirrel. This summary of the species' biology is based on studies on various subspecies of the northern flying squirrel, *Glaucomys sabrinus* (Wells-Gosling and Heaney 1984). Northern flying squirrels are thought to be active year-round, nesting in both tree cavities and stick nests. Tree cavities and stick nests used by *californicus* were found in live trees and snags of Jeffrey pine (*Pinus jeffreyi*) and white fir (*Abies concolor*) (Butler et al. unpubl. manuscript). Cavity nesting is thought to be more important during the winter, when groups of squirrels may nest together to conserve heat. Breeding generally occurs in April and May, with two to four young produced 37 to 42 days after mating (Muul 1969, Soper 1973). Juveniles have been reported in the fall and winter, indicating that reproduction can potentially occur year-round, given the appropriate environmental conditions.

Food items of northern flying squirrels include acorns and other nuts, conifer and hardwood seeds, wild fruits, insects, fungi and lichen, and tree sap. It is not known whether the food habitats of *californicus* differ from this, nor is the relative importance of these kinds of diet items known. In a study of flying squirrels in northeastern California, fungi and lichens were common diet items, as revealed by pellet analysis, and captive animals showed a preference for fungal sporocarps (fruiting

bodies; Waters and Zabel unpubl. manuscript). In the same study, the density of flying squirrels was correlated with the abundance of fungal sporocarps in the leaf litter and upper surface of mineral soil.

Flying squirrels are important prey items for the Threatened spotted owl in northern California, and have been detected in the pellets of southern spotted owls in the San Bernardino Mountains (Butler et al. unpubl. manuscript).

Habitat: *G. sabrinus* occurs in a range of coniferous and deciduous forest, including riparian forests. The San Bernardino flying squirrel has been reported in mixed conifer forests of Jeffrey pine and white fir. Sumner (1927) reported the habitat as white fir and black oak (*Quercus kelloggii*) woodlands. The literature contains different conclusions on the importance of old growth versus second-growth stands and the density of suitable tree cavities as habitat parameters that influence squirrel densities. In the fir forests of northeastern California studied by Waters and Zabel (unpubl. manuscript) flying squirrels were not old-growth specialists, although squirrel densities were higher in old growth than in young stands, a result also reported by Carey et al. (1992) and Rosenberg and Anthony (1992). In the unpublished study by Waters and Zabel, flying squirrel densities were not correlated with the densities of tree cavities. This result is expected in areas with high cavity densities and should not be generalized across the species' range. The Appalachian flying squirrel (*G. s. coloratus*) of the eastern U.S. prefers ecotones and mosaics of conifer and hardwood forest (Weigl and Knowles unpubl. manuscript). Whether this characterizes the habitat preferences of *s. californicus* is unknown.

Populations of northern flying squirrels are adversely affected by habitat fragmentation. Rosenberg and Raphael (1984) found that in northwestern California, the abundance of squirrels increased with stand size, they were generally absent in stands smaller than 20 ha, and approximately 75% of stands over 100 ha had flying squirrels. An additional problem with fragmented habitats is the constraints that open spaces pose to the movements of individuals and the colonization of unoccupied habitat patches. Mowrey and Zasada (1982) reported an average gliding distance of about 20 m in *sabrinus*, with a maximum of 48 m, and concluded that movements are unimpeded in areas with average openings of 20 m and occasional openings of 30 to 40 m.

Status: Class II. There are few data available on populations of *G. s. californicus*. This species is included on the Special Concern list because of its occurrence in restricted, disjunct populations, a lack of information on the two smallest populations, comparatively low densities of individuals in populations that have been studied, and ongoing habitat fragmentation as a result of development and forest practices within the species range. The species historically existed in three disjunct populations in the San Gabriel, San Bernardino, and San Jacinto mountains. There is no information available on the flying squirrels in the San Gabriel or San Jacinto mountains. In studies of the San Bernardino Mountains population, the frequency of captures (expressed per 1,000 functional trap nights) and the densities of flying squirrels (generally not calculated due to low numbers of captures), were substantially lower compared to flying squirrel studies in northern California and Oregon. The population densities of *sabrinus californicus* are comparable to densities observed in the Federally Endangered Appalachian Mountains flying squirrel (*G. s. coloratus*). The distribution of the San Bernardino population is fragmented by natural variation in vegetation cover (e.g., north and south of the Santa Ana River wash), an apparent preference for high elevation habitats, and barriers such as forest cover loss resulting from the 1978 Big Bear fire and ski developments. The San Bernardino population is at risk of being further subdivided by long-term plans for ski resort expansions. Due to its proximity to the Los Angeles basin, the recreational uses of the San Bernardino Mountains are expected to intensify for the foreseeable future. Impacts from recreational activities, and attendant development pressures, are expected to increase in the future. The restricted

distribution of *G. s. californicus*, its relatively low densities, its susceptibility to population subdivision caused by deforested swaths as narrow as 30 m wide, and identified threats are the reasons for its Special Concern status.

Management Recommendations: Most or all of the habitat of *G. sabrinus californicus* appears to be within the San Bernardino National Forest. The USFS habitat management recommendations are to restrict development to the existing urban centers within the forest, and to maintain forest cover by maintaining mixed age and species stands with target densities of snags and logs. The Interim Habitat Management Guidelines (IHMG) for the San Bernardino flying squirrel call for a minimum density of ten snags per 5 acres, giving preference to trees over 20 in (51 cm) dbh, and a minimum of nine down logs of all age and decay classes per acre (Butler et al. unpubl. manuscript). Field studies are needed on the distribution and abundance of *G. sabrinus californicus* in the San Gabriel and San Jacinto mountains. Additional studies on the distribution and abundance of flying squirrels in the San Bernardino National Forest are needed to guide the implementation of these policies with regard to flying squirrel management. An important question for further study is whether the flying squirrel population is currently fragmented (e.g., by barriers such as treeless areas), and whether extant populations are susceptible to further fragmentation as a result of current land use practices. Enforcement of the IHMGs should be closely monitored to maintain travel corridors that connect large but disjunct habitat patches. Additional genetic studies of *G. sabrinus californicus*, are needed to determine whether the San Bernardino flying squirrel is genetically unique or highly differentiated from other populations, and to obtain estimates of gene flow between known populations.

Palm Springs ground squirrel, *Spermophilus tereticaudus chlorus*

Philip V. Brylski

Description: This is a small gray-olive or cinnamon ground squirrel with a long, round tail. The pelage is pale, without spots, and blends with sandy desert soils. TL 204-278 mm, tail length 60 to 112. Body mass varies with season, but ranges from 110 to 170 g. The head is small, rounded, ear pinnae are reduced, eyes are large, and forefeet claws are heavy and recurved. There are two annual molts, once in spring, the other in late summer. The skull of *tereticaudus* is usually smaller than that of *mohavensis* (34 to 39 mm versus 38 to 40 mm, respectively) (Ernest and Mares 1987).

Taxonomic Remarks: This species was first described by Elliot (1901) based on specimens collected in Palm Springs. *S. tereticaudus* and *S. mohavensis* differ karyotypically and genetically, but hybridize where their ranges overlap in the western Mojave Desert (Hafner and Yates 1983). The intergradation between *S. t. chlorus* and *S. mohavensis* was recognized by Elliot (1904). They are considered separate species (Grinnell and Dixon 1918, Hafner and Yates 1983). No genetic research or recent taxonomic revisions have been undertaken for *chlorus* and other races of *tereticaudus*.

Distribution: This species occurred historically in Riverside County in the Coachella Valley from the San Gorgonio Pass area at Whitewater Station and Windy Point, east and south through the Coachella Valley to Mecca.

Life History: This discussion is based on various studies of the natural history of *S. tereticaudus*, few aspects of which have addressed in *chlorus*. With regard to annual patterns, animals are inactive from August until about January, during which time they remain in their burrows most of the time. The species probably does not hibernate, but enters torpor (inactivity with reduced body temperature). *S. mohavensis* differs in the respect that it is a true hibernator. With regard to daily patterns, activity in *S. tereticaudus* peaks during the morning and late afternoon, apparently with more activity on overcast afternoons (references in Ernst and Mares 1987).

The Palm Springs ground squirrel and other round-tailed ground squirrels are omnivorous. Diet has been reported to include leaves, flowers, bark and bean pods of mesquite (*Prosopis* sp.), creosote fruits (*Larrea tridentata*), cultivated plants, seeds of annuals, carrion, ants, termites, grasshoppers. The diet of *S. tereticaudus* in Death Valley consisted of mostly of green vegetation, with lesser amounts of seeds and insects. The proportion of green vegetation in the diet was highest in summer (100%); the proportion of seeds was highest in winter (35%). They are agile climbers. Like other herbivores, they spend a large amount of their time foraging (approximately 50% according to Dunford (1977). *S. tereticaudus* probably obtains its physiological water requirements from leafy and succulent vegetation, and, in the absence of vegetation, apparently requires water.

Breeding occurs from early spring through June (pregnancy in early March, parturition in April/May, lactation through June) (Ernst and Mares 1987). Average reported litter size is 6.5 (range, 1-12). In one study, most litter size variation was correlated with rainfall (Reynolds and Turkowski 1972); increases in winter rainfall were accompanied by increases in litter size. The gestation period is from 25 to 35 days (the exact gestation is uncertain). In *S. t. neglectus* in southern Arizona, juveniles molted to adult-like pelage in late June (Dunford 1975).

In Arizona, densities of *S. t. neglectus* averaged 5.3/ha and 40/ha in two study sites, with a peak post-weaning density of 210/ha (Drabek 1973, Dunford 1977). Such densities are not sustainable, but they indicate the species is capable of large population sizes. At the same Arizona population,

juvenile females generally stayed in their natal territory and juvenile males dispersed.

Habitat: *S. tereticaudus* inhabits sandy arid regions of Lower Sonoran Life Zone. Its scrub and wash habitats include mesquite- and creosote-dominated sand dunes, creosote bush scrub, creosote-palo verde and saltbush/alkali scrub (Ryan 1968). Substrates include wind-blown sand, coarse sand, and packed silt with desert pavement (Ryan 1968). In areas of overlap with *Ammospermophilus leucurus*, *S. t. chlorus* occurs in the sandier floodplain and *leucurus* occurs in rockier habitats. Burrows are dug at bases of shrubs, often creosote bushes. They may also use the burrows of other rodents. They show semi-colonial social organization, but maintain burrows much of the year. Burrows may be shared from winter to early spring, but not while females are pregnant or after young are weaned.

Status: Class II. Substantial loss of habitat to agricultural, suburban, and urban land uses has occurred within the species' historic range. Habitat loss has been high in historic sandy habitats in the western half of the valley, generally west of Highway 10 and from Indio south through Coachella, Thermal, and Mecca to the north end of the Salton Sea. Suitable habitat remains along the Whitewater River northeast of Palm Springs and east of Highway 10 from north of Indio to Desert Hot Springs and North Palm Springs.

Management Recommendations: Habitat protection is of the highest priority but currently, the species' distribution is poorly known. *S. tereticaudus chlorus* should be a priority target species in the Coachella Valley habitat conservation planning effort, now in the early stages of preparation. For this species to be effectively addressed under the HCP, studies are needed on the squirrel's distribution, abundance, and habitat requirements. It is likely that the cobbly soils and associated vegetation on the margins of the valley floor provide low to moderate habitat quality for the Palm Springs ground squirrel. The results of such studies are basic to designing regional conservation plans. A standard survey protocol should be adopted for *chlorus*, based on results of a field study comparing live-trapping and visual/auditory surveys techniques for providing indices of presence/absence and relative abundance.

San Bernardino kangaroo rat, *Dipodomys merriami parvus*

Philip V. Brylski

Description: A small, dark-colored four-toed kangaroo rat, with TL 230 to 235 mm, BL 95 mm; weight about 35 g. Dorsal pelage is dark and weakly ochreaceous with a heavy overwash of dusky. It is the only kangaroo rat found in the San Bernardino Valley, west of San Gorgonio Pass and south of Cajon Pass (see distribution). *D. m. parvus* is considerably darker and redder than *D. m. merriami*, which occurs to the north and east in the Mojave and Colorado deserts, respectively, and is darker, but not redder than *D. m. collinus*, which occurs to the south.

Taxonomic Remarks: One of the most differentiated subspecies of *D. merriami*, and may be a distinct species (Lidicker 1960). It was originally described as *D. parvus* (Rhoads 1893), and later relegated to a subspecies of *D. merriami* (Elliot 1901). *D. m. parvus* may intergrade with *D. m. merriami* through Cajon Pass to the north and with *D. m. collinus* to the south, near Menifee.

Distribution: Historically occurred in the San Bernardino and San Jacinto valleys from Cajon Wash, near Devore, east and south to Vallevista, near Hemet, and Menifee in Riverside County, and west to the vicinity of Ontario. Surveys conducted by biologists from the San Bernardino Museum of Natural History indicate that *parvus* still occurs at some historic localities, but its occurrences within this historic range have been greatly reduced by development. Current known localities include Lytle Creek Wash, Cajon Wash near Devore, Santa Ana River wash near Redlands, and Etiwanda Wash (all San Bernardino County) and Laborde Canyon in the Badlands, San Timoteo Canyon, Murrieta Hot Springs, Rimrock Reserve, and near Hemet (all Riverside County)(McKernan 1993). (see Status section for additional information.)

Life History: The results of numerous studies on *D. m. merriami* are used here to provide a general understanding of the life history of *parvus*. Detailed life history studies have not been carried out on *parvus*, although field surveys have provided information that show similarities in the ecology of *merriami* and *parvus*. Future studies on *parvus* may reveal important differences.

The species is active year-round and forages largely on seeds. Herbaceous vegetation and insects are consumed in the spring, and are important diet elements for reproduction. Year-round trapping studies of *parvus* in San Bernardino County have found pregnant females from February through October, with immatures captured from April to September (McKernan 1993 and unpubl. data). *D. m. merriami* can breed twice from spring through summer, apparently in response to favorable food supplies (seeds and herbaceous growth), although once is the norm. *D. m. parvus* probably shows a similar reproductive response, although there are no published accounts of such. Densities of from 0.3 to 18.5 individuals per ha have been recorded for *m. merriami* in creosote scrub habitats of California (Chew and Butterworth 1964, Christopher 1973, Soholt 1973). Live-trapping surveys indicate that the San Bernardino kangaroo rat is abundant in alluvial scrub habitats at some sites (e.g., Lytle Creek, Cajon, and Santa Ana River washes; R. McKernan unpubl. data; P. Brylski unpubl. data), but home range and density data are not available. Home ranges for other subspecies of *D. merriami* range from 0.3 to 19 per ha.

Habitat: Merriam kangaroo rats prefer sparse scrub habitats, and rarely occur in dense vegetation or rocky washes (Beatley 1976). *D. m. parvus* occurs in alluvial scrub/coastal sage scrub habitats on gravelly and sandy soils adjoining river and stream terraces and on alluvial fans.

Status: Class I. *D. m. parvus* is known to occur at eight localities. Four localities (Santa Ana River, Lytle and Cajon washes, and Etiwanda Creek) contain moderately large populations and four

(Badlands, Bautista Canyon, San Timoteo Creek, and San Jacinto River near Hemet) have small populations in fragmented and isolated habitat patches (R. McKernan pers. comm.). The distribution and abundance of *parvus* has dramatically declined due to the loss of alluvial scrub and coastal sage scrub habitats. Alluvial scrub habitat, where the species' reaches its highest densities, is considered an endangered habitat (Hanes et al. 1989). During the first half of this century, these habitats were reduced by agricultural development in San Bernardino and Riverside counties. Since then, habitat loss has accelerated from urban and suburban development and stream and river channelization for flood control, such as through the Santa Ana River Mainstem project. The remaining viable populations occur in the undisturbed alluvial fan sage scrub habitat along the Pacific slope of the eastern San Gabriel Mountains and western San Bernardino Mountains of San Bernardino County. The available data indicate that the populations at Reche Canyon, Jurupa Mountains, Fontana, Bloomington, and northern Colton (all in San Bernardino County), and all of the remaining Riverside County populations (Laborde Canyon in the Badlands, San Timoteo Canyon, Murrieta Hot Springs, Motte Rimrock Reserve, and near Hemet), are small, relictual populations that have persisted since development of the region and are at a high risk of extirpation.

On January 27, 1998, the U.S. Department of the Interior emergency-listed the San Bernardino kangaroo rat as Endangered (Federal Register, Emergency Rule, Vol. 63, No. 17, pp. 3835-3842, January 27, 1998). The rule stated that this taxon currently exists at only seven, widely-separated localities, and that the kangaroo rat is potentially threatened by vandalism of habitat, expansion of sand and gravel mining, and by construction of approved projects, primarily Seven Oaks Dam and levees on the Santa Ana River. [Editor's note: On September 24, 1998, the San Bernardino kangaroo rat listing as endangered was finalized.]

Management Recommendations: Providing protection for the San Bernardino kangaroo rat under CESA and FESA is the highest management priority. A similarly high priority need is to undertake habitat conservation planning efforts to define the strategies for preventing the further decline of *m. parvus*. The conservation strategies are likely to differ in San Bernardino and Riverside counties. San Bernardino County contains the most important populations and habitat, concentrated along major washes (Lytle Creek, Cajon, Etiwanda, and Santa Ana River), which are owned or leased by the tri-county (Riverside, San Bernardino, and Orange) flood control districts or, if they are privately held, are zoned as floodplain or hazard areas. The San Bernardino kangaroo rat is a target species of the Riverside County Multi-species Habitat Conservation Plan. Many of the remaining habitats in Riverside County are localized, dispersed, and in private ownership, although Riverside County also contains undisturbed alluvial floodplain habitat (e.g., San Jacinto River). To assist in defining the strategies for habitat conservation, a land use allocation study is needed to identify the ownership and zoning of occupied and potential *parvus* habitat and evaluate the importance of remaining habitat for the species' long-term conservation. Additional field surveys are needed throughout *parvus*' historic range, especially in undisturbed alluvial fan scrub habitats in western Riverside County (McKernan 1993). A genetic study of the systematics of *parvus* is needed to clarify whether its distinctive morphology (Lidicker 1960) warrants elevating the taxon to species status.

Short-nosed kangaroo rat, *Dipodomys nitratoides brevinasus*
Philip V. Brylski

Description: The short-nosed kangaroo rat is one of three subspecies of *D. nitratoides*, the San Joaquin kangaroo rat, the only four-toed kangaroo rat in the San Joaquin Valley. TL averages 237 mm, BL 102 mm and weight is about 44 g. The short-nosed kangaroo rat is larger and has paler dorsal coloration than the other species of *D. nitratoides* in the San Joaquin Valley (*D. nitratoides nitratoides*, the Tipton kangaroo rat, and *D. n. exilis*, the Fresno kangaroo rat), which generally occur in more eastern parts of the valley (Williams et al. 1993, Williams et al. 1997). Distinguishing the short-nosed kangaroo rat from these closely related subspecies is based on statistical measurements of a series of individuals using morphologic (Hafner 1979) or genetic (J. Patton and D. Williams unpubl. data) data. For practical purposes, identification of the subspecies is based on the locality of capture.

Taxonomic Remarks: *D. n. brevinasus* is one of three subspecies of the San Joaquin kangaroo rat, *D. nitratoides*. Grinnell (1920, 1922) described this subspecies on the basis of pelage coloration and skull dimensions. Although Hoffmann (1974) considered specimens of the short-nosed kangaroo rat from Cuyama Valley morphologically more similar to *D. merriami* than are other *brevinasus*, they are considered *brevinasus*.

Distribution: Historically, *brevinasus* occurred on the western, southern, and extreme southeastern side of the San Joaquin Valley, generally above the valley floor. Grinnell (1922) recorded the distribution as from the floor of the west side of the San Joaquin Valley from near the mouth of Panoche Creek in western Fresno County, south to near the mouth of San Emigdio Creek, in southwestern Kern County, and to the northeast of Bakersfield. It also occurs in Panoche Valley in eastern San Benito Valley, on the Carrizo Plain, in San Luis Obispo County, and the Cuyama Valley in San Luis Obispo and Santa Barbara counties (Williams et al. 1993). The elevational range of museum records ranges from 45 m at Mendota to 735 m in the Cuyama Valley. The northernmost records are from Livingston in 1893 (USNM 54869-72), and from Los Banos in 1894 (USNM 57896-57897). The southernmost records are from San Emigdio Creek, collected in 1918 (MVZ 28576-79).

The outline of the current range of the short-nosed kangaroo rat approximates its historic range, but the number of localities has diminished as a result of habitat loss, fragmentation, and degradation. Estimates of extant occupied area represent only about 1.5% to 3.75% of *D. n. brevinasus'* estimated historical habitat (Williams et al. 1997). Small, fragmented populations are still found near Los Banos; animals here construct their burrows on dikes and seasonally move into iodine brush shrublands (Johnson and Clifton in press *in* Williams et al. 1993). Although populations are known to occur or potentially occur in the following areas (listed from north to south), extensive cultivation has resulted in restricted and disjunct distributions within them: Panoche and San Joaquin valleys, Kettleman Hills, Antelope and Carrizo plains, and Cuyama Valley. Field surveys conducted in the Salt Creek/Tecuya Creek region (elevation approximately 400 m) in June 1991 resulted in no captures of short-nosed kangaroo rats and numerous captures of *D. heermanni* (P. Brylski unpubl. data).

Life History: Like all kangaroo rats, this species is active year-round and seeds form the majority of its diet. According to Williams et al. (1993), seeds of various genera of annual grasses such as *Avena*, *Bromus*, *Hordeum*, and *Vulpia* and the annual forbs *Filarea* sp. and *Capsella buras-pastoris* are also important in its diet. Although there have been numerous trapping surveys for *brevinasus*, few of these provide information on the species' movements, life history, densities, and home range.

Substantial new information on these topics was obtained by Williams et al. (1993) in a five-year study of the *brevinasus* population in the Carrizo Plain Natural Area in San Luis Obispo County, and forms the basis for the following information. Numbers of short-nosed kangaroo rats in the population studied declined over the 5-year study, principally due to the lack of successful reproduction. Densities ranged from 8.7 to 22.6/ha in 1987 and 1988, followed by dramatic declines in 1990 and 1991. The lowest densities of 1991 were about 6% of the highest densities recorded in 1987. These densities are comparable to those reported for other subspecies of *nitratoides* (range: from 3 to 25 individuals/ha; Hoffmann 1974, Koos 1977, Williams and Germano 1991, 1994). In the populations studied by Williams et al. (1993), the proportion of young of the year recruits declined from 33.3% in 1987-8 to 0% in 1989-91, and averaged 13.5%. No reproduction was observed in these populations in 1990. Females entered estrus in January and February, were pregnant in February and March, and weaned their young in April. Females bred once per year and juveniles were not reproductive. The period of reproduction for other races of *D. nitratoides* and with *D. merriami*, is largely from March to June. The gestation period is 32 days and litter size averages 2.3 (mode, 2) (Best 1991).

The maximum duration between the first and last capture of *brevinasus* in the Carrizo Plains Natural Area was 766 days for one male and 727 days for one female. Birth dates of these animals were unknown, but the assumption that they were born in mid-March, 1987 (based on the pattern of reproduction described above for the same population) yields an estimated minimum age of 3.4 years.

Habitat: Short-nosed kangaroo rats are generally found on friable soils on flat or gently rolling terrain in grassland and desert-shrub vegetation (primarily *Atriplex* sp. and *Ephedra californica*). In the Soda Lake area of the Carrizo Plains, they also occur on alkaline soils. Burrows are located in friable soils in slightly elevated areas to reduce likelihood of seasonal flooding, including the berms of roads, canal embankments, railroad beds, and the bases of shrubs and fences where wind-blown soils accumulate above the level of surrounding terrain (Williams 1986; Williams et al. 1993). In the Elkhorn Plain, burrows have been observed on rocky hillsides. In most of their current range, short-nosed kangaroo rats are usually more numerous in lighter, friable soils such as the sandy bottoms and banks of arroyos and other sandy areas (Williams et al. 1997).

Status: Class II. There has been extensive loss of habitat for the short-nosed kangaroo rat, particularly in the agriculturally productive and flatter lands of the San Joaquin, Panoche, and Cuyama valleys, and on the Antelope and Carrizo plains. The major cause of restriction of the species range and abundance is conversion of native habitats to agricultural use. The largest existing population of *brevinasus* occurs in the Lokern and Elk Hills regions in western Kern County. The only other sizeable population is in the Carrizo Plain Natural Area (Williams et al. 1997). The Carrizo Plain Natural Area consists of about 73,000 ha of remnant valley arid wildlands from the north end of Soda Lake to the southern end of the Carrizo Plain. Within this area, *brevinasus* habitat is concentrated on the floor and lower slopes of the smaller Carrizo Basin (Williams et al. 1993). The amount of *brevinasus*-occupied habitat within this area has not been estimated, but up to 35% of the habitat has been dry-farmed in the past and probably provides little or no habitat for the species. Elsewhere, within its historic distribution, it may now be restricted to islands of remaining natural habitat as a result of agricultural conversion of native arid scrub habitats.

Management Recommendations: Detailed components of a conservation strategy and (prioritized) conservation actions needed to conserve short-nosed kangaroo rats appear in the draft recovery plan for upland species of the San Joaquin Valley (Williams et al. 1997). In summary, the following actions are recommended: *i)* initiate and coordinate habitat management studies at sites representing

the range of existing habitat conditions for the species, *ii)* protect existing habitat, *iii)* design and implement a range-wide population monitoring program that measures population and environmental fluctuations at representative sites, *iv)* inventory and assess existing natural land within the historical range, *v)* develop and implement research on restoration of habitat on retired irrigated land, *vi)* include habitat needs in any government plans related to drainage problems, *vii)* restore habitat on retired agricultural lands as needed, and reevaluate the status of the short-nosed kangaroo rat within three years of recovery plan approval. [Editor's note: The final Recovery Plan for Upland Species of the San Joaquin Valley, California was approved September 30, 1998.] In addition, research underway on the systematics of *D. nitratoides* will clarify the taxonomy of the species, and could assist in redefining the conservation priorities for preserving the species' phylogeographic units. Field research on the habitat relations of *D. n. brevinasus* and the impact of grazing and other land uses on its habitat should be undertaken.

Santa Cruz kangaroo rat, *Dipodomys venustus venustus*
Philip V. Brylski

Description: This is a narrow-faced, five-toed kangaroo rat with dark coloration (Best 1992). There are two subspecies: *venustus sanctiluciae* and *v. venustus*. *D. v. venustus* is the darker of the two subspecies and has slightly more inflated auditory bullae (Grinnell 1922). *D. venustus* potentially overlaps with three other 5-toed kangaroo rats: *D. agilis*, *D. elephantinus*, and *D. heermanni*. *D. venustus* is much darker than *D. agilis*, and has bolder facial markings, much larger ears and a much longer tail, and a number of skull characters that require sacrificing the animal to observe. *D. venustus* is smaller than *D. elephantinus*, darker in color (most distinctive in the face and ears), and the ear is smaller. In general, the ear is less than 16.5 mm in length in *D. venustus* and greater than 16.5 mm in *D. elephantinus*, although this character is not always reliable. *D. venustus* is considerably darker and the ear is larger than *D. heermanni*.

Taxonomic Remarks: The taxonomic relationships of *D. venustus*, *D. agilis*, and *D. elephantinus* are uncertain. Honacki et al. (1982) suggested that *venustus*, *elephantinus*, and *agilis* may be conspecific, but provided few data to support this conclusion. Subsequent taxonomic reviews (Wilson and Reeder 1993, Williams et al. 1993) have recognized the three species, but all agree that *D. elephantinus* may be a subspecies of *venustus*. Whether *D. elephantinus* is considered a species, or is a subspecies of *D. venustus* has little or no impact on the need for measures to protect their populations.

Distribution: *D. v. venustus* occurs in the cool, maritime mountains of west-central California. Historical records range from Mount Hamilton to Corralitos, with most specimens collected around Mount Hermon, Felton, and Bonny Doon in Santa Cruz County. Populations of *D. v. venustus* in the Santa Cruz Mountains are disjunct from populations in the Diablo and Gabilan ranges (Williams et al. 1993). *D. v. sanctiluciae* occurs to the south, in the Santa Lucia Mountains in Monterey and San Luis Obispo counties. The current distribution is uncertain. Roest (1988) provides a partial summary of the species' distribution. The species occurs in Mount Hermon, but in remnant patches of suitable habitat surrounded by development. Burrow surveys at Bonny Doon suggest the species still occurs there, although limited live-trapping efforts yielded no captures.

Life History: Like all kangaroo rats, this species is active year-round and seeds form the majority of its diet. Burrows are simple (relatively short with few branches), often located in open, abandoned agricultural land. Like other heteromyids, burrows are not dug in orchards and other actively cultivated land. The diet consists mainly of annual seeds. In one study, the most common food item was *Heterotheca grandiflora* seeds, followed by seeds of *Bromus rigidus* (Hawbecker 1940). One or two litters of two to four young are produced annually.

Habitat: *D. v. venustus* occurs in chaparral habitat in the low foothills of the Santa Cruz Mountains, on substrates of sands, loams, and sandy loams. The habitat at the common collecting localities of Mount Hermon, Felton, and Bonny Doon were described as sandy ponderosa pine parkland, with a chaparral understory. The species' distribution conforms closely to the distribution of open chaparral habitat (including *Arctostaphylos* sp. and *Ceanothus* sp.) occurring on sandy soils (Zayante or Santa Margarita soils) (Hawbecker 1940, Rudd 1948, D. Laabs pers. comm.). Other plant species reported in habitat are *Adenostoma fasciculatum*, *Salvia mellifera*, *Arbutus menziesii*, and *Lithocarpus densiflora* (Best 1992).

Status: Class II. A status review is needed. The majority of records for the Santa Cruz kangaroo rat are museum specimens from localities trapped more than 30 years ago. Prior to 1984, *D. v. venustus*

had apparently not been seen since 1960 (Roest 1988). The known populations in the area around Mount Hermon have small, disjunct distributions corresponding to the fragmented habitat in the region. Habitat loss from suburban development and sand quarrying operations, and habitat degradation from recreational uses have resulted in small, fragmented patches of occupied and potentially occupied range. Existing populations are susceptible to local extirpation, while opportunities for recolonization have been reduced. Much of potential habitat is in private ownership, and under continuing development/mining pressure. Active sand quarries in the Mount Hermon area and urbanization of the Scotts Valley area continue to reduce the area of suitable habitat. The largest undisturbed area of occupied habitat in Santa Cruz County is apparently the S. H. Cowell Foundation property adjacent to Henry Cowell State park, a site that has been proposed for development by the San Lorenzo Water District and, most recently, by the Scotts Valley School District. The Department Reserve in Bonny Doon contains important patches of habitat, but it is uncertain whether the species occurs there. There are also small patches of occupied habitat within Wilder Ranch and Henry Cowell state parks.

Management Recommendations: A range-wide survey for this species is needed to describe its current distribution and status.

White-eared pocket mouse, *Perognathus alticola alticola*

Philip V. Brylski

Description: This is a small pocket mouse with TL from 142 to 198 mm and tail length from 70 to 106 mm. No weights are available. *P. alticola* belongs to the *parvus* group of pocket mice, and is distinguished from silky pocket mice (e.g., *P. longimembris*) by its larger body mass, coarser pelage, a longer tail relative to the body, and a lobed antitragus of the outer ear.

Taxonomic Remarks: *P. a. alticola* is one of two subspecies of the white-eared pocket mouse (the other is *P. a. inexpectatus*, another Class I taxon). These two subspecies and *P. xanthonotus* are Pleistocene relicts of *P. parvus*. Sulentich's (1983) examination of the systematics of these taxa found that *alticola* is weakly differentiated from *parvus olivaceous, xanthonotus* based on skull morphology and morphometrics. There are no genetic or chromosomal data available for *alticola*.

Distribution: Historic range was reported by Grinnell (1922) to be the Transitional Life Zone of the Tehachapi and San Bernardino mountains. Specimens have been collected from Strawberry Peak and Squirrel Inn in the San Bernardino Mountains between 1920 and 1933, at elevations from 1615 to 1830 m. The known localities occur within a 4 km radius (Sulentich 1983). Grinnell (1908) reported a partly eaten specimen of what may have been *P. a. alticola* at Sugarloaf Mountain, elevation 7,500 ft (2,288 m), but the specimen was not preserved. No specimens have been collected since, despite intensive survey efforts (Huckaby and Sulentich 1981, 1980).

Life History: Due to the difficulty of finding populations of the white-eared pocket mouse, there is virtually no information available on its life history. It is likely to hibernate from November to March or April, and breed from emergence until July or August, as do other members of the *parvus* group. The specimens found in museums were collected between June and October, with the majority of these captured in September and October. This indicates a highly restricted period of activity owing to the extreme conditions in high elevation habitats, and possibly a seasonal receptivity to trapping.

The food habits of the white-eared pocket mouse are unstudied. Like the Great Basin pocket mouse (*P. parvus*), they are expected to be mainly granivorous, and vegetation and insects may become important diet elements in spring and summer (Jameson 1954, Kritzman 1974).

Habitat: *P. a. alticola* was discovered in bracken fern (*Pteridium aquilinum*) and grassy flats with an overstory of yellow pine forest (Grinnell 1933). Based on the habitat affinities of *P. a. inexpectatus* and *P. parvus*, the species potentially occurs in chaparral, sagebrush scrub and pinyon juniper woodlands. However, the species has not been recorded in these habitats.

Status: Class I. The species has not been observed since 1933, despite intensive surveys by Huckaby and Sulentich (1981, 1980). These surveys appropriately focused on historic localities containing ponderosa pine/bracken fern habitat in and around the historic localities in the San Bernardino Mountains. Additional survey efforts in sagebrush and pinyon pine-juniper habitats on the northern slopes of the San Bernardino Mountains and in the Big Bear Basin are needed before the species is evaluated for listing as Threatened or Endangered. The species' distribution is largely within a private inholding within the San Bernardino National Forest. Although the species is apparently threatened with extinction, there are no known populations, and the proximate threats (as opposed to the vegetational changes associated with long-term drying trends in the region) are unknown. At this time, it is appropriate to maintain its current status as a Species of Special Concern, pending discovery of a population. The data on one or more extant populations would

influence the approach of future survey efforts and lead to a status review.

Management Recommendations: Additional surveys should be conducted in sagebrush and pinyon pine-juniper habitats on the northern slopes of the San Bernardino Mountains and in the Big Bear Basin. In *P. parvus*, the period of seasonal activity of high elevation populations is shorter compared to lower elevation populations (Zeiner et al. 1990). Although the activity patterns of *alticola* are unknown, it may be prudent to focus survey efforts in late July through August, when activity is likely to persist and when population numbers are likely to be highest (after annual recruitment). Biologists with the San Bernardino National Forest, which contains the known localities for *P. a. alticola* and additional potential habitat, are aware of the importance of locating and protecting extant populations (R. Butler and S. Lowe pers. comm), and should undertake field surveys the resources to do so become available.

Tehachapi pocket mouse, *Perognathus alticola inexpectatus*

Philip V. Brylski

Description: This is a small pocket mouse with TL from 165 to 185 mm and TAL from 87 to 98 mm. Dorsal pelage is yellow-brown lined with blackish hairs. The tail is bicolored. Weights for seven adults in the MVZ collection averaged 22 g (range, 18-29.3 g). This pocket mouse is distinguished from sympatric non-heteromyid rodents (e.g., *Peromyscus*) by the presence of external, fur-lined cheek pouches. *P. alticola* belongs to the *parvus* group of pocket mice, and is distinguished from silky pocket mice (e.g., *P. longimembris* and *P. inornatus*) by its larger body mass, a longer tail relative to the body, more penicillate tail, and a lobed antitragus of the external ear. Males are significantly larger than females in most or all body measurements (Sulentich 1983). On average, *P. a. inexpectatus* is larger than *P. a. alticola*, with a darker tail, and the black tip extends dorsally for at least one-half the length of the tail (Best 1994). According to Huey (1926), the ears are dark (versus pale in *P. a. alticola*). On the eastern slope of Tehachapi Pass and southern Sierra Nevada, it is potentially confused with *P. inornatus*. In *P. inornatus*, like other members of the silky pocket mouse group, the tragus of the outer ear is unlobed.

Taxonomic Remarks: Two subspecies of the white-eared pocket mouse are recognized, *alticola* and *inexpectatus*, both of which are Class I taxa. *P. a. inexpectatus*, *a. altcola*, and *P. xanthonotus* are Pleistocene relicts whose closest living relative is *P. parvus*. Sulentich (1983), in a biochemical and morphological review of *P. alticola* (both subspecies) and *P. parvus*, concluded *P. a. inexpectatus* was morphologically divergent enough to warrant species status and upheld the subspecies status of *P. a. alticola*, although it is weakly differentiated from *P. parvus olivaceous* and *P. xanthonotus* based on skull morphology. A re-analysis of these morphological and biochemical data on *inexpectatus* is warranted based on apparent inclusion of *P. inornatus* specimens from 8 mi (12.9 km) east of Tehachapi. There are no genetic or chromosomal data available for *alticola*.

Distribution: This taxon historically occurred from the vicinity of Tehachapi Pass, west to Mount Pinos, and south to Elizabeth and Quail Lakes, at elevations from 1030 to 1830 m. There are no recent records of the species, despite intensive survey efforts (Huckaby and Sulentich 1981, 1980).

Life History: Owing to the rarity of the species, and the difficulty of locating extant populations, little is known about the natural history of the Tehachapi pocket mouse. Like *P. a. alticola* and *P. xanthonotus*, the species hibernates during the winter, probably from October or November to March or April, and begins breeding immediately upon emergence from hibernation. It may also aestivate in hot weather. Based on a comparison with other pocket mice, the Tehachapi pocket mouse feeds mainly on seeds, and seasonally consumes other plants parts such as fresh herbaceous growth, and arthropods.

Habitat: The habitat at Mount Pinos (the type locality) was grassy flats among scattered yellow pine (Huey 1926). At lower elevations, it has been reported in chaparral and sage scrub, and rangelands dominated by non-native annual grasses. In the western Tehachapi Mountains, it has been reported from Joshua tree and pinyon-juniper woodland.

Status: Class II. The species has not been observed since 1933. The specimens collected from 8 mi (12.9 km) east of Tehachapi by Sulentich (1983) are *P. inornatus* rather than *a. inexpectatus*. Two important facts remain unknown: whether the species still exists, and the factors contributing to its rarity. The species is apparently Threatened, but is designated a Special Concern taxon here due to insufficient data. Most of the historic localities are private holdings. However, an important part of the historic range of *inexpectatus* is within the Angeles and Los Padres national forests. Although

this provides opportunities for protection and management, intensive surveys conducted there by Huckaby and Sulentich (1981, 1980) were unsuccessful. Additional information on the distribution and abundance of the species is needed before determining whether proposing it for listing is appropriate.

Management Recommendations: The highest priority is to locate populations of this species. The most recent trapping efforts in appropriate localities and habitats and during the appropriate time of year (from June to September) failed to confirm the existence of any populations of *P. a. inexpectatus* (Huckaby and Sulentich 1980, 1981). The Department should continue its efforts of: *i*) funding focused surveys trapping efforts; *ii*) encouraging mammalogists, graduate students, and field biologists to undertake research and field surveys; and *iii*) requiring that the environmental review of projects in appropriate habitat within the species' historic range contain adequate focused surveys for the species. The U.S. Forest Service should also undertake further surveys in the Angeles and Los Padres national forests. Based on the lack of success of previous extensive survey efforts, the species may (if still extant), have a patchy distribution, and may occur in microhabitats not previously surveyed. Although the activity patterns of *alticola* are unknown, it may be prudent to focus survey efforts in late July through August, when activity is likely to persist and when population numbers are likely to be highest (after juveniles wean). If one or more populations of *a. alticola* are found, the responsible agencies, in consultation with the Department, should: *i*) evaluate the need for emergency protective measures to ensure the species' survival, *ii*) determine the habitat requirements of the species and adjust resource management practices within the national forests accordingly, and *iii*) identify private landowners whose properties support the species and work to find land management strategies that are mutually beneficial.

Salinas pocket mouse, *Perognathus inornatus psammophilus*

Philip V. Brylski

Description: This is a small heteromyid rodent with a TL 130 mm and TAL of 62 mm (Williams et al. 1993). No weights are available in the literature, but are approximately from 10 to 13 g. The pelage is silky, lacking bristles or spines. Dorsal pelage ochreaceous buff to pinkish, overlaid with blackish hairs. The ventral pelage is white. The tail is faintly bicolored, relatively non-penicillate (the tail hairs extend ca. <6 mm posterior to the tail), and, on average, slightly greater than 50% of the TL. The antitragus of the ear is unlobed. All of the Central Valley forms differ from *P.l. longimembris* from the Mojave Desert, which have 56 chromosomes, silkier pelage, and a smaller, relatively longer tail. Distinguishing these two species is difficult and, pending resolution of the taxonomy of Central Valley *Perognathus*, may be relevant to field biologists mainly where they are sympatric in the western Mojave Desert.

Taxonomic Remarks: The taxonomy of silky pocket mice in the Central Valley is currently unresolved. The Salinas pocket mouse was originally described as *P. longimembris psammophilus* (von Bloeker 1937), later referred to *P. inornatus psammophilus*, and synonymized with *P. i. sillimani* by Williams et al. (1993). This account follows Williams et al. (1993) in recognizing three subspecies of silky pocket mice in the Central Valley: *P. i. inornatus*, *P.i. neglectus*, and *P. i. psammophilus*. Three cytotypes have been reported from the Central Valley: a 50-chromosome form from the floor and eastern edge of the San Joaquin Valley; a 56-chromosome form from the western part of the valley, referable to *i. neglectus*; and a 60-chromosome form from Lake County in the Sacramento Valley. A thorough analysis of biochemical and morphological data are needed to validate the conclusion that *P. longimembris* does not occur in the Central Valley region (Best 1993a, Williams et al. 1993) and clarify the taxonomy of *Perognathus* there.

Distribution: The three recognized subspecies of *P. inornatus* (*inornatus*, *psammophilus*, and *neglectus*) are distributed from the Sacramento Valley in Tehama County, south through the San Joaquin Valley and contiguous valleys (including Salinas Valley) to the western Mojave Desert in Los Angeles, Kern, and extreme western San Bernardino counties, and the Tehachapi Mountains and the foothills of the Sierra Nevada below approximately 2000 ft (Williams et al. 1993). The distribution of *psammophilus* was reported by Williams et al. (1993) to be from the Salinas Valley, near Soledad, southward to "at least Hog Canyon, Monterey County". This represents a reduction of the southern range of the subspecies from that reported previously (Williams unpubl.), resulting from specimens from the Carrizo Plain and the Cuyama Valley being assigned to *P. i. neglectus*.

Life History: Like other silky pocket mice, *P. inornatus* is nocturnal, spending the day in a burrow, the entrance to which is plugged with soil. Although seasonal activity patterns have not been studied in *P. inornatus*, French (1993) reported that captive *P. inornatus* remained underground for many months. All species of *Perognathus* enter torpor readily (French 1993). Torpor is a period of reduced activity and supranormal reduction of body temperature, typically as an adaptive response to low temperature, inadequate food or water, or a combination of these. French (1993) pointed out that among heteromyids that show seasonal dormancy, it is not uncommon to find some individuals active on the ground surface when most of the population is inactive. Individuals unable to cache sufficient seed supplies, for example, may find it necessary to emerge from their burrows in search of food. The Salinas pocket mouse forages mainly on seeds of grasses and forbs, but also seasonally eats green vegetation. Although the frequency at which arthropods are eaten is uncertain, it is probably occasional.

Densities reported for *inornatus* are 0.4-7.3/ha in grassland habitats (Horn and Fitch 1942, Howard

1953). The average home range in alkali sink habitat was 148 m^2 (range 0-333 m^2) and 258 m^2 (range 0-385 m^2) (Warner 1976 *cited in* Best 1993a).

Habitat: The habitat relations of the silky pocket mice in the Central Valley region are not well known, in large part due to extensive loss of its habitat to agricultural conversion early in this century. In general, *inornatus* occurs in open grassland and desert-shrub communities on alluvial sandy and wind drifted sands (Williams 1993, unpubl., von Bloeker 1937). Hawbecker (1951) reported *psammophilus* in *Ephedra* scrub near stream courses. Williams (no date) described the habitat as annual grassland, desert scrub (e.g., *Atriplex*, *Ephedra*, and *Haplopappus*), and oak savannah communities on sandy soils and other friable soils, although this apparently included populations now referable to *P. i. neglectus*. Similarly, Braun (1985) described the habitat for *P. inornatus* on the Carrizo Plain (previously considered to include *psammophilus*) as sandy loam flats dominated by herbs (*Erodium*, *Amsinckia*, and *Astragalus*) and grasses (*Bromus*). Historically, they were most abundant in uncultivated habitats on sandy and other friable soils on the valley floor, and less common in the marginal habitats on the valley edges.

Status: Class I. Extensive and continued habitat loss and fragmentation from agricultural and urban development has resulted in declines in the distribution and abundance of *P. inornatus* in the Central Valley region. Other threats include predation by feral cats and the use of rodenticides to control California ground squirrel populations. Despite the need for additional data on the taxonomy, distribution, and abundance of the *Perognathus* populations in the Central Valley region, each of its taxonomic units may be considered sensitive as a result of habitat loss (Williams and Kilburn 1992). The declines have been dramatic for *psammophilus*, for which there have been no recent captures or sightings. *P. i. psammophilus* meets the criteria for a Species of Special Concern, and may qualify for listing as Threatened under CESA. *P. i. inornatus* and *i. neglectus* are less threatened than *psammophilus*; *i. neglectus* is included on the list of Watch List taxa.

Management Recommendations: Williams (no date) recommended the highest priority be preservation of suitable habitat in the Salinas Valley, with secondary but still important conservation efforts in the southern part of the species' range. There is an urgent need for work on the systematics of Central Valley *Perognathus* owing to the historic rate of population decline and loss, which may be resulting in the loss of important genotypes of the species. Focused surveys in appropriate habitat in the Salinas Valley and in the southern part of its range are needed to locate extant populations.

Palm Springs pocket mouse, *Perognathus longimembris bangsi*
Philip V. Brylski

Description: This is a small heteromyid rodent with TL from about 110 to 151 mm and weight from 8 to 11 g. As in all silky pocket mice, the pelage is spineless, and there are usually two small patches of lighter hairs at the base of the ear. Silky pocket mice can be distinguished from sympatric pocket mice of the genus *Chaetodipus* (*fallax, formosus, and penicillatus*) by their smaller size (see Ingles 1965 for comparisons), the absences of a tail-crest, and an unlobed antitragus in the outer ear. There is considerable variation in pelage color, from gypsum-colored at the southern limit of the subspecies' range (near Ocotillo), to buff-colored individuals in the Snowcreek area of San Gorgonio Pass, where *bangsi* intergrades with *brevinasus*.

Taxonomic Remarks: The Palm Springs pocket mouse was originally described by Mearns (1898a) from a series collected from Palm Springs, 450 ft (137 m) in elevation, Colorado Desert, Riverside County, California. The subspecies was described based on skull characteristics (not evident in live animals) and on its light colored dorsal pelage, which matches the sandy substrate of the Colorado Desert. There is considerable variation in dorsal pelage color; whether this has taxonomic implications is now being investigated (P. Brylski and J. Patton unpubl. data). *P. l. bangsi* hybridizes with the Los Angeles pocket mouse (*P. l. brevinasus*) at its western boundary. The extent of overlap and intergradation with the Jacumba pocket mouse (*P. longimembris internationalis*) to the south, and little pocket mouse (*P. longimembris longimembris)* to the north, is unknown.

Distribution: Historically known from the San Gorgonio Pass area east to southern Joshua Tree National Park, south through the Coachella Valley to Ocotillo. Its historical range extends from Joshua Tree National Park southward, west to San Gorgonio Pass and down to Borrego Springs and the east side of San Felipe Narrows (Hall 1981). Individuals captured in the vicinity of Ocotillo (P. Brylski unpubl. data, Behrends pers. comm.) are apparently also referable to *bangsi* rather than *internationalis*. The current distribution of the species in the Coachella Valley is poorly known. Populations are known from the northwestern valley and from the vicinities of the University of California reserve at Deep Canyon and Anza Borrego Desert State Park. They no longer occur on the valley floor from Palm Springs to the Salton Sea in areas developed for urban and agricultural land uses, although they may persist in pockets of native desert scrub in this area. Whether *bangsi* is continuously distributed along the western edge of the valley floor, and whether they occur along the eastern edge of the valley floor between Indio Hills and the Salton Sea, is not known.

Life History: This discussion is based on various studies of *longimembris*, including *l. longimembris* and *l. nevadensis*, the results of which are included in this discussion. Little pocket mice hibernate in winter and are active above ground in spring, summer, and fall (French 1977). Individuals awaken from hibernation periodically to forage on seeds cached in burrows, and possibly elsewhere within the species' home range. The ability to become dormant/torpid for only a few nights or for the winter enhances survival during seasonal and short-term periods of environmental stress (Kenagy 1973). The activity patterns of the Palm Spring pocket mouse are not well understood. Based on studies of related desert subspecies (*P. l. panamintinus*, French 1977; *P. l. longimembris*, Kenagy 1973), it is likely that their winter hibernation spans from about October to March. Usually, they are not found above ground during this period. Occasionally, and for reasons that are not understood, populations have been active on the surface through all or part of the winter (Kenagy 1973). Surveys for the Palm Springs pocket mouse during July and August have failed to result in captures at sites where animals were found to abundant in the subsequent spring (P. Brylski unpubl. data).

The food habits of the Palm Springs pocket mouse have not been studied. Pocket mice eat seeds,

mainly, but also green vegetation in the spring. Beatley (1969) suggested that dietary water (and vitamins), available in winter annual vegetation prior to or at the onset of the breeding season, is necessary for reproduction to occur.

P. longimembris can show dramatic fluctuations in population numbers. Hall (1946) estimated a population in Nevada to be as high as 400 individuals/acre. Chew and Butterworth (1964) recorded densities ranging from 0.85 to 1.74 individuals/ha, and home ranges from 38.7 to 84.4 m. Dodd's (1996) field surveys for *bangsi* at five locations in the northern Coachella Valley and San Gorgonio Pass region revealed major differences in the distribution and abundance of the Palm Springs pocket mouse. A maximum of 73.1 individuals/ha were recorded on one 0.48 ha grid in the Snowcreek area, and density estimates at three sites in the northwestern Coachella Valley area averaged 51.1 individuals/ha. The number of captures was significantly lower at sites east of, and including, the Whitewater Preserve. While density estimates could not be determined at these sites, they were clearly far lower than 51.1 individuals/ha.

Habitat: *P. longimembris* is known from various vegetation communities, including creosote scrub, desert scrub, and grasslands, generally occurring on loosely packed or sandy soils with sparse to moderately dense vegetative cover. Dodd's (1996) recent study showed that *bangsi* in the northern Coachella Valley was abundant in creosote-dominated desert scrub on flat to gentle slopes with sandy soils. The most common plant species where *bangsi* was abundant are *Larrea tridentata*, *Encelia farinosa*, *Ambrosia dumosa*, and *Ephedra californica*. In the same study, Palm Springs pocket mice were absent or present in low numbers in areas with compacted, stony, and cobbly soils, in saltbush (*Atriplex* sp.)-dominated communities, in areas disturbed by human habitation, and on wind-formed dunes devoid of vegetation. In 1996, the densities of Palm Springs pocket mice were highest at sites with the greatest herbaceous growth.

Status: Class II. *P. l. bangsi* occurs only in the Coachella Valley, where substantial agricultural and urban/suburban conversion of habitat, especially in the valley floor, has occurred over the last century. The species occurs only in native habitats, and will continue to decline in areas where soils have been compacted and vegetation degraded, as occurs in areas used by off-highway vehicles (OHVs). In a recent population survey in the northern Coachella Valley (Dodd 1996), six survey sites in native habitat each showed evidence of increasing human encroachment, and all sites, including the preserves, showed the soil and vegetation impacts of extensive OHV activity. The existing protected areas of the northern Coachella Valley where *bangsi* occurs include the Coachella Valley Preserve System (including Coachella Valley Preserve, Whitewater Preserve, and a portion of Edom Hill/Willow Hole Preserve), established primarily for conservation of the Endangered Coachella Valley fringe-toed lizard, and the southern part of Joshua Tree National Park. Dodd's (1996) surveys of these areas (excluding Joshua Tree National Park), found low densities of *bangsi* in 1995. While these areas contribute to *bangsi* conservation, they do not appear to contain the habitat needed to support *bangsi* population centers of the northern Coachella Valley. These population centers are currently found outside of existing protected areas, and are under development pressure. In the southern valley, *bangsi* occurs in Anza Borrego Desert State Park, probably in good numbers. Development of the valley floor appears to have fragmented the historic population into disjunct northern and southern valley populations centered in the Whitewater/San Gorgonio Pass and Anza Borrego regions, respectively.

Management Recommendations: The preservation of remaining habitat is the highest priority for the conservation of the Palm Springs pocket mouse. The species is most abundant in native desert scrub on sandy soils, the combination of which is often lacking on the margins of its historic range. While there is sufficient open space in these marginal areas, *bangsi* may be absent from them or

present at low densities. Field studies started by Dodd (1996) on its distribution, abundance, and habitat relations should be continued, to guide conservation planning efforts now underway in the Coachella Valley. *P. l. bangsi* should be a priority target species in the Coachella Valley Multi-Species Habitat Conservation (MSHCP) effort, now underway. [Editor's note: The final draft of the Coachella Valley Multi-Species Habitat Conservation plan was being considered for approval in late September 2007. The Palm Springs pocket mouse is a species covered by the plan.] It is important to know whether populations along the western edge of the valley floor are connected through movements of individuals, or whether they are disjunct and functionally independent. The ongoing Coachella Valley MHCP effort should identify this issue of habitat connectedness and fragmentation as basic to long-term conservation planning of *bangsi* and other valley species whose wide fluctuations in numbers play an important role in metapopulation dynamics. The Coachella Valley MHCP should include a plan designed to prohibit OHV recreation from areas of high habitat quality, and monitor compliance.

Los Angeles pocket mouse, *Perognathus longimembris brevinasus*

Philip V. Brylski

Description: This is a small heteromyid rodent, averaging about 113 mm TL with weight from 8 to 11 g. The Los Angeles pocket mouse can be potentially confused only with juveniles of the sympatric California pocket mouse (*Chaetodipus californicus*), from which it can be distinguished by the absence of spiny hairs in the dorsal pelage and the absence of a distinct crest on the tail. Pelage is buff above and white below. Many of the dorsal hairs are black-tipped, giving the pelage a "salt and pepper" appearance, similar to but lighter than that of the Pacific pocket mouse (*P. l. pacificus*). Like all silky pocket mice, there is usually a small white spot at the anterior base of the ear, and an indistinct larger buff spot behind the ear, the plantar surface of the hindfeet are naked or lightly haired, and the lateral hairs of the hind toes project anteriorly and laterally, resulting in a "fringed-toed" effect, which may enhance locomotor efficiency on sandy substrates.

Taxonomic Remarks: This is one of eight subspecies of the little pocket mouse (*P. longimembris)* in California (Hall 1981). *P. l. brevinasus* was first described by Osgood (1900) as a race of the Panamint pocket mouse (*P. panamintinus*). Both *brevinasus* and *panamintinus* were arranged as subspecies of *P. longimembris* by Huey (1928). An important taxonomic character of *brevinasus* is its short rostrum, a character also shared by *pacificus. P. l. brevinasus* intergrades with *bangsi* in the Cabazon area of the San Gorgonio Pass, and with *P. l. internationalis* in the La Puerta Valley area of San Diego County.

Distribution: Historically occurred in the coastal basins of southern California, from San Fernando and Burbank in the San Fernando Valley east to Cabazon, south through the San Jacinto and Temecula Valleys to Aguanga, Warner Pass, Vail, and Temecula. The specimens collected by Grinnell at Dos Palmos Spring, Santa Rosa Mountains are either *brevinasus* or *bangsi*, and await resolution on biochemical and morphological grounds. The recorded elevational range is from 167 m (at Burbank) to 808 m (Oak Grove). The current range does not include the San Fernando Valley, the majority of which has been urbanized. There is potential for the species in the canyons of the San Fernando Valley (e.g., Tujunga wash), although no field surveys have apparently been conducted there. Currently, the western-most record for extant *brevinasus* is Etiwanda Wash. Apart from the San Fernando Valley, the outline of the current range of *brevinasus* is similar to its historic range. However, the species occurs sparingly in, or is absent from, many historic localities in the San Bernardino, San Jacinto, and Temecula valleys.

Life History: There have been few natural history studies on the Los Angeles pocket mouse, and the following information is based on research on various subspecies of *longimembris*, including limited work on *brevinasus*. Like all *Perognathus*, the Los Angeles pocket mouse hibernates in the winter, generally from October to February, and also becomes torpid when deprived of food for 24 to 36 hours. Little pocket mice periodically emerge from hibernation to feed on seed caches stored in their burrows. Emergence from hibernation is correlated with availability of forb and grass seeds. *P. longimembris* feed largely on seeds and seasonally eat forbs and, to a lesser degree, arthropods and larva.

Habitat: The habitat of Los Angeles pocket mice includes lower elevation grassland, alluvial sage scrub, and coastal sage scrub.

Status: Class II. The main threat to the Los Angeles pocket mouse is habitat loss by agricultural, suburban, and urban development in Los Angeles, San Bernardino and Riverside counties. The Los Angeles pocket mouse has been extirpated from most or all of the San Fernando and San Bernardino

valleys. The species is still uncommon to common at various localities from the base of the San Bernardino Mountains (e.g., Etiwanda Wash) east to Cabazon, and south to Temecula, and the surrounding foothills (e.g., Aguanga, Oak Grove and Vail). At the same time, the conversion of habitat to agricultural, suburban, and urban uses in the San Jacinto and Temecula valleys has greatly reduced and fragmented the historic habitat and its populations in this region, especially on the valley floor. While there are a number of extant populations, many of these are small and disjunct, and will likely disappear in the coming years. Many of the remaining habitats in Riverside County are in private ownership. Taken together, the available data indicate that the species is not yet Threatened but potentially will be if management actions are not implemented. The Riverside County Multi-Species Habitat Conservation Planning effort may provide the regional habitat protection needed to ensure the species' long-term conservation. However, this plan was in preparation while this document was being written, and could not be evaluated for the effectiveness of its design with respect to *brevinasus*.

Management Recommendations: *P. l. brevinasus* should be a high priority target species of the regional Habitat Conservation Planning efforts either underway or planned in Riverside and San Bernardino counties. [Editor's note: The Los Angeles pocket mouse is a covered species in the Western Riverside County Multiple Species Habitat Conservation Plan.] The creation of large blocks of habitat, protected by conservation easements and public ownership are needed to prevent continued declines in its distribution and abundance. Surveys are needed on its distribution and abundance, habitat relations, and natural history. Monitoring of existing populations and surveys of potential habitat within its historic range are needed.

Pacific pocket mouse, *Perognathus longimembris pacificus*

Philip V. Brylski

Description: This is a small heteromyid rodent, averaging about 113 mm TL, and weighing from 8 to 10 g. Silky pocket mice, including the Pacific pocket mouse, are distinguished from species of *Chaetodipus* by the absence of spiny hairs in the dorsal pelage and the absence of a distinct crest on the tail. There is usually a small white spot at the anterior base of the ear, and an indistinct larger buff spot behind the ear. The pelage is buff above and white below. Many of the dorsal hairs are black-tipped, giving the pelage a "salt and pepper" appearance typical of the species. The Pacific pocket mouse is the darkest of the *Perognathus longimembris* subspecies. Pelage color shows substantial age-related and seasonal variation; the pelage is darkest in juveniles, and relatively dark in newly-molted adults. The pelage in all age groups lightens gradually between molts. Like all heteromyids, there is a buff-colored lateral line. The plantar surface of the hindfeet is naked or lightly haired, and the lateral hairs of the hind toes project anteriorly and laterally, resulting in a "fringed-toed" effect, which may enhance locomotor efficiency on sandy substrates (Brylski 1993).

Taxonomic Remarks: The Pacific pocket mouse is one of eight recognized subspecies of the little pocket mouse (*P. longimembris)* in California (Hall 1981; Williams et al. 1993). As a species, the little pocket mouse shows considerable geographic and non-geographic variation in pelage color. *P. pacificus* was described by Mearns (1898a) from specimens collected at the mouth of the Tijuana River (San Diego County) near the border with Mexico. Huey (1939) relegated *pacificus* to subspecies status based on its similarity to the Los Angeles pocket mouse (*P. l. brevinasus*).

Distribution: The Pacific pocket mouse historically occurred in coastal southern California, from Marina del Rey and El Segundo in Los Angeles County, south to the vicinity of the Mexican border in San Diego County (summarized in Erickson 1993). The majority of records are within 1 mi (1.6 km) of the coast, at less than 600 ft (180 m) in elevation. Currently, populations are known at three locations: the Dana Point Headlands (Orange County), San Mateo Creek (northern San Diego County), and near the Santa Margarita River in Camp Pendleton (southern San Diego County).

Life History: The Pacific pocket mouse hibernates from November to February (Meserve 1976a,b). In contrast to other hibernators that accumulate fat reserves for hibernation, little pocket mice feed on seed caches stored in their burrows. Emergence from hibernation has is correlated with availability of forb and grass seeds (Meserve 1976a,b). Individuals also become torpid when deprived of food for 24 to 36 hours.

Relatively little is known of the breeding biology of Pacific pocket mice. Meserve (1976b) noted pregnant and lactating females from April through June, and immatures from June through September. In a study of the Dana Point Headlands population, lactating females were observed in July, two juvenile age classes were observed in June/July and July/August, indicating multiple litters, and several female juveniles were lactating, indicating that they had borne young within 30 days of weaning (Brylski 1993; unpubl. data).

The food of the Pacific pocket mouse includes seeds and stems of grasses and some forbs, and occasionally arthropods and larva (von Bloeker 1931a,b; Meserve 1976a,b). Bailey (1939) recorded seeds of the following species from the pouches of collected specimens: "*Lotus prostratus*, two species of salt bush, heliotrope, mustard, *Monanthochloe*, *Franseria*, a rush." Von Bloeker (*in* Bailey 1939) recorded the seeds of *Heterotheca grandiflora*, *Chrysothamnus*, *Centaurea melitensis*, *Croton californicus*, *Pulchea sericea*, and *Hordeum murinum* from the pouches of collected specimens. *P. l. pacificus* was observed to drink water regularly in captivity (Bailey 1939).

Data on home range have not been obtained for this species, but high densities have been observed at the three known populations. At the Dana Point Headlands, the maximum known number of animals (MNAs) was approximately 40 individuals (juveniles and adults) on 3.75 acres of contiguous habitat (Brylski 1993), yielding 10.6 individuals/acre. However, adult densities were approximately 2.5 individuals/acre. At the San Mateo site, there were approximately 37 MNAs on approximately 2 acres (18.5 individuals/acre). At the Dana Point Headlands and San Mateo Creek populations, 61% and 75% of the captures, respectively, were young of the year (juveniles and subadults). Both studies were conducted during July and August. Despite a potential trap bias (juveniles may be more trappable than adults), the age structure of these populations after reproduction was dominated by juveniles in 1993 (at Dana Point) and 1995 (at San Mateo Creek). The Pacific pocket mouse, like other subspecies of *P. longimembris* that have been studied, may show dramatic annual variation in density.

Habitat: Pacific pocket mice occur on fine-grain, sandy or gravelly substrates in the immediate vicinity of the Pacific Ocean (Mearns 1898a; von Bloeker 1931a,b; Grinnell 1933). The Pacific pocket mouse is or was known to occur on coastal strand, coastal dunes, river alluvium, and coastal sage scrub habitats on marine terraces (Grinnell 1933, Meserve 1976a,b). The occupied habitats for the three known populations are coastal sage scrub dominated by sagebrush (*Artemisia californica)* (Dana Point Headlands); mixed sage scrub and maritime chaparral sagebrush dominated by sagebrush and white sage (*Salvia apiana*) (San Mateo Creek), and the ecotone of coastal sage scrub and nonnative grassland, white sage and slender buckwheat (*Eriogonum elongatum*) (Santa Margarita). On all three occupied sites, sandy soil comprises from 10 to 20% of the occupied habitat, and the understory includes the California croton (*Croton californicus*), an indicator species of sandy soils.

Status: Class I. The Pacific pocket mouse has a patchy distribution and, since its description by Mearns (1898a), has been considered rare. The historical distribution of the Pacific pocket mouse was much more extensive prior to the considerable development of the coastal lowlands of southern California. Between 1894 and 1972, the Pacific pocket mouse was recorded from eight general localities and 29 specific locales from Los Angeles County south through San Diego County to the Mexican border, and is now known from only three localities (Erickson 1993). Current occupied habitat for the Pacific pocket mouse is estimated to be less than 100 total acres at three sites. None of the eight historic locales is fully protected, and all have been damaged by or are threatened by development.

Based on the number and small sizes of the three known populations, the sedentary nature of the Pacific pocket mouse (Meserve 1976b), and the fragmentation of its habitat, the Pacific pocket mouse is highly susceptible to extinction as a result of environmental or demographic variability. The Pacific pocket mouse was listed as Federally Endangered in 1994, and appears to meet CESA criteria for listing as Endangered.

The most significant threat to the Pacific pocket mouse is habitat loss and fragmentation. In addition, predation by house and feral cats on the Dana Point Headlands could conceivably result in the extirpation of this population. The Dana Point site has been proposed for development, and through agreements with the landowner under the Natural Community Conservation Plan for central Orange County, the USFWS and Department are cooperating to transplant the Dana Point population of pocket mice to another site, the location of which is unknown at this time. The San Mateo population is expected to be directly or indirectly impacted by a proposed freeway. The Santa

Margarita population is within the Camp Pendleton Marine Corps (CPMC) base. The CPMC is expanding its base-wide conservation planning efforts, now underway, to include the Pacific pocket mouse.

Management Recommendations: There are a number of management recommendations for this taxon: *i*) collect basic natural history data. The Pacific pocket mouse is known from few populations and its natural history is not well understood; *ii*) control depredation by house and feral cats. Although the Pacific pocket mouse has many predators (e.g., owls, snakes, skunks, and weasels), the greatest risk appears to be house and feral cats. House and feral cats in urban and suburban areas, such as at the Dana Point Headlands and potentially at San Mateo Creek, occur in high densities. An ongoing program for removing house and feral cats from these locations is needed; *iii*) continue field surveys for populations and suitable but unoccupied habitat. Surveys are needed to identify potential habitat that is either occupied by the species or can serve as a host site for increasing the number of populations. Since two of the three existing populations occur on less than 5 acres, the Pacific pocket mouse may persist in unlikely places, and survey efforts should be maintained to determine whether additional populations exist. Also, populations of *P. longimembris* can show dramatic fluctuations in numbers. Survey results (with either negative or positive results) in one area should not be applied to other, even adjacent, areas; *iv*) prepare and implement habitat management plans. Plans should be prepared to manage habitat to maximize pocket mouse populations. Two of the three populations are surrounded by habitat that could be altered (e.g., by brush thinning and removal of exotic plants) to promote growth and expansion of Pacific pocket mouse populations; and *v*) integrate conservation of the Pacific pocket mouse with appropriate NCCP lead agencies. The historic range of the Pacific pocket mouse overlaps with three existing programs being implemented under the NCCP program: two multiple species and multiple habitat conservation plans in San Diego County and the coastal conservation plan of Orange County. Currently, no known populations of the Pacific pocket mouse are protected under any of these NCCP projects; however, there is potential habitat where populations may later be discovered or which may serve as host sites for translocation efforts. The USFWS and the Department should work with the appropriate agencies to optimize the opportunity for the NCCP to effect conservation of the Pacific pocket mouse.

White-footed vole, *Arborimus albipes*

Paul W. Collins

Description: A small (149-182 mm, TL) *Microtus*-like rodent with a blunt face and short (12-16 mm) concealed ears; long, soft pelage; dorsum brown; ventrum gray washed with light brown; fore and hind feet (18-21 mm) with white dorsal surfaces and straight claws; small eyes; and a long (57-75 mm), sharply, bicolored (white below and blackish above), scantily-haired tail (Merriam 1901, Maser and Johnson 1967, Maser et al. 1981). Weight is from 17 to 28 g (Maser and Johnson 1967). They are distinguished from the closely related red tree vole (*Arborimus longicaudus*) by their slightly smaller size, white instead of dark brown-colored feet with straight claws, brown rather than orangish-red dorsal coloration, sparsely-haired and sharply-bicolored tail, and long, narrow, rounded skull (Merriam 1901, Howell 1926, Bailey 1936).

Taxonomic Remarks: The white-footed vole is one of three species in the genus *Arborimus*, a genus considered to be among the most primitive members of the vole family. Merriam (1901) first described the white-footed vole as *Phenacomys albipes*. Taylor (1915) later assigned it to the genus *Arborimus*, subgenus *Phenacomys*. Since then, the species has had a confusing taxonomic history (see Howell 1926, Hall and Cochrum 1953, Hall and Kelson 1959, Hall 1981, Repenning and Grady 1988). Johnson (1973) and Johnson and Maser (1982) elevated *Arborimus* to generic rank, recognized by Wilson and Reeder (1993). Pending additional molecular and morphological data, the name *Arborimus albipes* is recognized here.

Distribution: White-footed voles are confined to western Oregon and extreme northwestern California (Hall 1981). They inhabit humid forested areas along the coast from the Columbia River, Oregon, southward to Humboldt County in northwestern California (Maser and Johnson 1967). In California, *A. albipes* is known from six disjunct localities in Humboldt and Del Norte counties. The altitudinal range of this taxon is from near sea level to ca 3,500 ft (Maser and Johnson 1967). Most California localities are from low-lying areas (Williams 1986).

Life History: Little is known about the biology of this apparently rare vole (Maser et al. 1981). The species is secretive, probably active year-round, and generally nocturnal with some diurnal activity (Zeiner et al. 1990). White-footed voles may breed throughout the year (Maser 1966). However, pregnant individuals have been captured only from mid-April to late July (Johnson and Maser 1982), suggesting an extended spring-summer breeding season. White-footed voles probably produce a single litter annually of one to four (usually two or three) young per litter (Maser et al. 1981, Johnson and Maser 1982). Like the red tree vole (Carey 1991), aspects of the reproductive biology of white-footed voles, such as long reproductive period, small litter size, and possible slow development and extended nursing of young (Maser et al. 1981), have been linked to difficulties associated with metabolizing vascular plant leaves. Nest site requirements of this taxon are unknown; however, like other voles, it probably constructs nests of dried vegetation under stumps, logs, or rocks (Zeiner et al. 1990). There is no information on longevity, population structure, population density, movement, home range size, or social behavior of white-footed voles.

The diet consists entirely of leaves from trees, shrubs and herbs, with no evidence found for the use of seeds, fruits, fungi, or animal matter (Voth et al. 1983). Leaves from hardwood trees accounted for 57% of the diet of white-footed voles, followed by forbs (23%), and shrubs (15%) (Voth et al. 1983). Howell (1928) reported finding only finely triturated roots of herbaceous plants in the stomachs of three white-footed voles collected in California. Structural features, such as a longer tail and long nails, suggest that white-footed voles are probably more scansorial than most other species of voles (Johnson and Maser 1982). Its arboreal habits are substantiated by its dependence on alder

and willow leaves. Its terrestrial habits are confirmed by its capture in ground-based traps and the presence of low forbs and grasses in its diet (Voth et al. 1983). Thus based on food habit and trapping data, the spatial niche of the white-footed vole extends from ground level into tree and shrub canopies (Voth et al. 1983). Water is probably obtained from nearby streams and by licking condensation or rain from leaves.

Habitat: Early mammalogists reported the species only along small streams in humid coastal forested areas (Howell 1926, Grinnell 1933, Bailey 1936). Maser and Johnson (1967) concluded that it prefers areas of herbaceous growth found in riparian communities along small streams, or in small clearings created by fallen timber in redwood or Douglas-fir forests. Alder thickets and other riparian communities along small streams may constitute essential habitat for this taxon (Maser et al. 1981). In Oregon, the primary habitat for this taxon is riparian-alder thickets found along smaller streams (Voth et al. 1983). In California, this species has been captured in a variety of situations, but generally appeared to be associated with small clear streams flowing through humid coniferous forests (Maser and Johnson 1967). Of the eleven specimens captured in California, nine were found in close proximity to alder, bay or maple thickets along small clear streams flowing through redwood forests (Maser 1966). There are a few records of white-footed voles having been captured several hundred meters from streamside habitat on recently logged (two years after logging), or burned land (Maser and Johnson 1967, Maser and Hooven 1969).

Status: Class II. The principal reasons for concern are its restricted range in California, narrow habitat preferences, scarcity of numbers, and threat of continued degradation and destruction of its preferred riparian-redwood forest habitat from timber harvest. The white-footed vole is probably one of the rarest voles in North America (Maser et al. 1981). The only recent record of this species for California is a specimen (HSU 1509) captured in 1972 south of Patrick's Point State Park, Humboldt County. Based on the limited specimen records (11 specimens from 6 localities in California), this species should be considered rare and locally restricted in California. The species is associated with riparian habitats in old-growth redwood forests, and is probably adversely affected by clearcut logging, fires, windstorms and other alterations that destroy or alter the composition of riparian and understory habitats. Loss and fragmentation of undisturbed coast redwood forest habitat throughout the California range of this species has been extensive. Fox (1988) estimated that only about 12% of coastal old-growth redwood forests remain in California, with almost half of this on private or unreserved lands which are susceptible to continuing timber harvests.

Management Recommendations: The first priority is to obtain reliable data on its distribution and abundance, habitat needs, and extent of remaining suitable habitat. Improved inventory methods for this secretive vole are needed. Based on the distribution of white-footed voles in Oregon (Maser and Johnson 1967), the species may be found on forest lands situated farther inland and at higher elevations in Del Norte and Humboldt counties. State agencies, the National Park Service, and the U. S. Forest Service should undertake detailed surveys to determine the distribution, population status, and habitat needs of white-footed voles on lands administered by them within these two counties. Logging activities or any type of construction that alter the overstory canopy or understory habitat of riparian communities along small streams in coast redwood forests should be minimized or prohibited in the vicinity of sites found to support extant populations.

Mojave River vole, *Microtus californicus mohavensis*
Philip V. Brylski

Description: No measurement data for this subspecies were found. The species is highly variable in size: TL from 157 to 211 mm and TAL from 39 to 68 mm. The Mojave River vole is the only vole found within the historic range indicated below.

Taxonomic Remarks: The Mojave River vole was described by Kellogg (1918) based on specimens collected from Victorville. The subspecies is recognized by Hall (1981) and Wilson and Reeder (1993). The Mojave River vole is one of two subspecies of *M. californicus* with highly restricted and disjunct distributions. The other is the Amargosa vole (*M. c. scirpensis*), an Endangered species that occurs in riparian habitat within the Amargosa River drainage.

Distribution: The Mojave River vole has been collected at only two localities along the Mojave River: at Victorville (elevation 900 m) and Oro Grande. The distributional limits of the subspecies are uncertain, but here are considered to be the Mojave River in the vicinity of the two known localities, an area of covering approximately 50 km^2 (V. Bleich, unpubl. data).

Life History: The Mojave River vole is relatively unstudied, and the following information is drawn from studies of other subspecies of *M. californicus*. Voles are active year-round and forage largely on grasses, forbs, and marsh vegetation. They make conspicuous runways through the vegetation (especially near their burrows), burrow extensively in non-flooded areas, and utilize downed wood, brush piles, and their burrows for cover. Voles are important for various predators, both mammalian and avian (Lidicker unpubl.). They typically show dramatic annual and multi-annual population cycles. Breeding activity may occur year-round but is concentrated in the wet season, from February through March for *mohavensis*. The gestation period is 21 days. Litter size averages 4 (range 1-9) and from two to five litters may be produced annually. Individuals may breed in their first year (reviewed in Zeiner et al. 1990). Because of their large population fluctuations (up to four orders of magnitude), their persistence in a habitat patch following periodic bottlenecks may show a strong positive correlation with patch size. Moreover, there is a strong negative interaction with house mice (*Mus musculus*) (Lidicker 1966), a non-native species that is typically numerous in suburban native habitats. The California vole is a good swimmer.

Habitat: As a species, the California vole occurs in a variety of habitats, including oak woodlands, grasslands, and freshwater and tidal marshes, at least where flooding does not occur regularly (Lidicker unpubl. data). Given the narrow juxtaposition of riparian and desert scrub habitat within its historic range, the Mojave River vole is restricted to the grassy or riparian habitats within the Mojave River corridor. In areas impacted by agricultural and suburban development, it may be confined to the more narrow riparian belt. The closely related Amargosa vole utilizes three elevations of marsh habitat: the lower elevations (within its range) marshes that are susceptible to annual flooding, the higher riparian-associated habitats that provide refuge during normal annual flooding, and the adjoining upland habitats that provide temporary habitat during unusually high flood events (Thelander et al. 1994).

Status: Class II. There are no recent records for the Mojave River vole. Riparian habitat along the Mojave River within its historic range has been heavily impacted by agricultural and urban land uses. Damage to residential developments along the Mojave River during recent flooding has resulted in pressures to control flooding through channelization. Bleich (in review) considered *mohavensis* vulnerable to extinction as a consequence of its restricted distribution, previous habitat loss, and the ongoing urbanization in lands adjoining its range. Populations are probably subject to

local extirpation following severe flooding events.

Management Recommendations: Basic data are needed on the population status of the Mojave River vole, as well as an analysis of minimum viable population size (Bleich in review). Bleich (in review) recommended the following management actions: *i*) undertake studies of populations of *mohavensis* at its historical localities in Victorville and Oro Grande to determine its status, collect data on its natural history, and determine minimum viable population size and the number of populations necessary for recovery. Field surveys should be designed to determine the species' distribution along the Mojave River; *ii*) undertake a hydrology study to determine the importance of spring subterranean water flows for maintaining its habitat; *iii*) analyze the natural and human impacts to yield further recommendations on how to maintain optimal densities and target habitats to receive high levels of protection; and *iv*) acquire privately-owned habitat considered critical to the continued viability of the species.

Riparian woodrat, *Neotoma fuscipes riparia*

Paul W. Collins

Description: This is a medium-sized (206-312 g, WT) rat-like rodent with grayish brown dorsum; pale to white venter; long (160--227 mm), faintly-bicolored, scantly-haired, tail; and relatively large (24-36 mm), naked ears (Ingles 1965, Jameson and Peeters, 1988, Carraway and Verts 1991). Riparian woodrats can be distinguished from adjacent subspecies by their larger overall size (434-452 mm, TL), lighter, more grayish dorsal coloration, distinctly bicolored tail (207-224 mm), larger (43-45 mm) hind feet with white rather than dusky colored upper surfaces, and larger more massive skull (40.0-44.7 mm, basilar length) (Hooper 1938).

Taxonomic Remarks: This taxon in one of 11 described subspecies of the dusky-footed woodrat (Hooper 1938). The morphological characters of *N. f. riparia* show considerable overlap with other races of *N. fuscipes*.

Distribution: Developing a clear picture of the historical range of this California endemic is difficult because much of the riparian forest habitat which this taxon inhabited was destroyed even before it was described by Hooper (1938), and because there are only a few woodrat specimens from the floor of the San Joaquin Valley available for study. According to Hooper (1938), the range of *riparia* encompassed the area in the vicinity of Kincaid's Ranch, about 3 km (2 mi) northeast of Vernalis, Stanislaus County (the type locality), and probably occurred historically along the west side of the San Joaquin River from southern Merced County or northern Fresno County north to the Suisun Straits region in Contra Costa County. Others list a more restricted historic range for this taxon which encompasses an area along the San Joaquin, Stanislaus, and Tuolumne rivers in Stanislaus and San Joaquin counties (Williams 1986, Williams and Kilburn 1992). Goldman (1910) listed a dusky-footed woodrat from El Nido in southern Merced County, which Hall and Kelson (1959) assigned to *riparia*. Williams (1986) suggests that this specimen may have originated from somewhere along the San Joaquin River west or south of El Nido. Three specimens assigned to *riparia*, one (CSUF) collected from 10 mi southwest of Los Banos, Merced County (Williams 1986), and the other two (MVZ 94769 and 128790) collected from Corral Hollow Creek in western San Joaquin County, are outside the accepted geographic range for *riparia*. If these outlying specimens turn out to be riparian woodrats, then the historic range of this taxa would have included an area of the San Joaquin Valley floor encompassed by the San Joaquin River and its tributaries, extending from southern Fresno County north to its confluence with the Sacramento-San Joaquin River Delta in Contra Costa County. Clarifying the historic range of *riparia* will have to wait until the taxonomic status of all available specimens collected from sites across the floor of the San Joaquin Valley in Merced, Fresno, Stanislaus, Contra Costa and San Joaquin counties is reevaluated.

Currently, a single population is known to exist on about 102 ha (250 acres) of riparian forest along the Stanislaus River in and immediately adjacent to Caswell Memorial State Park (Cook 1992, Williams 1993). Williams (1993) estimated that approximately 437 woodrats inhabited 91 ha of this 104 ha (258 acre) park. Riparian woodrats also may still be present along the San Joaquin River in the vicinity of the type locality near Vernalis, Stanislaus County; however, there are no reported sightings there since the 1970s (Williams and Kilburn 1992). Woodrats are also occasionally found in wood duck nest boxes along the lower San Joaquin and Tuolumne rivers which suggests the possible presence of additional extant populations of this taxon along these two rivers (Williams 1986). Intensive, range-wide surveys throughout the northern San Joaquin Valley floor of remnant stands of riparian forest habitat along the San Joaquin River and its larger tributaries are needed to clarify the current distribution and population status of this taxon.

Life History: No studies have been conducted on the life history of the riparian woodrat. This account is based on studies of other subspecies of dusky-footed woodrats (Linsdale and Tevis 1951, Carey 1991, Carraway and Verts 1991).

The distribution of dusky-footed woodrats is apparently restricted by factors such as their limited dispersal abilities, daily water requirements, and the availability of dense, brushy habitat (Carey 1991). With a minimum daily requirement for water of 10.2% of their body mass (Carpenter 1966), dusky-footed woodrats tend to be restricted to habitats that are in close proximity to a year-round water supply. They are primarily nocturnal showing peak activity at dawn and dusk. They are equally proficient on the ground and in the foliage of trees and shrubs (Linsdale and Tevis 1951). In California, dusky-footed woodrats breed from December to September, with the majority of litters born in mid-spring (Carraway and Verts 1991). Following a 28-33 day gestation period (Carraway and Verts 1991), females give birth to one annual litter (Vestal 1938). Litter size averages 2.6 young per litter but ranges from one to four (Carraway and Verts 1991). Juveniles rarely disperse more than 50 ft to establish home ranges in or adjacent to the maternal range (Linsdale and Tevis 1951). The matrilineal social structure of dusky-footed woodrat societies results in populations that are female-biased and in which adjacent females are closely related. Unlike females, males disperse away from their birth den, and are highly territorial and aggressive during the breeding season.

The dusky-footed woodrat is a social animal which lives in colonies of conical stick houses constructed with sticks, bark, plant cuttings, and other objects (Carraway and Verts 1991). Individual colonies are relatively stable with the number of adults remaining fairly constant (Wallen 1982). Woodrat colonies are generally situated in flood-free areas. Colonies established in areas subject to flooding may be abandoned in favor of sites on higher ground (Cranford 1977). Woodrats generally construct their houses in locations which provide good cover, low to medium humidity, cool temperatures, and dark surroundings (Linsdale 1957). At Caswell Memorial Park, riparian woodrat houses were generally positioned over or next to logs in areas with a dense canopy cover, ground cover high in leaf litter and a light growth of sedges, and a moderate understory of vines, seedlings, and shrubs (Cook 1992). Each house represents the efforts of many generations of woodrats and can be occupied continuously for 13-25 years (Linsdale and Tevis 1956, Wallen 1982). Woodrat houses used as residences are generally occupied and vigorously defended by a single adult woodrat. Some houses are "common" houses which are used by many individuals and serve as places where males and females meet (Wallen 1982). Houses are used for nurseries, protection from predation and temperature extremes, resting, self care, food storage, and social communication (Vestal 1938, Wallen 1982). In California, woodrat stick houses occur in densities of 7.4-37.1/ha (Vogl 1967, Cranford 1977) with an average of 1.8 houses/home range (M'Closkey 1972). The number of houses is typically greater than the number of woodrats present in a given area. At Caswell Memorial Park, riparian woodrat houses have been recorded at a mean density of 6.6 to 8.3 houses/ha for a park-wide estimate of 673-847 houses (Cook 1992, Williams 1993). Although dusky footed woodrats can occur at densities ranging from 3.2-7.3/ha (Cranford 1977, Wallen 1982), they have relatively small home ranges. Riparian woodrats have been recorded at a mean density of 4.8 woodrats/ha, for an estimated population size of 437 woodrats in 91 ha of Caswell Memorial State Park (Williams 1993). Based on a density of 6.6 woodrat houses/ha, Cook (1992) extrapolated a population estimate of 673 woodrats for Caswell Memorial Park. In California, dusky-footed woodrat home ranges averaged 0.23 ha (0.58 acres) for males, 0.19 ha (0.48 acres) for females, and 0.17 ha (0.43 acres) for juveniles (Cranford 1977). On average, females travel 837 meters and males 949 m from initial points of capture (Smith 1965).

Habitat: Historically, riparian woodrats probably inhabited the riparian forests in the floodplain along the San Joaquin River and its tributaries. The riparian woodrat occurs in riparian woodland

with an overstory canopy of trees and moderate to dense shrub understory, with abundant dead branches and downed woody material (Williams 1993). Low-growing woody vegetation provides important protection from predators, shade, food sources, suitable limbs for runways between houses, sufficient woody materials for constructing nests and houses, and vertical woody support required for stabilizing a large house (Linsdale and Tevis 1951, Carey 1991). Nest sites are also located in tree cavities, logs, and talus slopes. At Caswell Memorial Park, *N. f. riparia* occurred in dense understory shrubs under a closed canopy of riparian forest trees (Cook 1992, Williams 1993).

Status: Class I. This taxon appears to meet CESA criteria for listing as Endangered because of its restricted distribution in a single small population, and ongoing threats of continued loss and degradation of its riparian forest habitat to urban and agricultural development and flood control activities. Because of its small population size, the single population is at risk of extinction from genetic (inbreeding depression), demographic (disease), and environmental (flooding, wildfire) variability.

The principal reason for the decline of riparian woodrats in California has been the destruction, fragmentation, and degradation of the San Joaquin Valley native riparian forest community, due in part to the construction of dams and canals which diverted water for irrigation of farm lands and permanently altered the hydrology of Valley streams. During pre-settlement times, San Joaquin Valley riparian forest was distributed as stringers or corridors along water courses and over much of the riverine floodplains on the floor of the northern San Joaquin Valley (Katibah 1984). Historically the northern San Joaquin Valley from the Merced River north to confluence of the San Joaquin and Sacramento rivers in Contra Costa County contained approximately 75,100 ha (185,600 acres) of riparian forest habitat (Katibah 1984). By the mid-1980s only about 11.1% (8,336 ha) of this habitat remained, and the majority continues to be impacted by human activities (Katibah 1984). Today, San Joaquin Valley riparian forest habitat is only a vestige of what was present 100 years ago and is confined to a few disjunct patches and narrow ribbons along the San Joaquin River and a few of its larger tributaries. Gone are the broad expanses of this woodland habitat that once covered large areas of the valley floor in the northern San Joaquin Valley. Caswell Memorial State Park provides one of the largest remaining patches (104.5 ha) of San Joaquin Valley riparian forest habitat and is the only locale within the historic range with a surviving population of riparian woodrats (Williams 1993). Other threats include: continued loss of riparian and native floodplain habitats to cultivation and ongoing flood control projects; regulation of stream flow; stream channelization and levee maintenance; removal and burning of undergrowth (brush, trees, and snags) from riverside habitat which reduces the available cover critical to this species; and use of rodenticide treated grain within the range of this species to control California ground squirrel populations (Williams 1986, Williams and Kilburn 1992). Cattle grazing may adversely impact *riparia* habitat by removing available brushy cover (Linsdale and Tevis 1956). Wildfires and prescribed burning are also detrimental.

Management Recommendations: If listed, the riparian woodrat would be eligible for the allocation of funds and resources for its protection and recovery, and would receive protection from proposed developments that could alter its habitat by requiring pre-project biological consultation in accordance with CEQA and CESA. Such a consultation would ensure that mitigation measures and project alternatives developed during the CEQA environmental review process would be implemented as terms of project approval.

The draft recovery plan for upland species of the San Joaquin Valley (Williams et al. 1997) provides detailed recommendations for the management and conservation of the riparian woodrat. A summary of these is as follows: *i)* establish linkage corridors to reduce the effects of population fragmentation, *ii)* survey and map all riparian areas along the San Joaquin River and its major

tributaries, *iii)* collaborate with owners of riparian land and local levee-maintenance districts to develop an incentive program for preserving cover and riparian vegetation, *iv)* develop a plan for the restoration of riparian habitat, establishement of riparian corridors, and reintroduction (if necessary) of riparian woodrats to suitable habitat, *v)* initiate genetic studies of existing populations, *vi)* establish conservation agreements with willing landowners, *vii)* restore and link riparian habitat and reintroduce woodrats, *viii)* reevaluate the status of the riparian woodrat within three years of recovery plan approval. [Editor's note: The final Recovery Plan for Upland Species of the San Joaquin Valley, California was approved September 30, 1998.]

A trapping survey of remaining riparian forest habitat along all river corridors throughout the historic range of the riparian woodrat is needed to clarify the distribution and abundance of extant woodrat populations. Threats to remaining populations should be identified. Basic life history data that are needed to develop recovery and habitat conservation plans include habitat requirements, dispersal characteristics, and minimum viable population size. Genetic and morphologic studies are needed to clarify the taxonomic status and phylogenetic relationship of dusky-footed woodrats on the floor of the San Joaquin Valley from southern Fresno County north to the Delta in Contra Costa County; to clarify the systematic status of woodrats at Corral Hollow Creek, along the San Joaquin River near El Nido, and from areas south of Los Banos; and to determine levels of genetic diversity and inbreeding in the woodrat population at Caswell Memorial State Park.

Riparian woodrats are afforded some protection because they co-occur with the State-listed riparian brush rabbit (*Sylvilagus bachmani riparius*), and because the only know population occurs in Caswell Memorial State Park. However, the conservation needs of these species may differ in important respects. Listing this taxon as Endangered would lead to recovery and management actions that address its specific needs. In developing recovery and management strategies, measures recommended to protect and enhance San Joaquin Valley riparian forest habitat for the Endangered riparian brush rabbit (Larsen 1993) should be reviewed and modified where appropriate to ensure that habitat for the riparian woodrat is also being enhanced.

Ramona grasshopper mouse, *Onychomys torridus Ramona*

Paul W. Collins

Description: Southern grasshopper mice (*Onychomys torridus*) are short-tailed (39-52 mm), stocky (20-26 g) mice with sharply bicolored pelage (pale-brown to grayish or pinkish cinnamon dorsally and white ventrally); short, thick, distinctly bicolored (dark dorsally and white distally) tail with a white tip; and large hind feet (18-23 mm) with four tubercles and densely-furred soles (Hollister 1914, McCarty 1975, Jameson and Peeters 1988). Grasshopper mice can be distinguished from coexisting species of white-footed mice (*Peromyscus* spp.) by their relatively short (generally less than 50% of head and body length), club-like tail, and larger hind feet with hairy soles (McCarty 1975). The Ramona grasshopper mouse (*O. t. ramona*) is distinguished by its dark brown to grayish dorsal coloration (Rhoades 1893, Hollister 1914). This distinctive subspecies is the darkest colored race of *O. torridus* found in the United States (Hollister 1914). In size and skull characters this subspecies is similar to adjacent subspecies of *O. torridus* (Mearns 1907, Hollister 1914).

Taxonomic Remarks: This taxon was originally described as *O. ramona* (Rhoades 1893) and was later relegated to a subspecies of *O. torridus* by Merriam (1904a). Intergradation with the desert-inhabiting *O. t. pulcher* was reported in the west end of San Gorgonio Pass (Hollister 1914) and along the western side of Anza Borrego Desert State Park (Banks 1964). In areas where these two subspecies intergrade, it is difficult to assign specimens to a particular subspecies (Banks 1964). It is unknown to what extent these two forms intergrade elsewhere where their populations meet. Data on genetic and morphologic variability within *O. t. ramona* are lacking.

Distribution: In California, the Ramona grasshopper mouse ranges southward from Los Angeles County to the Mexican border, generally west of the desert. Historically, it inhabited mesas and valleys along the Pacific slope of the Peninsular and Transverse Ranges in southwestern California and extreme northwestern Baja California, Mexico (Hollister 1914, Grinnell 1933). It ranged from about Mint Canyon and San Fernando (Los Angeles County), east to Valle Vista in San Jacinto Valley (Riverside County), and south to La Puerta Valley and Jacumba (San Diego County) and Tecarte Valley (Baja California, Mexico) (Hollister 1914, Grinnell 1933, von Bloeker 1932). The known elevational range is from near sea level at the mouth of Tia Juana River (San Diego County: USNM 126061) to ca. 4,160 ft, north of Boulevard (San Diego County: LACM 81297). Specimen records indicate that it generally occurs below 3,000 ft elevation. Although *O. t. ramona* typically occurs west of the deserts on the Pacific slope side of the San Gabriel and San Bernardino mountains south through the Peninsular Ranges to the Mexican border, it also occurs at a number of scattered sites along the extreme western desert slope of the San Gabriel Mountains and the Peninsular Ranges. Specimens from these sites should be examined to determine their subspecific affinities, and whether intergradation is occurring between *O. t. ramona* and *O. t. pulcher* at sites situated along the desert slope of the Transverse and Peninsular ranges.

Life History: The life history of the Ramona grasshopper mouse is apparently similar to that of the related Tulare grasshopper mouse (see *O. t. tularensis* account). In general, they are primarily carnivorous, have large home ranges, occur in low densities, are highly territorial, and generally reproduce during the spring and early summer. Mearns (1907) reported collecting two gray-pelaged juveniles on 21 and 25 May at the foot of the Santee Mountains in San Diego County. Ramona grasshopper mice produce litters which average four young from March through June (Stephens 1906). According to Stephens (1921), *O. t. ramona* was "not common" in San Diego County. There is little additional data available on the life history of the Ramona grasshopper mouse.

Habitat: Little is known about the habitat requirements of the Ramona grasshopper mouse. This

taxon is believed to inhabit flat, sandy, valley floor habitats (Stephens 1906, Grinnell 1933). At Valle Vista in San Jacinto Valley, Riverside County, Grinnell and Swarth (1913) collected *O. t. ramona* among scattered brush on a gravelly valley floor. In San Diego County, it inhabited mesas and valleys in the coastal region (Stephens 1921). Like *O. torridus* elsewhere in California, this taxon probably inhabits a variety of low, open and semi-open scrub habitats including coastal sage scrub, mixed chaparral, low sagebrush, riparian scrub, and annual grassland with scattered shrubs.

Status: Class II. The Ramona grasshopper mouse occurs in relatively low densities, and was considered uncommon by Stephens (1906, 1921). There are also few museum records for the species over the past 20 years (per our museum specimen records inventory). Recent records document the occurrence of this taxon on the desert slopes of the San Gabriel Mountains and the Peninsular Ranges, near Sage and Aguanga in Riverside County, and from the vicinity of Banner, Jacumba, Boulevard and Oak Grove in San Diego County. However, there are no recent records from the Los Angeles Basin, from the vicinity of Riverside and San Bernardino, from most of Orange County, or from western San Diego County. The Ramona grasshopper mouse is more susceptible to small- and large-scale habitat loss and fragmentation than other rodents, due to its low fecundity, low population density, and large home range size. The species has been extirpated from large areas of its historic range, including most flat valley bottom land, mesas, and low foothills, as a result of conversion of its habitat to urban and agricultural uses. Large-scale loss of habitat has occurred throughout the Los Angeles Basin, in coastal areas of Orange and San Diego counties, and in interior valleys of San Bernardino, southwestern Riverside and northern San Diego counties.

Management Recommendations: Studies on the current distribution, population status, and life history of this species are needed.

Tulare grasshopper mouse, *Onychomys torridus tularensis*
Paul W. Collins

Description: See the species account for *O. t. ramona* for a general description of the species. The Tulare grasshopper mouse (*O. t. tularensis*) can be distinguished from adjacent subspecies of *O. torridus* by its slightly darker dorsal coloration (pale grayish-drab tinged with dark pinkish-cinnamon), and smaller size (Merriam 1904a, Hollister 1914).

Taxonomic Remarks: The Tulare grasshopper mouse (*O. t. tularensis*) was described by Merriam (1904a), and is currently one of nine recognized subspecies (Wilson and Reeder 1993). There have been several recent taxonomic studies of the southern grasshopper mouse, *O. torridus* (VanCura and Hoffmeister 1966, Matson and Friesen 1978, Hinesley 1979, Sullivan et al. 1986), but there have been no systematic revisions of the species since Hollister (1914). A genetic and morphologic review is warranted.

Distribution: The historic range of the Tulare grasshopper mouse extended along the foothills and floor of the southern San Joaquin Valley from western Merced and eastern San Benito counties, east to Madera County, and south to the foothills of the Tehachapi and San Emigdio mountains (Grinnell 1933, Newman and Duncan 1973, Williams and Kilburn 1992). It also occurs on the Carrizo Plains in eastern San Luis Obispo County, Cuyama Valley, Caliente Creek Wash in southern Kern County, Weldon and Kelso Valley in northeastern Kern County, the Tulare Basin, and the Panoche Valley (Merriam 1904a, Hollister 1914, Grinnell 1933, Williams and Kilburn 1992). The known elevational range extends from ca. 279 ft at Alila (=Earlimart, Tulare County: USNM 126396) to approximately 2650 ft near Weldon (Kern County: MVZ 15187).

Life History: The following information is based on data from other subspecies of *Onychomys torridus* (McCarty 1975, Zeiner et al. 1990). The Tulare grasshopper mouse appears to be primarily nocturnal and is active year-round (Williams unpubl. observ.). Southern grasshopper mice are largely insectivorous (Bailey and Sperry 1929, Chew and Chew 1970, Horner et al. 1964). Typical prey includes grasshoppers, crickets, caterpillars, moths, scorpions, and beetles (Bailey and Sperry 1929). Incidental foods eaten include seeds, small mice, spiders, mites, ants, lizards, salamanders and frogs (Horner et al. 1964, McCarty 1975, Zeiner et al. 1990). Southern grasshopper mice are capable of breeding year-round (Pinter 1970). Following a 27 to 32 day gestation, females give birth from May through July to from two to six young per litter, with up to three litters produced per year (Taylor 1968). Based on laboratory studies, females are generally sexually active for a single breeding season and exhibit a rapid onset of reproductive senility following the first year (Taylor 1968). In the laboratory, southern grasshopper mice survived up to three years, but in the wild they probably live less than 12 months (Horner and Taylor 1968). Although southern grasshopper mice may construct nests in burrows which they excavate, they typically construct nests in burrows which have been abandoned by other rodents (Bailey and Sperry 1929).

Southern grasshopper mice occur in low densities and have larger home ranges than rodents of similar size (McCarty 1975). In desert scrub in Nevada, *O. torridus* densities averaged 1.83 mice/ha (Chew and Chew 1970). In New Mexico, the average home range of *O. torridus* was 3.2 ha (7.8 acres) for males and 2.4 ha (5.9 acres) for females (Blair 1943). In southeastern Arizona, the average home range of adult *O. torridus* was 11.45 ha (Chew and Chew 1970). No data are available on dispersal. Adult male southern grasshopper mice are highly territorial and emit high-pitched calls which apparently function as a territorial advertisement and spacing mechanism (Horner and Taylor 1968, McCarty 1975). These vocalizations may also play a role in mate acquisition (Hafner and Hafner 1979).

Likely predators include barn owls (*Tyto alba*), burrowing owls (*Athene cuncularia*) (Conroy and Chesemore 1992), American badgers (Taxidea taxus), San Joaquin kit foxes (*Vulpes macrotis*), introduced red foxes (*Vulpes vulpes*), coyotes (*Canis latrans*) and long-tailed weasels (*Mustela frenata*). Small mammals which Tulare grasshopper mice are generally associated with include giant (*Dipodomys ingens*), San Joaquin (*D. nitratoides*)and Heermann kangaroo (*D. heermanii*) rats, California ground squirrels (*Spermophilus beecheyi*), San Joaquin antelope squirrels (*Ammospermophilus nelsoni*), San Joaquin (*Perognathus inornatus*) and California pocket mice (*Chetodipus californicus* spp.), deer mice (*Peromyscus* spp.), western harvest mice (*Reithrodontomys megalotis*) and feral house mice (*Mus musculus*) (Hawbecker 1951, D. Williams unpubl. data).

Habitat: *O. torridus* inhabit low, open scrub and semiscrub habitats (e.g., alkali desert scrub and desert scrub) in arid, Lower Sonoran associations (McCarty 1975, Zeiner et al. 1990). Grinnell (1933) reported that *O. t. tularensis* favors "compact soils with a sparse growth of perennial grasses." In the literature, this taxon has been recorded in Blue Oak Savannah, where it is rare (Newman and Duncan 1973), and in desert scrub associations composed of grasses and shrubs such as California ephedra, San Francisco snake weed (*Gutierrezia*), narrowleaf goldenbush (*Ericameria*), and California buckwheat (*Eriogonum*) (Hawbecker 1951). Tulare grasshopper mice have been captured in a variety of Lower Sonoran vegetative associations in the western San Joaquin Valley and on the Carrizo Plain including: Valley Sink and Saltbush Scrub communities dominated by one or more shrubs such as saltbush (*Atriplex*), iodine bush (*Allenrolfea*), shrubby seablite (*Sueda*), alkali heath (*Frakenia*) and alkali goldenbush (*Isocomoa*); Coast Range Saltbush Scrub dominated by all-scale saltbush (*Atriplex*), alkali goldenbush, San Joaquin matchweed (*Gutierrezia*), bladderpod (*Isomeris*), California ephedra (*Ephedra californica*), and Diablo and black locoweeds (*Astragalus*); Great Valley Mesquite Scrub on the valley floor dominated by western honey mesquite (*Prosopis*), all-scale saltbush, and alkali goldenbush; and Valley Grassland dominated by Arabian schismus (*Schismus*) and red brome (*Bromus*) (see Griggs et al. 1992 for community names and plant dominants; Williams and Kilburn 1992).

Status: Class II. The Tulare grasshopper mouse was considered uncommon in the San Joaquin Valley by Stephens (1906) and is now considered to be "the rarest species of rodent in the San Joaquin Mammalian Faunal Region" (Williams and Kilburn 1992). The species' low fecundity and low population density make it vulnerable to threat (Williams and Kilburn 1992). Although it is apparently widespread, nowhere is it locally abundant (Williams and Kilburn 1992). Intensive small mammal trapping during the past fifteen years at a number of sites on the valley floor, such as Alkali Sink Ecological Reserve, Pixley National Wildlife Refuge, Tule Elk State Reserve, Kerman Ecological Reserve, several sites in Madera County, and Lemoore Naval Air Station, have failed to capture a single Tulare grasshopper mouse (Clark et al. 1982, Harrison et al. 1992, D. Williams pers. comm.). Based on these surveys, there are apparently no fragmented islands of native scrub habitat on the valley floor, either large or small, where grasshopper mice still persist (D. Williams, pers. comm.). The Tulare grasshopper mouse continues to be fairly common in western Kern County and at the Carrizo Plain Natural Area in San Luis Obispo County, and is uncommon at a few sites in the Diablo Ranges in Fresno, Kings, and Kern counties (D. Williams pers. comm.). There have been no recent range-wide surveys conducted for this taxon.

Habitat loss and fragmentation and agricultural conversion in the San Joaquin Valley are the principal reasons for the decline of the Tulare grasshopper mouse. The adverse affects of insecticides on natural lands to control beet leafhoppers probably contributed to the disappearance of grasshopper mice from fragmented islands of natural land on the Valley floor (Williams et al. in litt.). Insecticides adversely affect grasshopper mice through direct and indirect poisoning and by

reducing insects, their staple food. Other factors contributing to the extirpation of grasshopper mice from fragmented parcels on the San Joaquin Valley floor include secondary poisoning from rodenticides, used to control California ground squirrels, and pesticide drift from aerial spraying of adjacent farm lands (Williams et al. in litt.). The most serious threats to Tulare grasshopper mice come from the continued fragmentation and loss of native habitats to agriculture, and from inappropriate land management practices on remaining fragments of native habitat (Williams in litt.). In addition, its low fecundity and low population density make it susceptible to local extirpation following even moderate habitat loss and fragmentation (Williams and Kilburn 1992).

Management Recommendations: Since the Tulare grasshopper mouse lives in the same communities as listed species of kangaroo rats (*Dipodomys ingens, D. nitratoides exilis*, and *D. n. nitratoides*), the blunt-nosed leopard lizard (*Gambelia sila*), and the San Joaquin kit fox (*Vulpes macrotis mutica*), its habitat needs are essentially the same as these "umbrella species", and habitat protection measures for the listed species should benefit the grasshopper mouse as well. Measures for these species should be reviewed, however, to ensure the habitat needs of the Tulare grasshopper mouse are not compromised. The draft recovery plan for upland species of the San Joaquin Valley (Williams et al. 1997) lists a number of additional recommended conservation actions for the grasshopper mouse. In summary, they include *i)* determine current distribution and population status of remaining populations of Tulare grasshopper mice, *ii)* analyze the environmental features of inhabited versus uninhabited fragmented islands of natural land, *iii)* establish a range-wide monitoring program at representative sites, *iv)* if habitat on the Valley floor are increased in size by retirement of agricultural land, restore habitat and reintroduce grasshopper mice, *v)* include Tulare grasshopper mice in studies of management and land uses on habitat of other species of the same community associations, and *vi)* reevaluate the status of the grasshopper mouse within three years of recovery plan approval. In addition, the taxonomic status of California populations of the southern grasshopper mouse should be clarified using morphometric and biochemical methods. Finally, remaining large blocks of historical native scrub habitats on the valley floor of the Tulare Basin should be protected from further conversion to agriculture.

Colorado River cotton rat, *Sigmodon arizonae plenus*

Paul W. Collins

Description: A medium-sized (276-346 mm) rat-like rodent with rough, coarse fur; hispid blackish-brown dorsum; silvery or whitish venter with base of hairs blackish; scaly, sparsely haired tail (usually 110 mm or longer) which is shorter than the head and body length; large ears (19-24 mm) which are hidden by hair; and relatively large hindfeet (usually 32 mm or longer) (Clark 1972, Blood 1981, Hoffmeister 1986). No single character consistently separates *S. arizonae* from *S. hispidus*. However, distinguishing them is based on a suite of characters: *S. arizonae* can be distinguished by its larger overall size, hindfeet which are 32 mm or longer, broad presphenoid, round occipital shield, sharp anterior spine on the infraorbital plate, and nasal bones with straight lateral borders (Severinghaus and Hoffmeister 1978, Hoffmeister 1986, Blood 1990). In his original description of *plenus*, Goldman (1928) separated this taxon from *eremicus* because of its large size, pallid coloration, more massive skull, and broader rostrum.

Taxonomic Remarks: The Colorado River cotton rat is closely related to *Sigmodon arizonae*, based on genetic (Zimmerman 1970, Blood 1990) and morphologic data (Severinghaus and Hoffmeister 1978, Hoffmeister 1986, Blood 1990).

Goldman (1928) first described *plenus* as a subspecies of *Sigmodon hispidus*. Based on a difference in chromosome number and structure, Zimmerman (1970) synonymized *S. h. plenus* and *S. arizonae*, but left the status of *S. hispidus eremicus* in question. Zimmerman (1970) reported a chromosome number of 22 and a fundamental number of 38 for *S. arizonae*, and 24 chromosomes and a fundamental number of 38 for *S. a. plenus* from Parker, Yuma County, Arizona. This contrasts with *S. hispidus* which has 52 chromosomes and a fundamental number of 52 (Zimmerman 1970). Blood (1990) confirmed that *Sigmodon* populations along the Colorado River in California north of the Palo Verde Mountains had a karyotype of 24 and were morphologically most similar to *S. arizonae*. He also reported that cotton rats from along the Colorado River in Imperial County, California had a karyotype of 52 and were morphologically most similar to *S. hispidus* (Blood 1990).

Distribution: *S. a. plenus* is found in California and Arizona in moist riverside habitats along the Colorado River floodplain north of the Palo Verde Mountains, from Palo Verde Valley to the vicinity of Parker, Arizona (Hoffmeister 1986, Blood 1990, Blood in review). Populations that occurred historically in southern Nevada are now considered to be extinct (Hall 1946, Bradley 1966). Specimen records, along with recent surveys in California, confirm that the distribution of this taxon is patchy (Blood 1990).

Life History: This discussion is based on the hispid cotton rat (*Sigmodon hispidus*) (Cameron and Spencer 1981), a close relative of the Colorado River cotton rat, which is poorly studied. Cotton rats are active year-round, both nocturnally and diurnally. Cotton rats are vegetarians that feed primarily on grass stems, leaves, roots, and seeds but occasionally also eat insects, and animal flesh, and make well-defined runways through dense herbaceous growth. They are also capable swimmers.

The Arizona cotton rat probably has a relatively high reproductive potential. They breed year-round; young have been observed during the spring (February-April) and fall (August-October) (Hoffmeister 1986). Females are sexually active at 30-50 days of age and produce more than one litter annually. Litter sizes range from 1-15 young per litter with most litters averaging 5-7. Based on embryo counts, Hoffmeister (1986) recorded litters in *S. arizonae* ranging from 5-12 per litter. Schwartz and Schwartz (1959) recorded population peaks every 2 to 5 years in hispid cotton rats. Maximum densities in hispid cotton rats tend to occur in the fall (range from 14 to 69/ha) and

minimum densities occur in the winter or summer (range from 0.5 to 25/ha) (Zeiner et al. 1990). Colorado River cotton rat populations occasionally reach relatively high densities (Hoffmeister 1986). Males tend to have larger home ranges (0.35 to 0.39 ha) than females (0.22 ha).

Habitat: There is little literature on the habitat of *S. a. plenus*. Until 1970, *Sigmodon* populations along the Colorado River north of the Palo Verde Mountains were thought to represent a single species (whereas now they are known to comprise *a. plenus* and *h. eremicus*). Consequently, information contained in the early literature about habitat associations of cotton rats along the Colorado River pertains to both *S. a. plenus* and *S. h. eremicus*. Grinnell (1914) reported that cotton rats in California were associated with the willow-cottonwood plant association along the lower Colorado River. Grinnell (1933) reported that *S. h. eremicus* "inhabits tracts of sedge, rushes, or cane close to edges of permanent streams or sloughs." According to Clark (1972), *S. h. eremicus* in California were generally associated with drainage ditches, canals and seeps vegetated with plants such as arrowweed, saltgrass, common reed, screwbean, cattails, sedges, tamarisk, heliotrope and annual grasses.

Colorado River cotton rats probably frequent some of the same mesic habitats as *S. h. eremicus*. According to Goldman (1928), *plenus* was apparently restricted to "isolated sections of alluvial bottom along the Colorado River." The climate in areas adjacent to the river is too hot and arid to support cotton rats except in the immediate vicinity of the river flood plain (Williams 1986). Hall (1946) collected *S. a. plenus* from a small marsh in southern Nevada along the Colorado River supporting cattails (*Typha* sp.) and Bermuda grass (*Cynodon* sp.) and ringed by mesquite (*Prosopis glandulosa*). Near Parker, Arizona, Zimmerman (1970) captured *plenus* in stands of common reed (*Phragmites communis*). North of Blythe, Blood (1981) captured *plenus* in marginal habitat of a single row of salt cedar (*Tamarix ramosissima*) and an adjacent field of sagebrush (*Artemsia* sp.). Along the Arizona side of the Colorado River, Hoffmeister (1986) collected *plenus* in irrigated agricultural fields and along an irrigation canal. Elsewhere in Arizona, *S. arizonae* has been found in a variety of habitats, ranging from mesquite and tumbleweed (*Salsola tragus*) arid scrubs, to mesic areas such as along canals and banks of small streams vegetated with weeds and brush (Hoffmeister 1986). Based on the limited data presently available, Colorado River cotton rats are probably confined to isolated mesic habitats such as desert riparian, grassland, and fresh emergent wetlands in alluvial bottom lands along the Colorado River, and avoid surrounding true desert habitats (Goldman 1928, Hoffmeister 1986, Zeiner et al. 1990, Blood in review). Occasionally, they inhabit irrigated croplands and herbaceous borders along canals and irrigation ditches in the immediate vicinity of the Colorado River.

Status: Class II. Extensive alteration and destruction of wetland and riparian habitats along the lower Colorado River during the past 100 years (Ohmart et al. 1988) has adversely affected this taxon. A review of museum specimen records (n=162) indicates that *S. a. plenus* occurred historically along the Colorado River at eleven sites in California, five sites on the Arizona, and one site in Nevada. Attempts to trap cotton rats in 1979 along the California side of the Colorado River between Blythe to Earp resulted in the capture of *plenus* at a site 33 mi (53.1 km) north of Blythe near the town of Earp (Blood 1981). Bradley (1966) caught no cotton rats along the Colorado River in Nevada, where the species occurred historically (Hall 1946). Based on the absence of habitat, Bradley (1966) argued that the wetland vegetation at this marsh reverted to drier desert vegetation as a result of the elimination of annual flooding along the Colorado River due to channelization of the river, and hydrological changes as a result of dams and the filling of Lake Powell.

The principal reason for the decline of Colorado River cotton rats in California has been the destruction, fragmentation, and degradation of seasonally flooded riparian and wetland communities

along the floodplain of the lower Colorado River. Much of this resulted from the construction of dams and canals which diverted water for urban and agricultural uses and which controlled annual flooding along the lower Colorado River. Some sites were flooded when lakes filled behind newly constructed dams, while other sites reverted to unsuitable dry desert habitats when annual flooding along the river flood plain was eliminated. Following the construction of dams and levees along the river, extensive areas of seasonally flooded riverside habitats were converted to irrigated agriculture. Urban and recreational developments have also eliminated habitat that probably once supported this taxon. Other threats to the continued survival of this taxon include use of rodenticide treated baits within its historic range, and continued loss of remaining areas of riverside habitat to urban, recreational and agricultural developments. It is unknown at this time whether extensive recreational uses of the lower Colorado River are having any adverse affects on this taxon.

Management Recommendations: The first priority for this taxon should be to gather current, reliable data on its distribution, population status, habitat needs, and extent of remaining suitable habitat. Live-trapping surveys at historical localities and potential habitat elsewhere within its range are needed to evaluate its current status in California. The southern distributional limits of this taxon along the Colorado River also needs to be investigated to clarify its distributional limits and to see whether there is any overlap with *S. h. eremicus* populations. Since there is no basic life history information for this taxon, detailed studies are needed to gather specific information on habitat requirements, reproductive biology, demographics, dispersal capabilities, food habits, and factors that are threatening extant populations. Basic life history data are needed before effective management recommendations can be developed for this taxon. The feasibility of securing native habitat along the Colorado River found to support extant populations of this taxon should be investigated.

Point Reyes jumping mouse, *Zapus trinotatus orarius*

Paul W. Collins

Description: This is a small (211-238 mm TL), long-tailed (112-155 mm), dark yellow-brown mouse with an indistinctly bicolored dorsum, white ventrum, faintly tinged with yellow, sparsely haired bicolored tail, enlarged hind legs and feet (30-36 mm) adapted for jumping, internal cheek pouches, grooved upper incisors, wide pterygoid fossae, large oval infraorbital foramen, and baculum with a spade-shaped tip (Howell 1920c, Ingles 1965, Hall 1981, Gannon 1988, Jameson and Peeters 1988). The pelage of the Point Reyes jumping mouse is tricolored; the upper parts are dark to cinnamon-brown (ochraceous) overlaid with black hairs forming an indistinct dark dorsal band; the sides are lighter (orange-yellow flecked with coarse black hairs) than the back; and the underparts are mostly white, faintly tinged with yellow (Howell 1920c, Krutzsch 1954, Ingles 1965, Gannon 1988). The sparsely-haired tail is dark brown above and white to yellowish-white below (Krutzsch 1954). TL is 224.3 mm (range 222-249 mm), TAL is 129.4 mm (range 121-148 mm), and HF is 31.6 mm (range 30.0-34.0 mm) (Howell 1920c). It is distinguished from *Z. t. eureka* by its brighter coloration; shorter hind foot and tail (58% of TL); smaller skull with a narrower interorbital width; narrower interpterygoid fossa; shorter incisive foramina and molar tooth row; smaller, less inflated auditory bullae; and longer palatal bridge (Preble 1899, Howell 1920c, Krutzsch 1954).

Taxonomic Remarks: The Point Reyes jumping mouse is the southernmost population and smallest subspecies of the Pacific jumping mouse (Gannon 1988). Originally described as a monotypic species (*Z. orarius*) (Preble 1899, Howell 1920c), Hooper (1944) arranged it as a subspecies of *Z. trinotatus*, a conclusion later supported by Krutzsh (1954), based on morphological data.

Distribution: The Pacific jumping mouse occurs along the narrow, fog zone in coastal forests west of the Cascades, from southwestern British Columbia south along the coasts of Oregon and Washington to Marin County, California (Krutzsch 1954, Hall 1981). The Point Reyes jumping mouse is restricted to the Point Reyes Peninsula in southern and western Marin County (Krutzsch 1954). The elevational range of *orarius* is from 10 ft at the west end of Elk (=Tennessee) Valley to about 300 ft at Ledum Swamp 3 mi (4.8 km) west of Inverness (Williams 1986). The nearest known record for its conspecific, *Z. t. eureka*, is from Albion River, 0.5 km east of MacDonald's Ranch, Mendocino County, 115 km from the northernmost record for *orarius* (Lidicker in review).

The Point Reyes jumping mouse is known from five localities on the Point Reyes Peninsula in western Marin County and two localities on the Marin Headlands Peninsula in southern Marin County (Williams 1986 and Evens 1988). Four skulls were recovered from barn owl pellets collected from the Lewis Dairy at the west end of Elk (=Tennessee) Valley in extreme southern Marin County (Smith and Hopkins 1937). Hooper (1939) failed to capture any Point Reyes jumping mice in Elk Valley despite trapping areas of suitable-looking jumping mouse habitat. Recent trapping efforts at Point Reyes National Seashore and the Golden Gate National Recreation Area failed to capture a single jumping mouse (G. Fellers pers. comm.). According to Evens (1988:147), it is "probably distributed throughout the swales of the outer peninsula." There have been no intensive range-wide trapping programs for this taxon; as a result, its present distribution is poorly known.

Life History: The life history of the Point Reyes jumping mouse is not well known, but is expected to be similar to other subspecies of the Pacific jumping mouse (Maser et al. 1981, Gannon 1988, Zeiner et al. 1990). Pacific jumping mice are mainly nocturnal but show some crepuscular activity. Pacific jumping mice accumulate subcutaneous and visceral fat during the summer and fall to sustain them during winter hibernation (Gannon 1988). *Z. trinotatus* breeds from May to late September, and gives birth to one or two litters of five (range 4-8) young following an 18 to 23 day gestation

(Bailey 1936, Maser et al. 1981, Gannon 1988). During the summer, this species constructs a grass nest on the ground in lush, fine grass and vegetation (Mossman 1979). Young are born and reared in this well-hidden, fragile, spherical grass nest (Maser et al. 1981). Burrows are dug and used during winter hibernation (Maser et al. 1981). *Z. trinotatus* is primarily granivorous, preferring seeds of forbs, grasses and grass-like monocots (Jones et al. 1978). It also eats fruits, berries, certain fungi, and insects (Krutzsch 1954, Jones et al. 1978). Pacific jumping mice forage mostly at ground level in moist places where they cut plant stems in order to reach ripening seed heads (Bailey 1936, Gannon 1988). Predators include foxes, coyotes (*Canis latrans*), bobcats, house cats (*Felis sylvestris*), hawks, owls, snakes, and fishes (Gannon 1988, Zeiner et al. 1990).

Habitat: In California, *Z. trinotatus* occur in wet, marshy coastal meadows (Jameson and Peeters 1988), loose, humus-filled dark soils associated with coast redwood forests (Gannon 1988), thickets of deciduous woody vegetation along streams and seepage areas, and, less frequently, in grassy areas beneath open-canopied coniferous forests (Zeiner et al. 1990). The species may require areas to burrow that are safe from winter floods (Krutsch 1954), moist areas overgrown with grass or weeds, and grassy habitats which have little or no grazing and some ground litter for adequate protection of their ground nests (Mossman 1979).

The habitats recorded for the species include bunch grass marshes on the uplands of Point Reyes Peninsula (Howell 1920c); meadows or marshlands with sedges or rushes, and occasionally with rather open low-growing chaparral (Hooper 1944); moist areas that are safe from continuous inundation (Krutsch 1954); and "wet, grassy meadows adjacent to coniferous forests, marshlands with high growth of sedges or rushes, or low-growing chaparral" (Evens 1988).

Status: Class II. The principal causes for concern are its restricted range, small population size, and the absence of captures in recent surveys. In addition, native habitats within a large portion of this taxon's historic range in Marin County have been degraded through a century or more of intensive livestock grazing, and conversion to agricultural uses (Evens 1988). Native perennial grassland and marshland habitats suitable for *Z. t. orarius* still occur at the Point Reyes National Seashore. Although grazing pressure from introduced herbivores has been reduced in the Point Reyes area since the establishment of Point Reyes National Seashore, over 5,000 head of cattle, an unknown number of feral pigs, 300-500 axis deer, and over 900 fallow deer continued to degrade native habitats as of 1988 (Evens 1988). Although current park policy is aimed at further reducing grazing pressure in sensitive areas (Evens 1988), there are no policies or action plans in place that will protect habitat occupied by jumping mice from grazing. The recent Mount Vison fire destroyed habitat, but its impact on the Point Reyes jumping mouse is unknown, in part owing to the uncertainty of whether the species hibernates like other populations of *Z. trinotatus* (G. Fellers pers. comm.).

Management Recommendations: The National Park Service and other responsible public agencies should develop and implement policies to protect remaining areas of native habitat that either contain or could contain this species, and should evaluate possible impacts to this taxon from any future developments or changes in land use practices proposed for lands they administer. The National Park Service should evaluate the impact of grazing on *orarius* at Point Reyes National Seashore, and mitigate these impacts as appropriate. Perennial grasslands, wet grassy meadows, and grassy margins of freshwater marshlands, streams and seepages should be intensively surveyed for this taxon and, if found to support extant populations, should be protected from further degradation due to introduced herbivore grazing and feral pig rooting. Studies are needed to gather information on the species' distribution and status, habitat requirements, home range, density, dispersal distance, food habits, reproductive biology, and the effects of feral herbivore grazing and fires. Field surveys

should be conducted for *orarius* to determine its current distribution, including suitable habitat outside its historic range, especially to the northeast (e.g., Mount Tamalpais State Park) (Lidicker in review).

Yuma mountain lion, *Felis concolor browni*

Thomas E. Kucera

Description: The mountain lion is the second largest of the American felids. According to Young and Goldman (1946), the type specimen of *browni* (a male from along the Colorado River 12 mi [19.2 km] below Yuma, Arizona) is 2,235 mm TL, TAL of 724 mm, and weight of 170 pounds. A male from along the Colorado River in California, 20 mi (32 km) north of Picacho, had a TL of 1981 mm. Males of *F. concolor* can be up to 50% larger than females (Dixon 1982). The pelage is usually tawny, although Young and Goldman (1946:225-226) described additional pelage colors of *F. c. browni* ranging from "cinnamon-buff" to "pinkish-buff" to "pure white" on various parts of the body. They describe the pelage as shorter and paler than that of the *californica* subspecies to the west.

Taxonomic Remarks: The Yuma mountain lion was described by C. Hart Merriam in 1903 after examining one specimen. Merriam (1903) named it *F. aztecus browni* after the collector, Herbert Brown. Young and Goldman (1946) examined nine catalogued specimens and revised the name to *F. concolor browni*. In reviews of the Yuma mountain lion, McIvor et al. (1994, 1995) doubted the validity of the subspecies. Morphometric analysis of various skull characters (McIvor et al. 1995) indicated that some separation was possible among *browni* and three adjacent lion populations tested (*F. c. azteca*, *F. c. californica*, and *F. c. kaibabensis*). Although McIvor et al. (1995) "identified sufficient deficiencies in the [morphometric] data set to conclude that the data currently available will not support a rigorous statistical analysis", they stated "that the existing evidence does not support the subspecific designation of this population". In contrast, results of an investigation of the genetic differentiation of *P. c. browni* and four neighboring subspecies (*azteca, kaibabensis, californica*, and *improcera*), (Culver and O'Brien 1997) revealed: *i)* a high degree of genetic similarity among *browni, azteca*, and *kaibabensis*; and *ii)* significant genetic deviation between *californicus* and these three subspecies. These results indicate that there may be two distinct lineages of mountain lions in California, represented by the widespread *californicus* and the more restricted *browni*.

Distribution: According to Grinnell et al. (1937), the Yuma mountain lion occurred in the bottomlands and adjacent uplands of the Colorado River Valley at least as far north as the Riverside Mountains. Young and Goldman (1946) described its distribution as the desert plains and low mountains of the Colorado River Valley in southeastern California, southwestern Arizona, northeastern Baja California, and northwestern Sonora (the latter two in Mexico). Since six conflicting range maps have been published for *F. c. browni* (see McIvor et al. 1994, 1995), and the distribution and taxonomy of the subspecies are in question, the map provided here reflects only the one California locality based on a museum specimen.

Life History: Little is known of the life history of the Yuma mountain lion. Mountain lions usually breed at about 2.5 years of age. In other subspecies studied, young are produced year-round, with a peak in parturition from April to August. Gestation is 80-100 days, and litter size is from one to six (Dixon 1982). However, there are no specific data available on *browni*.

Deer (*Odocoileus* sp.) typically are the main prey, although mountain lions are known to take a variety of other large and smaller mammals (Dixon 1982, Currier 1983). The following prey species have been recorded for mountain lions inhabiting arid habitats of Arizona: deer, bighorn sheep (*Ovis canadensis*), coyote (*Canis latrans*), skunk (*Mephitis, Spilogale*), badger (*Taxidea taxus*), raccoon (*Procyon lotor*), cattle, and rabbits and hares (*Sylvilagus, Lepus*)(Cashman et al. 1992 *in* McIvor 1994). The most important prey for *browni* is the burro deer, *Odocoileus hemionus eremica*,

although Nelson's bighorn sheep, *Ovis canadensis nelsoni*, are also taken. Bighorn sheep, where present, may constitute a significant prey item. Mountain lion predation on bighorn sheep and subsequent significant reduction of sheep numbers has been documented in the Granite Mountains (eastern Mojave Desert) and Mount Baxter (eastern slope of Sierra Nevada, north of Independence) populations (Wehausen 1996).

The home range of four individuals was reported by Peirce and Cashman (1993) to range widely, from 389 km^2 to 1621 km^2. These are comparable to home range estimates for other mountain lions in desert environments (range 122-1032 km^2).

Habitat: Grinnell et al. (1937:587) described the habitat of the Yuma mountain lion as "mostly in the heavy riparian growths of the bottom lands, but is reported also from the rocky desert uplands adjacent". Young and Goldman (1946:225) describe the habitat as mainly Lower Sonoran Zone. According to McIvor et al. (1994), the subspecies has been observed in most or all of the habitats within its range. In general, its habitat coincides with the habitat of its principal prey, the burro deer. On the perimeter of their range, Yuma mountain lions used ridge tops of typical Sonoran desert vegetation, and to a lesser extent, adjoining chaparral and arid grasslands. Habitat within the range described for the Yuma mountain lion in California has been modeled and is considered to be of low or no suitability for mountain lions (Torres et al. 1996).

Status: Class II. McIvor et al. (1994) discuss whether the Yuma mountain lion is a "sustainable subspecies". Factors to consider include the following:

i) Is there adequate remaining habitat and prey base to sustain the population? On the basis of their estimated densities of Yuma mountain lions and deer within the total range (i.e., California, Arizona and Mexico) of *browni*, McIvor et al. (1994) calculated a total population of 138 Yuma mountain lions. The pre-hunting season estimated population size of the burro deer herd within the California range of the Yuma mountain lion was 1,500 animals during 1997, with an estimated 1997 hunter harvest of 90 deer. The average estimated deer habitat loss in Imperial County due to conversion to urban/agriculture is 6,300 acres for the years 1990-2000, and 5,500 acres for 2000-2010. For Riverside County, average acreage lost is estimated to be 75,500 acres during 1990-2000, and 68,100 acres for the years 2000-2010 (Calif. Dept. Fish and Game 1997).

ii) Any barriers to the movement of *browni*, either within its reported range or between its range and that of adjacent subspecies, are probably ephemeral in nature (e.g., seasonal lack of water or prey, high seasonal temperatures) (McIvor et al. 1995). What then, is the nature of the difference between the subspecies?

iii) According to McIvor et al. (1995), the fact that no breeding females have been reported from the range of *F. c. browni* has led to speculation (by Peirce and Cashman 1993) that extant prey may not support breeding females, and that the 10:4 ratio of males to females represented in the specimens from *F. c. browni* range also suggests that females are underrepresented. If reproduction rates are low or absent in the range of the Yuma mountain lion, the area would represent a population sink occupied by lions dispersing from surrounding populations (McIvor et al. 1995).

iv) Mountain lions in California have been protected from hunting since 1972 (Torres et al. 1996). As lion numbers increase and formerly vacant habitats and territories become occupied, transient lions are pushed into increasingly marginal habitats. Conditions exist, therefore, that encourage dispersal into *F. c. browni* range from surrounding lion populations (McIvor et al. 1995).

In spite of the questions about the validity of retaining the Yuma mountain lion as a valid subspecies, it should be considered a Species of Special Concern unless and until published results of a genetic analysis indicate that *F. concolor browni* is not a valid subspecies. Habitat loss is a serious concern within the historic range of *F. c. browni*. Native habitats within the former floodplain of the Colorado River and areas adjoining the river corridor have been impacted by water developments, and converted to agricultural and suburban land uses. In a study of burrow deer, Haywood et al. (1984, cited *In* McIvor et al. 1994) reported previous losses of up to 1,200 ha/yr of riparian vegetation along the lower Colorado River. Although much of the land within *browni*'s historic range is publicly-owned and administered by the Bureau of Land Management and the Department of Defense, as well Indian Reservation lands, the impacts of habitat conversion and the more dispersed land uses such as seasonal patterns of recreational use, have adversely impacted wide-ranging species such as the mountain lion. According to McIvor et al. (1995), "[p]robably the greatest threat to [Yuma] mountain lions... stems from loss of habitat, particularly riparian and wetland communities (Williams and Kilburn 1984), as it relates to loss of prey species, especially deer herds (Duke et al. 1987). Additional threats to lions and their prey stem from agricultural and recreational activities, mining, off-road vehicles, canal mortality, and competition with domestic livestock (Duke et al. 1987)."

Management Recommendations: Management goals for all mountain lions in California include: 1) maintaining viable populations of mountain lions, 2) minimizing conflicts related to public safety, property damage, and other wildlife, 3) protecting important habitats, 4) recognizing their ecological role and value, 5) monitoring populations and conducting research, and improving public awareness (Torres et al. 1996). Genetic studies on the validity of the subspecies should be completed and published in a peer-reviewed journal. Should the subspecific designation prove to be valid, field studies on the status, ecology, and distribution of the Yuma mountain lion should be implemented. Information on diet, movements, and habitat use are needed in order to design management programs. No doubt one of the major components of any management plan will be to maintain and improve habitat quality for the burro deer.

Southwestern river otter, *Lutra canadensis Sonora*

Thomas E. Kucera

Description: The river otter is 900-1,300 mm in TL, with a tapering tail one-third the length of the body (Toweill and Tabor 1982). Weight is from 5 to 13 kg. The short, dense fur is dark brown to nearly black above and lighter silver or gray on the underside. The feet are webbed with strong claws. Males are larger than females (van Zyll de Jong 1972).

Taxonomic Remarks: The North American river otter, *Lutra canadensis*, is one of eight species of *Lutra*, a genus of the family Mustelidae that occurs in Europe, Asia, Africa, and North and South America (Mason 1990). Van Zyll de Jong (1972) recognized seven subspecies of *L. canadensis*. The Sonora river otter (*L. c. sonora*), one subspecies of river otter in California, was named based on the type specimen taken in Yavapai County, Arizona (Allen 1898). One specimen from California exists, taken 12 km north of Needles (Hall 1981).

Distribution: The river otter historically had one of the greatest ranges of any North American mammal, occurring in "all the major waterways of the United States and Canada until at least the eighteenth century" (Toweill and Tabor 1982:688). Hall (1981) described the distribution of *L. c. sonora* as including extreme southeast California and southern Nevada along the Colorado River, extending eastward through southern Utah and southwestern Colorado south through most of Arizona and New Mexico. No sightings of this subspecies have been reported in California since 1933 (Gould 1977a). Gould (1977a) stated that "[t]his subspecies was never common along the Colorado River and it now must be considered extirpated from this part of its range."

Life history: Little is known specifically about the life history of *L. c. sonora*. River otters usually reach sexual maturity at two years of age (Toweill and Tabor 1982). Breeding occurs in spring. River otters exhibit delayed implantation of the blastocyst, and young are born the following spring after a gestation of 240-285 days and an active pregnancy period of about 50 days (Toweill and Tabor 1982). Litter sizes range from one to six, with a mean litter size of about three. Diet consists mainly of fishes and crustaceans, with insects, amphibians, birds and mammals also reported (Mason and Macdonald 1986, Melquist and Dronkert 1987). Home ranges vary from 4 to 78 km in length, and often overlap among individuals, especially in exploited populations. Territoriality may exist in stable, unexploited populations (Melquist and Dronkert 1987).

Habitat: Throughout their vast range, river otters are found in a variety of aquatic habitats. Although most common in food-rich estuarine areas, they are also found in riverine systems that are relatively unpolluted and unaltered by humans (Toweill and Tabor 1982). Riparian vegetation also is essential for river otters (Melquist and Hornocker 1983, Polechla 1990). River otters benefit from the presence of beavers (*Castor canadensis*), which increase wetland areas and provide den sites in their lodges (Melquist and Hornocker 1983, Polechla 1990).

Status: Class II. Hunting or trapping of river otters in California has been prohibited since 1961. Otters rarely cause depredation problems; live-trapping and relocation is employed when necessary (Gould 1977a). The Colorado River and adjacent riparian vegetation have been greatly modified as a result of altered flow regimes, agriculture, and human development. These habitat changes were likely the cause of declines in southwestern river otter populations. The species is highly secretive and therefore difficult to census, *sonora* is thought to have been historically uncommon to rare along the Colorado River. The Sonora river otter is thought to be extirpated on the California and Nevada sides of the Colorado River, based on the absence of observational and trapping records since 1975 (Spicer 1987).

Management Recommendations: Surveys should be undertaken to determine if the southwestern river otter is still extant. If so, current, empirical data on distribution and population size of *L. c. sonora* should then be obtained by additional studies (Macdonald and Mason 1990, Polechla 1990). Any measures that favor riparian vegetation and decrease pollution are likely to benefit any remaining otters (Mason and Macdonald 1990).

Humboldt marten, *Martes americana humboldtensis*

Thomas E. Kucera

Description: The American marten is a small-to-medium (500-1,200 g) mustelid with rich, brown fur. TL varies from 465 to 650 mm; females are about one-third lighter and somewhat shorter than males. The bushy tail is about 150 mm long in both sexes (Strickland et al. 1982). Pelage is typically dark brown, with a pronounced orange or yellow throat patch, and darker on the legs. Winter pelage is usually darker than that of summer.

Taxonomic Remarks: Mustelids are characterized by the loss of the carnassial notch from the upper fourth premolar, a delicate zygomatic arch, five digits that contact the surface when walking, and enlarged anal scent glands (Buskirk 1994). There are seven species in the genus *Martes* (Mustelidae, Carnivora) (Buskirk 1994). The fisher (*M. pennanti*), the largest member of the genus, is endemic to North America. The American marten is the smallest of the four "boreal forest martens" (*M. martes, M. zibellina, M. melampus*) that occur from Ireland east across Eurasia to Newfoundland, in mature coniferous forests. Anderson (1994) calls this group plus the stone marten (*M. foina*), native to western and southern Europe eastward to Mongolia, a "superspecies." The stone marten also has established a feral population in southeast Wisconsin (Long 1995). The yellow-throated marten (*M. flavigula*) occurs in eastern and southern Asia (Anderson 1994). An extinct North American species, the noble marten (*M. nobilis*), is known from late Holocene deposits (Anderson 1994), although Youngman and Scheuler (1991) argue that *M. nobilis* is in reality *M. americana*. Hall (1981) recognized 14 subspecies of *M. americana;* Hagmeier (1956) distinguished six subspecies.

Distribution: Based on specimens of American martens taken at known localities in California, Grinnell et al. (1937:209) concluded that "two well-marked races occur within the State". The Humboldt marten (*M. a. humboldtensis*) occurred in the coastal redwood (*Sequoia sempervirens*) zone from the Oregon border south to Fort Ross, Sonoma County. The Sierra Nevada marten (*M. a. sierrae*) occurred from Trinity and Siskiyou counties east to Mount Shasta and south through the Sierra Nevada to Tulare County.

Trapping data indicate that martens were taken in at least 21 California counties, including Humboldt and Del Norte, until trapping was prohibited in 1953 (Calif. Dept. Fish and Game unpubl. data, Sacramento). Twining and Hensley (1947) expressed concern about the status of the Humboldt marten. Yocum (1974) presented locations of reported sightings of American martens in northern California between 1961 and 1973, and Schempf and White (1977) summarized existing information on marten distribution throughout the state. A more recent description of the distribution of American martens in North America (Gibilisco 1994), including California, was based on responses to a survey mailed to agency personnel in 1990-91. Kucera et al. (1995) presented empirical data on the distribution of American martens in California based on field surveys conducted between 1989 and 1995. They concluded that the Sierra Nevada marten, *M. a. sierrae*, occupies much of its historic range from northwestern Shasta County to the southern Sierra Nevada, and that the Humboldt marten, *M. a. humboldtensis*, in Humboldt and Del Norte counties, is extremely rare or extinct (Kucera et al. 1995). In 1996 and 1997, American martens were detected at two of 468 track plate stations placed within the range of the Humboldt marten in Del Norte County (Zielinski et al. 1998).

Life history: American martens live in or near coniferous forests (Buskirk and Ruggiero 1994), although their arboreal habits have been exaggerated (Buskirk 1994). They find much of their food on the ground or under snow. Microtine rodents are particularly common dietary items, with birds, squirrels, and vegetation also reported (Martin 1994). The association of American martens with

late-successional forests has been long and widely recognized (Buskirk and Powell 1994). The physical structure of such forests, rather than plant species composition or age, seems to be most important. Martens prefer forests with overhead cover and complex ground structure to allow access to subnivean spaces (Buskirk and Powell 1994). Dens occur both in hollow trees and on or under the ground in logs or rock piles.

Females typically breed at 15 months, and produce a first litter at 24 months of age. Litter size averages 2.85, and ranges from 1 to 5 (Strickland et al. 1982). Mating usually occurs in July or August, and gestation ranges from 220 to 265 days. Martens exhibit delayed implantation; parturition is most common in April, after an active pregnancy of about 27 days (Strickland et al. 1982). Young reach adult size in about three months.

Home-range sizes of adult males reported in the literature vary from less than one to more than 15 km^2, with those of females about half that of males (Buskirk and Ruggiero 1994). Both sexes exhibit intrasexual territoriality. Population densities are low, about one-tenth that expected on the basis of body size alone (Buskirk and Ruggiero 1994).

Habitat: American martens are associated with coniferous forests, typically more mesic than xeric (Buskirk and Powell 1994). In a study in the Sierra Nevada, martens selected riparian forests for foraging (Spencer et al. 1983). Physical structure of the forest, including large live and dead trees, coarse woody debris, and a relatively low and closed canopy, appears more important for American martens than species composition (Spencer et al. 1983, Hargis and McCullough 1984). This structure is produced by late-seral-stage forests. Although talus fields are occasionally used, martens usually avoid open areas. This preference for physical structure or overhead cover is thought to arise from a need for protection from predators and, in areas of deep snow, access to subnivean areas provided by complex structures on the ground such as logs and rocks. Little is known of the specific habitat ecology of *M. a. humboldtensis* from the north coast.

Status: Class I. *M. a. humboldtensis* appears to meet CESA criteria for listing as Endangered in its historic range of Del Norte, Humboldt, Mendocino, and Sonoma counties. The combination of historic trapping and more recent habitat loss by timber harvest has led to the severe reduction or extirpation of this taxon (Kucera et al. 1995). Extensive field surveys have failed to detect Humboldt martens in any but the most northern portion of their historic range.

M. a. sierrae is still widely distributed in its historic range (Kucera et al. 1995) and does not meet criteria for listing as Threatened species or a Species of Special Concern at this time. However, given the extremely low population densities of American martens, they should be considered when assessing the effects of habitat alterations such as timber harvest. We have therefore placed *M. a. sierrae* on the Watch List.

Management Recommendations: An intensive survey to document the existence and distribution of *M. a. humboldtensis* in areas that have not yet been examined should be conducted, using recently described, non-lethal methods that produce empirical, verifiable information on presence (Zielinski and Kucera 1995). Given its apparent rarity, the Humboldt marten should be included in ecosystem management and biodiversity planning efforts in the coastal redwood zone along with listed, forest-dwelling species such as the marbled murrelet (*Brachyramphus marmoratus*) and northern spotted owl (*Strix occidentalis*), and Species of Special Concern such as the Pacific fisher (*M. p. pacificus*). If Humboldt martens are extirpated on the North Coast, their reintroduction to areas of remaining habitat within their historic range, such as Redwood National Park and Humboldt Redwoods State Park, should be considered.

Pacific fisher, *Martes pennanti pacifica*

Thomas E. Kucera

Description: The fisher, a medium-sized member of the family Mustelidae, is the largest member of the genus *Martes* and occurs only in North America. The dark brown, glossy fur often looks black. Fishers have white or cream patches on the chest and around the genitals. Fishers are the among the most sexually dimorphic of the mustelids. Adult male fishers range from 90 to 120 cm TL and weigh 3.5-5.5 kg. Adult females are from 75 to 95 cm TL and weigh about 2.5 kg (Powell 1993). Tail length is about one-third of body length. The conical shape of the tail, thicker near the body and tapering to a thinner tip, distinguishes the silhouette of the fisher from that of the American marten, *M. americana*.

Taxonomic Remarks: Mustelids are characterized by the loss of the carnassial notch from the upper fourth premolar, a delicate zygomatic arch, five digits that contact the surface when walking, and enlarged anal scent glands (Buskirk 1994). There are seven species in the genus *Martes* (Mustelidae, Carnivora) (Buskirk 1994). The fisher (*M. pennanti*), the largest member of the genus, is endemic to North America. One congener, the American marten (*M. americana*), also occurs in North America. Goldman (1935) recognized 3 subspecies of fisher, *M. p. pennanti*, *M. p. columbiana*, and *M. p. pacifica*. The validity of these subspecies was questioned by Hagmeier (1959), who found no morphological characteristics on which to separate the subspecies. Nevertheless, Hall (1981) and Anderson (1994) retained the three subspecies (Powell and Zielinski 1994).

Distribution: Before European settlement, fishers occurred in forests across North America. They were in the Appalachian Mountains as far south as Tennessee and in the Midwest to southern Illinois in appropriate forest types. They ranged along the Rocky Mountains at least into Wyoming, and down the West Coast to the southern Sierra Nevada (Grinnell et al. 1937, Powell 1993, Gibilisco 1994). Following European settlement of the continent, fisher range contracted drastically, particularly in the southern portions, due to deforestation and trapping (Powell 1993). In California, Grinnell et al. (1937) described the original range of the fisher as including the northern Coast Range, Klamath Mountains, southern Cascades, and western slope of the Sierra Nevada (Zielinski et al. 1995). Recent empirical data indicate that fishers currently occur in two widely separated regions of the state: the northwest, including the northern Coast Range and Klamath Province, and the southern Sierra Nevada (Zielinski et al. 1995).

Life History: In western North America, fishers are associated with late-successional conifer forests (Buskirk 1994). Powell and Zielinski (1994) hypothesized that forest structure was more important than tree species for fisher habitat. Structure, including a diversity of tree sizes, snags, downed trees and limbs, and understory vegetation, provides den and rest sites and prey for fishers. Generalized predators, fishers prey on a variety of small and medium-sized birds and mammals, and on carrion (Powell 1993). Where they occur, snowshoe hares (*Lepus americana*) are important prey. Fisher diets also include mice (*Microtus* sp., *Clethrionomys* sp., *Peromyscus* sp.), squirrels and chipmunks (*Sciurus* sp., *Glaucomys* sp., *Tamiasciurus* sp.), and porcupines (*Erethizon dorsatum*) (Powell and Zielinski 1994, Martin 1994).

Female fishers can breed at one year of age. Parturition occurs in March and April; females come into estrous and breed 3-9 days later (Powell and Zielinski 1994). Implantation is delayed about ten months, and can occur from January to April. Typical litter size is two or three. Natal dens are high in cavities in both live and dead trees.

Fishers exhibit intrasexual territoriality. Male home-range size, 40 km^2 (range 19-79), is nearly three

times that of females (15 km^2; range 4-32) (Powell and Zielinski 1994).

Habitat: Fishers in the western United States are associated with habitats that have high canopy closure; these typically are late-successional forests (Buskirk and Powell 1994, Powell and Zielinski 1994). They apparently are restricted to areas without frequent deep, fluffy snow, which is thought to restrict their movements. Resting and denning occur in large live trees, snags, and logs associated with late-successional forests.

Status: Class I. The status of the fisher in California has been of concern for most of this century. Dixon (1925) believed that the fisher was close to extinction in California and proposed that protective measures be taken. Trapping of fishers was prohibited in 1946. Subsequent assessments of the status of the fisher in California concluded that they occurred at relatively high density in the northwestern and North Coast areas of the state, were present at lower density in the southern Sierra Nevada, and were extremely rare or absent between (Schempf and White 1977). The USFWS recently denied a petition to list the fisher on the West Coast (Washington, Oregon, and California) and in the Rocky Mountains (Idaho, Montana, and Wyoming) as Threatened under the Federal Endangered Species Act. The stated reason was that "the petition did not present substantial information indicating that the two fisher populations [West Coast and Rocky Mountains] in the western United States requested to be listed constitute distinct vertebrate population segments" (Federal Register 61(42):8016). Recent detection efforts throughout the historic range of the fisher in California indicate that fishers occur in two disjunct populations, a larger one in the northwestern part of the state and a smaller one in the southern Sierra Nevada, separated by approximately 420 km (Zielinski et al. 1995). These data were not available when the petition to Federally list the fisher was filed.

M. pennanti pacificus appears to meet CESA criteria for listing as Threatened in California. Its current disjunct distribution, with a relatively small population in the southern Sierra Nevada, separated from a larger one in northwestern California by more than 400 km, and potential effects of forest management practices on it, are causes for serious concern for its continued existence as a well-distributed, native species.

Management Recommendations: An understanding of the habitat ecology of fishers in the Sierra Nevada is essential to understanding its current distribution and why fishers have not recolonized the central and northern Sierra Nevada and southern Cascades. Current research being conducted there by the USDA Redwood Sciences Laboratory and University of California, Berkeley, should continue. Systematic survey efforts in the central and northern Sierra Nevada using standardized techniques (Zielinski and Kucera 1995) should be conducted to ensure that remnant populations are not being overlooked. If no fishers are found, reintroduction(s) to expand its range in the Sierra Nevada should be considered. Research to understand the responses of fisher populations to forest management practices both in the Sierra Nevada, Klamath Province, and Coast Range should be undertaken.

Channel Islands spotted skunk, *Spilogale putorius amphiala*

Paul W. Collins

Description: This is a medium-sized mustelid with a complex pattern of white markings on a black background consisting of four to six broken white stripes, a triangular white forehead patch, a series of shorter white stripes resembling spots, and white on part of the ventral surface and tip of the tail (Van Gelder 1959). It is distinguished from spotted skunk subspecies on the mainland by its shorter tail (95-175 mm) with less white ventral coloration (45% white compared to 55% white in mainland skunks), slightly larger size (222-317 mm BL), broader skull (38 mm facial breadth), and proportionately less white and more black in the pelage color (Dickey 1929, Van Gelder 1959, 1965, von Bloeker 1967). Like mainland subspecies, Channel Islands spotted skunks exhibit sexual dimorphism, with males averaging 642 g (range 566-793 g) and females averaging 500 g (Van Gelder 1959, Crooks 1994a). This skunk is considerably smaller (355-466 mm TL) than striped skunks (*Mephitis mephitis*) on the mainland and has softer, glossier pelage (Van Gelder 1959, Jameson and Peeters 1988).

Taxonomic Remarks: Grinnell (1933) considered *amphiala* a subspecies of *S. gracilis*, the western spotted skunk. Van Gelder's (1959) revision placed it in *S. putorius*, followed by recent treatments (Hall 1981, Wilson and Reeder 1993). Some workers recognize two species of spotted skunks on the mainland, *S. gracilis* and *S. putorius* (Hall and Kelson 1959; Mead 1968a; 1968b; Jones et al. 1975, 1992; Williams 1979). Resolution of this issue awaits further genetic and morphologic analyses.

Distribution: Channel Islands spotted skunks currently occur only on Santa Cruz and Santa Rosa islands where they are widely distributed (Crooks and Van Vuren 1994, C. Drost unpubl. data). Spotted skunks occurred on San Miguel Island, probably until the late nineteenth century. Fossil material was collected on San Miguel Island (Walker 1980) and a spotted skunk was reportedly collected from San Miguel Island sometime during the 1870s (Henshaw 1876). Intensive live-trapping of island foxes on San Miguel Island during the 1980s and 1990s failed to capture a single spotted skunk, which suggests that this taxon is extirpated from San Miguel Island.

Life History: Channel Islands spotted skunks are nocturnal. Activity begins at dusk, peaks during the early evening, and continues intermittently until dawn (Crooks 1994a, 1994b). On Santa Cruz Island, spotted skunks nest in cavities, burrows, and other natural crevices, as they do on the mainland. Dens are constructed in roots and earth under shrubs, cavities in rocks, open grassy areas, road cuts, human-made structures, and trunks and roots of oaks (Crooks 1994b, 1994c). Individuals use several dens distributed throughout their home range; some dens are used by two or more individuals either sequentially, or for females, simultaneously (Crooks 1994c).

The breeding season for spotted skunks on the islands is probably similar to spotted skunks on the mainland. Western spotted skunks mate in September and October, and following delayed implantation and a 210-310 day gestation, give birth in April and May to 2-6 young (Mead 1968b). Counts of three and five uterine scars have been recorded from two skunks collected at Santa Cruz Island in September (Pearson 1948 unpubl. field notes, Van Gelder 1959).

On the mainland, spotted skunks eat primarily insects and small mammals, as well as reptiles, birds, eggs, carrion, fruits and grains (Howard and Marsh 1982). Spotted skunks on the Channel Islands have similar diets as those reported on the mainland. Scat analyses of Channel Island spotted skunks on Santa Cruz Island showed they are carnivorous, consuming primarily deer mice (*Peromyscus maniculatus*) and insects along with occasional lizards (Crooks 1994b). Jerusalem crickets were the most frequent prey, but other prey included grasshoppers, crickets, beetles (scarab, darkling and

long-horned beetles), caterpillars, earwigs, and ants. Seasonally available fruits and berries were apparently absent from spotted skunk scats examined by Crooks (1994b). However, stomach contents from five skunks collected on Santa Cruz Island consisted of insects (Jerusalem crickets), deer mice, carrion, grapes (*Vitis* sp.), and summer holly (*Comarostaphylis diversifolia*) stems and berries (Pearson 1948, unpubl. field notes). Stomach contents from eight spotted skunks collected on Santa Rosa Island in 1927 contained 75% orthopterans (grasshoppers, crickets and Jerusalem crickets) and 25% cactus (*Opuntia* sp.) fruits (Sheldon 1927).

Although no density estimates are available for spotted skunks on the islands, they are relatively rare on Santa Cruz Island (Crooks 1994a), and apparently more abundant on Santa Rosa Island (Sheldon 1927). Mean home range size for spotted skunks on Santa Cruz Island during the wet season was 26.3 ha, and 61.1 ha during the dry season. Channel Island spotted skunks and island foxes have similar-sized and overlapping home ranges (Crooks 1994a, 1994b). However, these two taxa differ dramatically in their population densities, with spotted skunks being rare and island foxes being abundant (Crooks 1994a). This difference in density may be a result of the more specialized carnivorous diet of the spotted skunk compared to the more omnivorous diet of the island fox.

Habitat: Spotted skunks on the Channel Islands show habitat preferences similar to those reported for the mainland subspecies (Grinnell et al. 1937, Zeiner et al. 1990). Based on radiotelemetry studies, spotted skunks on Santa Cruz Island showed a preference for chaparral-grassland, open grassland, fennel-grassland, and ravines (Crooks 1994b, Crooks and Van Vuren 1994). On Santa Rosa Island, spotted skunks were found to be associated with rocky canyon slopes, cactus patches (Sheldon 1927), chaparral, coastal sage scrub, open woodland, other scrub-grassland communities, and riparian habitat along streams (C. Drost pers. comm.). On both islands, the species has also been recorded in or under human dwellings and ranch outbuildings (von Bloeker 1967, Laughrin 1982, C. Drost pers. comm.). The elevational range of the Channel Islands spotted skunk extends from sea level to approximately 600 m.

Status: Class II. The status of the Channel Islands spotted skunk is of concern due its restricted distribution, small population size (Crooks and Van Vuren 1994), and the loss and degradation of habitat resulting from more than a century of overgrazing by domestic stock (cattle and horses) and feral, nonnative herbivores (sheep, deer, and elk), and rooting by feral pigs. Other threats to this taxon come from the possible introduction of diseases, to which skunks are susceptible, from domestic cats and dogs brought to the islands as pets. The species occurs widely on Santa Cruz Island, but is uncommon to rare (Crooks 1994b), and apparently is more common on Santa Rosa Island. The capture of a single skunk during twelve years of intensive island fox trapping and fifteen years of observation led Laughrin (1982) to conclude that the skunk population on Santa Cruz Island was at a "low level." Crooks and Van Vuren (1994) recommended that this taxon be listed as a Threatened subspecies due to its rarity on Santa Cruz Island. The species may have been abundant in the past (Sheldon 1927). Spotted skunks on Santa Rosa Island also occur in low numbers, are widely scattered around the central portion of the island, and are most abundant in canyons along the north and northwest sides of the island (Crooks 1994b, C. Drost pers. comm.).

Despite the removal of nearly 38,000 feral sheep from Santa Cruz Island in the early 1980s (Schuyler 1993) and the termination of cattle ranching operations in 1988, spotted skunk habitat on Santa Cruz Island continues to be degraded by feral pigs and sheep grazing on the eastern third of the island. The rooting activities of feral pigs destroy skunk dens, and skunks are sensitive to competition with feral pigs for invertebrate foods.

Until The Nature Conservancy eliminates feral pigs from Santa Cruz Island, the spotted skunk

population on this island will continue to be threatened with possible extinction. The outlook for spotted skunks on Santa Rosa Island is somewhat brighter since the National Park Service eradicated feral pigs there in the 1980s (Halvorson 1994).

Management Recommendations: Studies are needed on the distribution and abundance of Channel Island spotted skunks, their natural history, and the impact of feral pigs and feral herbivores. These studies will provide a basis for the preparation of conservation and management guidelines for this taxon. The Nature Conservancy on Santa Cruz Island and the National Park Service on Santa Rosa Island should continue with feral animal eradication programs. The most immediate need is to remove feral pigs from Santa Cruz Island.

Watch List Accounts

Salinas ornate shrew, *Sorex ornatus salaries*

Paul W. Collins

Museum records of *S. o. salarius* extend from the vicinity of the mouth of the Pajaro River (Watsonville Slough), Santa Cruz County (Rudd 1948), south along the immediate coast to Carmel (Von Bloeker 1939). This subspecies was originally described as inhabiting coastal salt-marshes and adjacent sandhill areas in the vicinity of Monterey and Carmel bays, Monterey County (Von Bloeker 1938, 1939). According to Williams (1986), it occupies riparian, wetland and upland terrestrial communities in the vicinity of the Salinas River Delta. The capture of 61 ornate shrews near the Salinas River mouth in July 1990 with 700 trap-nights of effort suggests that *S. o. salarius* may still be common in the area (J. Maldonado pers. comm.). More recent data than these on the distribution and status of this subspecies were not available during the preparation of this document. Although the Salinas ornate shrew has a restricted distribution in a region under pressure from urban and agricultural developments, it occupies a diversity of habitats, and much of the remaining coastal salt marshes within its geographic range are protected from development. Recent surveys indicate it is still common. Rudd (1948) and Junge and Hoffmann (1981) questioned the currently accepted taxonomy of ornate shrews from the vicinity of Monterey Bay. A more extensive range-wide genetic and morphologic evaluation of ornate shrews is currently under way (Maldonado pers. comm.). Results of that study should help to clarify whether ornate shrews from the vicinity of Monterey Bay warrant subspecific recognition.

Monterey vagrant shrew, *Sorex vagrans paludivagus*

Paul W. Collins

The Monterey vagrant shrew inhabits riparian and tidal and freshwater wetlands of the San Francisco Peninsula, Salinas River Delta, and lowlands adjacent to Monterey Bay (Findley 1955, Hennings and Hoffmann 1977). Museum records are from the immediate coast of the San Francisco Peninsula from San Gregorio, San Mateo County, south to Seaside, Monterey County. Vagrant shrews collected from various localities in San Francisco County (Twin Peaks, Presidio, Lake Merced, Daly City and San Francisco) could be *S. v. paludivagus* or *S. v. halicoetes*. These specimens have yet to be evaluated in any of the recent taxonomic treatments of the *Sorex vagrans* complex (Findley 1955, Hennings and Hoffmann 1977, Junge and Hoffmann 1981, Carraway 1990). If these specimens are *paludivagus*, then its range would include the entire San Francisco Peninsula, excluding the salt marshes along its eastern border. No data are available on its current distribution and population status. This, in addition to the observation that a number of the coastal salt marshes and wetlands within its geographic range are protected from development, are the principal reasons why the Monterey vagrant shrew was not consider a Special Concern taxon. The highest priority for the Monterey vagrant shrew is to obtain data on its distribution and population status, and the taxonomic status of populations in the northern San Francisco peninsula.

Angel Island mole, *Scapanus latimanus insularis*

Paul W. Collins

The Angel Island mole is confined to Angel Island, Marin County (Hall 1981), a 740 acre island situated about 1 mi south of the Tiburon peninsula in the northern portion of San Francisco Bay. Palmer (1937) described *S. l. insularis* as being somewhat larger and darker than *S. l. parvus* and *S. l. latimanus*, but similar in overall size and color to *S. l. caurinus* from the adjacent mainland. Palmer

(1937) reported that in 1935 and 1936 Angel Island supported a large population of moles. Mole mounds and surface ridges were common across the island, particularly on the north side of the island in moist soil under chaparral (Palmer 1937). We were unable to find any recent information regarding the present distribution or status of Angel Island moles. Apparently, there has been no further work on this subspecies since it was described in 1937. Although the native biological resources of Angel Island State Park are now under the jurisdiction of the California Department of Parks and Recreation (CDPR 1979), native plant communities on the island along with their associated fauna have been seriously impacted by past human activities, intensive overgrazing by an introduced mule deer (*Odocoileus hemionus*) herd, and by the introduction and expansion of nonnative trees and shrubs. Introduced conifers and eucalyptus cover more than 100 acres of the island (CDPR 1988). Mesic woodland habitats on Angel Island (e.g., mixed evergreen forest, northern coastal scrub and chaparral) which provide potentially suitable habitat for moles, have been and continue to be seriously degraded by these factors. While the CDPR has instituted a program to remove introduced eucalyptus from natural areas on Angel Island (CDPR 1988) and has a Department-approved program in place to cull the introduced deer herd (CDPR 1979) when the population gets too large, they have not developed any specific measures designed to protect or enhance habitat for the Angel Island mole. The CDPR has gathered no data on the current distribution and status of the Angel Island mole nor does it evaluate how its current or proposed management activities affect this species. Based on the lack of data on the distribution and status of this species, the ongoing threats to its preferred habitat, and the fact that CDPR does not manage for the mole, we recommend that the Angel Island mole be on the Watch List. Immediate priorities regarding this subspecies include determining its population status and habitat affinities, and identifying factors that impact the population.

Alameda Island mole, *Scapanus latimanus parvus*
Paul W. Collins

Scapanus latimanus parvus is known only from Alameda Island, Alameda, Alameda County (Hall 1981). Since this subspecies was first described, a total of 18 specimens have been collected, two in 1916, 15 between 1932 and 1945, and one in 1958 (MVZ 123561). We were unable to locate any observational records that would confirm the existence of an extant population of *S. l. parvus* on Alameda Island. All of the specimens that have been collected are from residential neighborhoods in Alameda. Based on two specimens, Palmer (1937) described this subspecies as being smaller, shorter and having a broader skull than mainland *S. l. latimanus*. Palmer (1937) also suggested that *parvus* might occupy salt marsh areas around the eastern and southern margins of San Francisco Bay. However, despite intensive trapping programs for *Reithrodontomys raviventris* and *Sorex vagrans halicoetes*, no salt-marsh inhabiting mole populations have been reported from salt marshes around the margins of the San Francisco Bay. Alameda Island is intensively developed with Alameda Island Naval Air Station (Nimitz Field) occupying the northern half, and most of the remainder of the island occupied by commercial, industrial and residential developments. Besides the Robert W. Crown Memorial State Beach Park, there are twelve city parks on the island. Since most of Alameda Island has been converted to developed uses, and because there is no recent information on the current status of *S. l. parvus*, this subspecies should be kept on the Watch List. Immediate priorities regarding this subspecies include determining its present distribution and population status, and evaluating its taxonomic validity. This information is essential for deciding whether the Alameda Island mole is threatened with extinction and thus in need of special legal protection and more intensive management.

Silver-haired bat, *Lasionycteris noctivagans*
Elizabeth D. Pierson & William E. Rainey

The silver-haired bat, *Lasionycteris noctivagans*, is broadly distributed across much of the United States and southern Canada. Nevertheless, its distribution in California is limited, and remains poorly understood. Breeding populations are relatively common in northern portions of the state, along the Sacramento River drainage in Shasta and Siskiyou counties (Rainey and Pierson 1996, Pierson et al. 1996). There are also a few records of reproductive populations in the Sierra Nevada foothills and at higher elevations in the Coast Range as far south as Ventura County. The only records for southern California are from the spring, fall or winter. Although it appears to be associated with forested mountain habitat, the extent of its distribution in both the Trinity Mountains and the Sierra Nevada are not well known.

L. noctivagans is a forest-dwelling species that shows a high association with old growth habitat in the Pacific Northwest (Perkins and Cross 1988). Maternity roosts, containing up to 70 animals, are found almost exclusively in trees, primarily in woodpecker hollows. Roosts have also been located occasionally under loose bark, and in one instance, in a building (B. Hogan pers. comm.). A number of studies on the roosting requirements of this species have shown that it prefers large diameter snags, with roosting sites at least 15 m above the ground (Rainey and Pierson 1996, Betts 1996, Campbell et al. 1996, Mattson et al. 1996, Vonhof 1996, Vonhof and Barclay 1996). In a study conducted in northern California, this species roosted preferentially in ponderosa/Jeffrey pine and black oak (Rainey et al. 1996). Hibernating sites in California are unknown, although elsewhere in its range *L. noctivagans* has been found hibernating in hollow trees, under sloughing bark, in rock crevices, and occasionally in buildings, mines and caves (Barbour and Davis 1969, Kunz 1982, van Zyll de Jong 1985). A few scattered museum records suggest that in California this species may migrate to the southern part of the state in the winter. *L. noctivagans* travels up to 17 km one way from its roost to its foraging area (Rainey and Pierson 1996), and feeds in or near coniferous or mixed deciduous forest, often following stream or river drainages (Kunz 1982, Rainey and Pierson 1996). In northern California it has been netted both over open water in and areas with considerable clutter, and shown to forage on a variety of taxa, with moths appearing to dominate the diet (Rainey et al. 1996). In other areas it has been shown to feed opportunistically on abundant prey, including chironomids (Barclay 1984, Barclay 1985, Barclay 1995-1996).

This species is being placed on the Watch List because of its high dependence on snags, and the coincidence of its distribution, as we understand it, with prime timber harvest areas. More information is needed on the distribution and habitat needs of this species in California. Potential impacts of current timber harvest practices, particularly the adequacy of snag retention standards, need to be investigated.

Hoary bat, *Lasiurus cinereus*
Elizabeth D. Pierson & William E. Rainey

The hoary bat, *Lasiurus cinereus*, is the most widely distributed of all North American bat species, and occurs from sea-level to high elevation. In California, it occurs with greatest frequency in forested regions, both along the coast and in the mountains. Although the seasonal movement patterns of this migratory species within California are not completely understood, it appears that the primary summer distribution is in the northern part of the state, and winter distribution is along the coast from San Francisco Bay to the Mexican border (Grinnell 1918, Dalquest 1943, Vaughan and Krutzsch 1953, Constantine 1959, Tenaza 1966). Migration appears to occur both along the coast

and in the Sierra Nevada. All mid-summer records are of males. Females appear to occur in California only in the fall, winter, and spring, making it unlikely that this species raises its young in California.

L. cinereus is a solitary species that roosts primarily in foliage, 3-12 m above the ground, in both coniferous and deciduous trees (Constantine 1959). Perkins and Cross (1988) found that in Oregon, hoary bats were associated with older age Douglas fir/western hemlock forests, and absent in younger stands. In California this species occurs in a wider variety of habitats, from lower elevation mixed coniferous/hardwood forest to higher elevation conifers. They also have been found roosting in fruit orchards (Constantine 1959). Some unusual roosting situations have been reported in caves, beneath a rock ledge, in a woodpecker hole, and in a squirrel's nest (Tenaza 1966, Shump and Shump 1982b, van Zyll de Jong 1985), but the species is generally found in trees. It forages over long distances, up to 40 km from its roost (Barclay 1984), feeding primarily on large moths, dragonflies and beetles (Barclay 1985, Barclay 1985-1986).

Despite its wide distribution almost nothing is known of the current status of this species in California. We included on the Watch List because of its high association with forested habitats, and its apparent dependence on trees for roosting, thus raising the possibility its populations could be impacted by current timber harvest practices. The fact that it is unlikely to raise young in California does, however, reduce the population risk. Surveys are needed to delineate seasonal movement patterns and habitat associations.

Long-eared myotis, *Myotis evotis*
Elizabeth D. Pierson & William E. Rainey

The long-eared myotis, *Myotis evotis*, is distributed across the western third of the United States and southern Canada, and is highly associated with forest habitat (Cross 1976, Barbour and Davis 1969, K. Navo pers. comm.). In California, it is found in a number of habitats from lower-elevation oak woodlands to mid-elevation mixed conifer forest and higher elevation coniferous forest. It is generally absent from the Central Valley and desert. While it is typically rare, it appears to be one of the more common species in Giant Sequoia habitat (Pierson and Heady 1996).

This species roosts under loose bark, in hollow trees, in rock crevices, in fissures in clay banks, and sometimes in caves, mines and buildings (Manning and Jones 1989, Vonhof and Barclay 1996). It has been found in rimrock roosts in southern Oregon. A radiotracking study in northern California documented roost sites under loose bark of black oaks, and in rock crevices of highway riprap (Rainey and Pierson 1997). Also, a number of building roosts are known. Caves, mines and bridges are used frequently as night roosts. This species forages along the edge of forests, over open meadows near tall timber, and along water courses (Manning and Jones 1989). It appears to be flexible in its foraging strategy, catching insects both by substrate gleaning and aerial pursuit (Faure 1990). In one study in northern California, radiotagged animals fed predominantly over riparian vegetation, and within an upslope mixed deciduous/coniferous forest (Rainey and Pierson 1997). In some settings this species has been shown to feed primarily on beetles and moths (van Zyll de Jong 1985). Limited diet samples from northern California indicated animals were feeding on a variety of taxa, including primarily Lepidoptera, Coleoptera, Hymenoptera, and Tricoptera (Rainey and Pierson 1996).

It is being placed on the Watch List because of its rarity and its apparent association with forested habitat. The impacts of current timber practices on this species are unknown.

Little brown bat, San Bernardino Mountains population, *Myotis lucifugus*
Elizabeth D. Pierson & William E. Rainey

Myotis lucifugus is one of the most widely distributed North American bat species (Fenton and Barclay 1980), yet in California it is limited primarily to the higher latitudes and/or altitudes. It is found along the coast north of the San Francisco Bay area, and in mountainous areas above about 5,000 ft. It is generally absent from southern California, with the exception of an isolated population in the San Bernardino Mountains. This population is known primarily from collecting that was done at Big Bear Lake in the 1940s (D. Constantine pers. comm.). When first located, animals were found under loose bark of a lightning-struck tree and in the attic of an adjacent house. This colony was revisited in the 1960s, at which time the tree roost was gone, and the owner expressed intention to have the bats in the attic exterminated. In the early 1990s about a half dozen *M. lucifugus* from this area were turned into the State Department of Health Services. The animals had been found dead on a lawn, suggesting they had been poisoned (D. Constantine pers. comm.). As tourist development intensifies around Big Bear Lake, natural habitat is being lost, and risks to the animals from pest control efforts increase.

This population is being placed on the Watch List because of its isolation and apparently very limited distribution. Only limited information is available on its historical status, and its current status is completely unknown (D. Constantine pers. comm.).

Oregon snowshoe hare, *Lepus americanus klamathensis*
Paul W. Collins

L. a. klamathensis occurs in mid- to upper-elevations of the Cascade Mountains from the vicinity of Mount Hood, Oregon, southward to Mount Shasta and the Trinity Mountains of California (Bailey 1936, Orr 1940). An isolated population of this subspecies occurs in the Warner Mountains of Modoc County (Orr 1940). In California, Oregon snowshoe hares are generally found above the Yellow Pine Zone, in Canadian and Hudsonian associations (Orr 1940). They are usually associated with thickets of deciduous trees such as alders and willows along streams and around the margins of mountain meadows, dense thickets of young evergreen conifers and shrubs in forests, and occasionally in dense patches of *Ceanothus* and *Arctostaphylos* (Williams 1986). Jameson and Peeters (1988) report that in the northern Sierra Nevada, snowshoe hares are abundant in dense stands of manzanita that develop following a major forest fire. Based on the small number of available specimens in museums, scant confirmed sightings, and early accounts (e.g., Merriam 1899, Kellogg 1916), Oregon snowshoe hares were apparently not historically common in California. Although existing records suggest that California populations of this species are probably small and locally distributed, the lack of specimen and sighting records of *L. a. klamathensis* may reflect biased collecting and survey techniques as well as this species' concealing coloration, shy and secretive behavior, more nocturnal and crepuscular activity pattern, and tendency not to be flushed by predators. This species is rarely seen because it hides during the day in forms (daytime resting places) located in dense cover such as thickets and jumbled piles of fallen timber (Bailey 1936). *L. a. klamathensis* has a wider distribution in Oregon where it has been recorded as not numerous (Bailey 1936) to locally common (Dalquest 1942). Populations of this subspecies do not appear to undergo periodic extreme population fluctuations observed in other snowshoe hare species (Maser et al. 1981). There are no data to suggest that numbers of Oregon snowshoe hares have declined in California or elsewhere in its range. Even though this subspecies is not widespread in California, it is probably not jeopardized.

Williams (1986) considered the Oregon snowshoe hare to be a Special Concern species because of

its apparent rare status, and because of the potential for habitat loss due to logging and conversion of riparian habitat. The species is included on the Watch List because of the peripheral nature of its distribution in California (most of its range occurs in Oregon), and because there are no reliable data on its status. Bittner and Rongstad (1982) noted that great abundances and population explosions of snowshoe hares elsewhere in North America tend to be associated with early successional forest stages following fires, whereas their populations are small and isolated to thickets of willow, alder and low-growing woody vegetation in forests where there have been no recent fires. In California, the snowshoe hare is listed as a game species which can be hunted from July 1 through January, with a bag limit of five per day. The overall effect of hunting on populations of *L. a. klamathensis* in California is unknown, but is not thought to contribute to its apparent rarity. Priorities for California populations of this subspecies include obtaining information on present distribution, current status, population abundance and habitat affinities to more accurately determine both its status and appropriate hunting quotas. Such data are especially needed for the Warner Mountains population of Oregon snowshoe hares to determine whether it should be added to the list of Special Concern species.

Western white-tailed hare, *Lepus townsendii townsendii*
Paul W. Collins

L. t. townsendii is widely distributed from southern British Columbia southward east of the Cascade Crest to the southern Sierra Nevada in California, and eastward to extreme western Montana and western Colorado (Hall 1981). In California, this species occupies open forests and sagebrush-grassland associations in the higher parts of the northeastern Great Basin area of California (Orr 1940). It also occurs in moderate numbers at high elevations, generally at or above timberline, along the crest and upper eastern slope of the Sierra Nevada (Grinnell 1933, Orr 1940) and in the White Mountains (Howell 1924). The southernmost records of this species in the Sierra Nevada are from Tulare County in the Inyo National Forest at Monache (Sumner and Dixon 1953) and Kennedy Meadows (C. Hawkins pers. comm.). In the Sierra Nevada, there is evidence to suggest that white-tailed hares migrate to higher elevations in the summer and descend to lower areas in winter, especially along the sagebrush-covered eastern slopes of the Sierra Nevada (Merriam 1904b, Orr 1940). This species inhabits a variety of habitats, including sagebrush, perennial grasslands, alpine dwarf-shrub, and wet meadows to timberline and above, and early successional stages of a variety of conifer habitats including lodgepole pine, yellow pine, western juniper, dwarf juniper, red fir, and mixed conifers (Verner and Boss 1980, Williams 1986, Zeiner et al. 1990). In most of these habitats, *L. townsendii* prefers open or sparsely wooded areas with young or stunted conifers, or scattered shrubs which they use for protective cover during the day (Grinnell and Storer 1924, Verner and Boss 1980, Harris 1982). White-tailed hares are usually solitary and are primarily nocturnally active unless they are flushed from cover. Even though this is a large and conspicuous hare, its habit of remaining hidden during the day, along with its protective coloration, result in it rarely being seen, even in locations where its signs are abundant.

There is no current information available regarding the overall distribution, abundance and population status of this subspecies in California. According to Orr (1940), the white-tailed hare in California is one of the rarer members of the genus *Lepus*, and is not abundant anywhere. Specimen and sighting records of this subspecies suggest that it is uncommon but not rare, at least in the central and southern Sierra Nevada (C. Hawkins pers. comm.). Harris (1982) reports that this species is common in Mono County, while Airola (1980) suggests that it has declined throughout the Great Basin province area of California. This subspecies has declined in numbers and range especially at lower elevations in the sagebrush-grassland associations of the Great Basin province (Grayson 1977). Loss of habitat to cultivation and other developments, coupled with competition for available

forage from domestic livestock, are probably the principal factors responsible for its decline in portions of the Great Basin province (Dalquest 1948, Mossman 1979). This hare is currently a Resident Small Game species in California with no closed season or daily bag limit. Hunting may be contributing to the decline of this species, at least in northeastern California, but it is probably less important than habitat loss.

Williams (1986) considered the western white-tailed hare to be a Special Concern species because of its apparent rare status, and because of population declines recorded in the sagebrush-grassland associations of the Great Basin province as a result of loss of habitat and competition from livestock grazing. We have decided to relegate this species to the Watch List because of its widespread distribution in western North America, and because its populations in most of the Sierra Nevada appear to be stable and not threatened by intensive grazing or habitat loss. In addition, there are no survey data available to support the claim that populations of this species have declined in northeastern California or elsewhere in California. Priorities for California populations of this species include obtaining information on present distribution, current status, population abundance and habitat needs. The effects of grazing and hunting on populations of this species in California need to be thoroughly evaluated.

Marysville kangaroo rat, *Dipodomys californicus eximius*
Philip W. Brylski

The Marysville kangaroo rat is known only from the vicinity of Sutter Buttes in Sutter County, where it occurs in chaparral and scrub oak communities on well-drained soils. Museum records are known from specimens collected in 1912 at two localities: Moore Canyon, Marysville Buttes, 4 mi northwest of Sutter and Butte Slough (Sutter County). A single specimen was collected in 1930 from 1 mi northeast of West Butte. There are apparently no confirmed sightings since 1930. Recent and repeated attempts to live-trap individuals at one or more of the historical localities were unsuccessful (W. Anderson pers.comm., A. Bills pers. comm.). The Marysville kangaroo rat is included on the Watch List because of its highly restricted distribution and the failure of survey efforts to locate individuals at the historical localities. It is uncertain whether the population still exists. The majority of habitat is within private ownership, and cooperation with landowners should be sought to undertake a status review.

Berkeley kangaroo rat, *Dipodomys heermanni berkeleyensis*
Philip W. Brylski

The historic range of the Berkeley kangaroo rat is from the hills and valleys east of San Francisco Bay, from the Berkeley Hills, eastward to Mount Diablo and Livermore Valley and southward to southern Alameda County. The museum records for the species are from the vicinities of Berkeley, Orinda, Brentwood, and Mount Diablo (Contra Costa County), and Livermore and Calaveras Reservoir (Alameda County). The species occurs in open, grassy hilltops and open spaces in chaparral and blue oak/digger pine woodlands. The habitat at most of these localities and surrounding areas, except Mount Diablo, has been converted to urban, suburban, and agricultural uses. There are no recent (e.g., less than 10-year old) records for the species, although populations may persist in regional and State parks within its historic range (Roest in review). The Berkeley kangaroo rat is included as a Watch List taxon because of habitat loss within it historic range and the absence of recent records in remaining suitable habitat. The recommendation by Williams (1986) that the geographic range of *h. berkleyensis* and *h. tularensis* (the Tulare kangaroo rat) be clarified is still valid. The closest museum specimen locality for *tularensis* is Tracy (east of the *berkeleyensis* distribution). It would also be useful to clarify the distributional boundaries with *h. goldmani*, the

nearest museum specimen locality of which is San Jose (south of the *berkeleyensis* range).

McKittrick pocket mouse, *Perognathus inornatus neglectus*
Philip W. Brylski

Perognathus inornatus neglectus occurs along the western edge of the San Joaquin Valley from near Suisun Bay (Contra Costa County) to the southern end of the valley, west into the Carrizo Plain and Upper Cuyama valleys of Santa Barbara and San Luis Obispo counties, and east to Tehachapi Pass. The closely related *P. i. psammophilus* occurs in the Salinas Valley southward at least to Hog Canyon, Monterey County. The taxonomy of *P. inornatus* in the Central Valley, and the boundaries of the distributions of the two other currently recognized subspecies *i. psammophilus* and *i. inornatus* await clarification. *P. inornatus* in the Central Valley occur in annual grassland, desert scrub (e.g., *Atriplex*, *Ephedra*, and *Haplopappus*), and oak savannah communities on sandy soils and other friable soils, from near sea level to about 1,500 ft (484 m) (Williams 1986, no date). Braun (1985) described the habitat for *P. i. neglectus* on the Carrizo Plain as sandy loam flats dominated by herbs (*Erodium*, *Amsinckia*, and *Astragalus*) and grasses (*Bromus*). The species is common in the Carrizo Plain and Upper Cuyama Valley, and probably also in the grasslands and oak woodland habitats above the valley floor. However, habitat over much of its historic range in the San Joaquin Valley has been converted to agricultural and residential uses, where it now apparently occurs in fragmented patches of suitable habitat and generally at low densities. The McKittrick pocket mouse is included on the Watch List because declines in its distribution and abundance since the turn of the century necessitate regular monitoring of its status.

Yellow-eared pocket mouse, *Perognathus parvus xanthonotus*
Philip W. Brylski

The yellow-eared pocket mouse is known from four localities on the eastern slope of the Tehachapi Mountains, Kern County, at Horse, Sage, Freeman, and Indian Wells canyons, at elevations from 1400 to 1615 m. The majority of museum records are from the vicinity of Freeman Canyon, east of Walker Pass, at elevations from 4,900 to 5,300 ft (1,580-1710 m). The species has most often been captured in Great Basin sagebrush (*Artemisia tridentata*). Although it has been reported from Joshua tree woodland, it may occur there mainly in association with Great Basin sagebrush. At higher elevations, it is reported to occur at the ecotone of Joshua tree and pinyon-juniper woodlands (Sulentich 1983). No studies based on systematic live-trapping efforts are available to assess the status of this species. Individuals were captured in 1974 (Huckaby pers. comm.), and Sulentich (1983) captured several individuals in 1982 from the vicinity of Walker Pass and the head of Kelso Valley. No new information on the species or threats to its persistence have become available since Williams (1986) first designated it as a Species of Special Concern. The species has been difficult to locate by conventional live-trapping methods, which may indicate that it is uncommon or rare within its highly restricted range. Including it on the list of Watch List taxa is intended to ensure that impacts to the species are considered in land use decisions, including grazing practices, recreational activities, and development proposals. A biochemical and morphological study by Sulentich (1983) supported placement of *xanthonotus* as a subspecies of *P. parvus* rather than as a distinct species, a recommendation followed by Williams et al. (1993).

South coast marsh vole, *Microtus californicus stephensi*
Philip W. Brylski

The south coast marsh vole occurs in a narrow band of wetland communities and associated grasslands in the immediate coastal zone from southern Ventura County to northern Orange County.

According to Hall (1981), *M. c. stephensi* occurs from the type locality at Point Mugu, Ventura County, south to Sunset Beach, Orange County. Museum records for intervening localities are known for Ballona Wetlands and adjacent Playa del Rey, Los Angeles County. Vole populations that occur south of Sunset Beach, such as in the tidal marshes of Anaheim Bay near Newport Beach, are referable to the more widespread *M. c. sanctidiegi*. Coastal development from Sunset Beach north to Pacific Palisades, Los Angeles County, has resulted in the loss or degradation of the once extensive tidal marshes, leaving a series of fragmented and isolated habitat patches. Within this zone, suitable habitat remains at the Seal Beach Naval Weapons Center north of Sunset Beach, and at Ballona wetlands. Populations of the south coast marsh vole still occur in these areas, although no data are available on their status. Much of the coastal habitat from Pacific Palisades west and north to Point Mugu is afforded some protection from State parkland and the regulatory restrictions of the Malibu Coastal Plan and the Significant Ecological Areas identified under the Plan. Although no data are available on the status of the species, the south coast marsh vole is included on the Watch List rather than as a Special Concern taxon. Bleich (in review) also acknowledged the likely impact of coastal development on the south coast marsh vole, but considered the data to be insufficient to assign a risk of extinction to the species. Bleich (in review) also recommended that because the distribution of *M. c. stephensi* is surrounded by *M. c. sanctidiegi*, which in turn is surrounded by *c. californicus*, follow-up taxonomic or experimental work should, at a minimum, include all three forms.

Monterey Bay harvest mouse, *Reithrodontomys megalotis distichlis*
Paul W. Collins

R. m. distichlis inhabits coastal salt marshes, freshwater wetlands and probably sandhill grasslands near the seacoast in the vicinity of the Salinas River mouth (von Bloeker 1937). Based on available specimen records, this taxon inhabits coastal estuaries from Elkhorn Slough, Moss Landing south to Seaside Lagoon and sandhills inland to Castroville, Fort Ord and Strawberry Canyon (Von Bloeker 1938). There are apparently no current data on the distribution and status of *R. m. distichlis*. *R. m. distichlis* was described based on morphological differences (smaller size and darker dorsal coloration) observed in a small sample collected from sand dunes and salt marshes bordering Monterey Bay, Monterey County (von Bloeker 1937, 1938). However, a subsequent cytological and morphological evaluation of harvest mice in the lower Salinas River Valley concluded that *R. m. distichlis* was not morphologically distinct from interior (upriver) populations of *R. m. longicaudus*, and as such, did not warrant subspecific recognition (Blanks 1967). Although western harvest mouse populations from the lower Salinas Valley were found to represent a polymorphic form of *R. megalotis*, it was concluded that these polymorphic populations did not warrant separate subspecific recognition (Blanks 1967, Blanks and Shellhammer 1968). The Monterey Bay harvest mouse was initially considered for inclusion on the working list for this document because of its restricted distribution and because much of the area within its geographic range is under intense pressure from urban and agricultural developments. However, it was relegated to the Watch List because of its questionable subspecific status and because most of the salt marsh and freshwater wetlands within its range are presently protected from development. A study using currently accepted genetic and multivariate morphometric techniques is needed to properly evaluate the taxonomic validity of *R. m. distichlis*. If such a study finds that harvest mouse populations from coastal areas bordering Monterey Bay are not distinct from interior upland *R. m. longicaudus* populations, then this form could be removed from the Watch List.

Harvest mouse, Santa Cruz Island population, *Reithrodontomys megalotis longicaudus*
Paul W. Collins

Harvest mice were discovered on Santa Cruz Island at the Prisoners' Harbor marsh in 1948 and were described as *R. m. santacruzae*. They were distinguished from mainland *R. m. longicaudus* by their larger size, and grayer, more lax pelage (Pearson 1951). In a recent genetic and morphologic study of western harvest mouse populations from island and coastal areas of southern California, Collins and George (1990) concluded that there were no substantive genic or cranial shape differences that distinguished the Santa Cruz Island population of harvest mice from adjacent mainland populations. As a result, *R. m. santacruzae* was considered synonymous with *R. m. longicaudus*. Collins and George (1990) found that harvest mice on Santa Cruz and Santa Catalina Islands were slightly larger in overall body size than harvest mice on the adjacent mainland.

Pearson (1951) reported that harvest mice on Santa Cruz Island were confined to a small, grassy area adjacent to a small, freshwater marsh at Prisoners' Harbor. He suggested that this habitat was rare and that harvest mice were probably limited to that one spot on the island. Williams (1986) first considered the Santa Cruz Island harvest mouse for inclusion on the draft Mammal Species of Special Concern list because of its apparent restricted habitat, Pearson's (1951) belief that the entire island population was very small, and because native plant communities on the island were being damaged by a variety of introduced ungulates. He removed the species from the final species of concern list because there were data to suggest that the species was more widely distributed on the island, and because 90% of the island had recently come under management of The Nature Conservancy. A subsequent status review of this island population determined that, although harvest mice were widely distributed on Santa Cruz Island, they were uncommon to locally rare (Collins 1987). Additional small mammal trapping programs conducted on Santa Cruz Island during the 1990s further confirmed the wide distribution but locally rare status of this species (G. Rohmer and R. Klinger pers. comm.). Collins (1987) concluded that alterations of native habitats, particularly mesic habitats, from feral pig rooting, and from grazing, trampling, and soil compaction by sheep and cattle, was the primary factor threatening the continued survival of harvest mice on Santa Cruz Island. During the 1980s, feral sheep and cattle were eliminated from the western 90% of the island (Schuyler 1993, Klinger et al. 1994, Junak et al. 1995). Despite the removal of these two feral herbivores from over 90% of the island, wild pigs remain widespread and abundant on the entire island and feral sheep continue to roam free on the eastern third of the island (Junak et al. 1995). Based on the results of this status review, results of small mammal trapping conducted on the island during the 1990s, and on the fact that feral sheep and wild pigs continue to degrade native plant communities on Santa Cruz Island, it was decided that this island population of the western harvest mouse should be kept on the Watch List.

Even though Santa Cruz Island is currently under the management of the National Park Service and The Nature Conservancy, feral herbivores will need to be permanently eliminated from the island and native plant communities restored, or harvest mice on the island will continue to be at risk. A more intensive island-wide trapping program should be undertaken to obtain current data on the distribution, abundance, and habitat associations of harvest mice on Santa Cruz Island. This type of information is needed to determine whether the removal of feral herbivores and the subsequent recovery of the native plant communities has had a beneficial affect on harvest mice, and to see if continued rooting and degradation of mesic habitats by feral pigs is threatening the long-term survival of this locally restricted population of harvest mice.

Yuma hispid cotton rat, *Sigmodon hispidus eremicus*

Paul W. Collins

S. h. eremicus ranges along the southern end of the Colorado River from Palo Verde south to the Colorado River Delta, and in the irrigated portions of the Imperial Valley from the Mexican Border

north to approximately Niland at the southern end of the Salton Sea (Clark 1972; Blood 1981, 1990). Yuma hispid cotton rats are believed to have immigrated to the Imperial Valley soon after completion of the canal from the Colorado River (Dixon 1922). Their range in California has increased in part due to the construction of canals and ditches for transporting water to irrigate agricultural developments throughout the Imperial and lower Colorado River valleys. Along the Colorado River, western cotton rats inhabit back-water sloughs and marshy areas adjacent to the river which are vegetated with seedling willows, sedges or tule, borders of wire grass or dense thickets of arrowweed (Grinnell 1914, Hoffmeister 1986). Western cotton rats in California also occur in association with drainage ditches, canals and seeps which have a weedy vegetative cover composed of arrowweed, saltgrass, common reed, screwbean mesquite, cattails, sedges, tamarisk, heliotrope and annual grasses (Clark 1972). Western cotton rats have invaded agricultural fields where they have caused crop damage to sugar beets and citrus (Clark 1972). *S. h. eremicus* is included on the Watch List, and not as a Species of Special Concern, because it has been found to be fairly common along canals and irrigation ditches in the Imperial Valley (B. Blood in review), where it inhabits weedy irrigation ditches, and because of its ability to exploit agricultural crops such as cotton, sugar beets and citrus. Although the subspecies is not widespread in California, it is probably not jeopardized. Priorities for this subspecies include determining its distribution, population status and habitat affinities along the Colorado River, and identifying the nature and extent of any immediate or anticipated threats to its continued survival.

Pallid bobcat, *Lynx rufus pallescens*

Thomas E. Kucera

The pallid bobcat is widely distributed throughout the Great Basin. In California, it occurs only in Modoc, Lassen, Shasta, and Siskiyou counties (Hall 1981). Williams (1986) listed the pallid bobcat as a "Priority Four" species because of the high pelt prices and large take by fur trappers in the 1970s. Lee (1978) reported that average price paid for a bobcat pelt in 1976 was $133 in 1975-76; Gould (1977c) reported that a prime pelt of a pallid bobcat sold for $405 in 1977. Statewide, the reported annual take of bobcats by fur trappers in 1976-77 was 3618, a 15-fold increase in 10 years; the take of bobcats by hunters and predator control agents was approximately equal to that of trappers (Gould 1977c). This level of take remained through the 1980s, when average pelt prices declined to below $50 and reported annual trapper take declined to about 1000 through the present time (CDFG 1997). If pelt prices remain low, trapping is unlikely to affect the status of the pallid bobcat in California. However, in the event of a large increase in demand for bobcat pelts, the taxon could be at risk. In such an event, a rigorous monitoring program should be instituted.

Sierra Nevada marten, *Martes americana sierrae*

Thomas E. Kucera

Data on the current distribution of the Sierra Nevada marten is more plentiful than that for other wide-ranging mammalian taxon in California (Kucera et al. 1995). Surveys since 1990 have demonstrated that martens occupy much of their historic range in the high-elevation coniferous forests in the southern Cascade Range and the Sierra Nevada. As top carnivores, American martens naturally occur in low densities, with home ranges of from 1 to >20 km^2 (Powell 1994). Their preference for forests with mature or old conifer trees with large-diameter standing and downed wood for maternal and winter dens, as well as a complex understory, make them vulnerable to habitat loss from timber production (Buskirk and Powell 1994, Thompson and Harestad 1994) or from catastrophic fire. The U.S. Forest Service lists the American marten as a "Sensitive" species in California (Macfarlane 1994).

Badger, *Taxidea taxus*

Thomas E. Kucera

Williams (1986) listed the badger as a “Priority Three” species, noting that badger numbers have declined drastically in California in the 20th century. Agricultural and urban development, direct and secondary poisoning, and shooting and trapping for control all have had deleterious effects on badgers in California. Since 1991, fewer that 50 badgers annually have been reported taken by fur trappers, and pelt prices averaged below $5 apiece. There are no reliable data on the species' current distribution or status. Williams’ (1986) recommendations for data on current badger populations, mandatory reporting of take, and assessing the effects of continuing habitat loss, rodent poisoning, and trapper mortality remain valid.

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Appendix 1. List of California Terrestrial Mammals. Taxa endemic to California are denoted with an asterisk.

Family/Species	Subspecies	Common name
Didelphidae		
Didelphis virginiana		Virginia opossum
	Didelphis virginiana virginiana	
Soricidae		
Notiosorex crawfordi		desert shrew
	Notiosorex crawfordi crawfordi	
Sorex bendirii		Pacific water shrew
	Sorex bendirii bendirii	Pacific water shrew
	Sorex bendirii palmeri	Pacific water shrew
Sorex lyelli *		Mt. Lyell shrew
Sorex merriami		Merriam shrew
	Sorex merriami leucogenys	
	Sorex merriami merriami	
Sorex monticolus		dusky or montane shrew
	Sorex monticolus obscurus	
Sorex ornatus		ornate shrew
	Sorex ornatus californicus *	
	Sorex ornatus ornatus *	
	Sorex ornatus relictus *	Buena Vista Lake shrew
	Sorex ornatus salarius *	Salinas ornate shrew
	Sorex ornatus salicornicus *	So. California salt-marsh shrew
	Sorex ornatus sinuosus *	Suisun shrew
	Sorex ornatus willettii *	Santa Catalina shrew
Sorex pacificus		Pacific shrew
	Sorex pacificus pacificus	
Sorex palustris		water shrew
	Sorex palustris navigator	
Sorex preblei		Prebley shrew
	Sorex preblei preblei	

Sorex sonomae *		
	Sorex sonomae sonomae	
	Sorex sonomae tenelliodus	
Sorex tenellus		Inyo shrew
Sorex trowbridgii		Trowbridge shrew
	Sorex trowbridgii humboldtensis *	
	Sorex trowbridgii mariposae	
	Sorex trowbridgii montereyensis *	
	Sorex trowbridgii trowbridgii	
Sorex vagrans		vagrant shrew
	Sorex vagrans halicoetes *	salt marsh vagrant shrew
	Sorex vagrans paludivagus	
	Sorex vagrans vagrans *	
Talpidae		
Neurotrichus gibbsii		shrew-mole
	Neurotrichus gibbsii gibbsii	
	Neurotrichus gibbsii hyacinthus *	
Scapanus latimanus		broad-footed mole
	Scapanus latimanus campi *	
	Scapanus latimanus caurinus *	
	Scapanus latimanus dilatus	
	Scapanus latimanus grinnelli *	
	Scapanus latimanus insularis *	Angel Island mole
	Scapanus latimanus latimanus *	
	Scapanus latimanus minusculus *	
	Scapanus latimanus monoensis	
	Scapanus latimanus occultus	
	Scapanus latimanus parvus *	Alameda Island mole
	Scapanus latimanus sericatus *	
Scapanus orarius		coast mole
	Scapanus orarius orarius	

Scapanus townsendii		Townsend mole
Phyllostomidae		
Choeronycteris mexicana		Mexican long-tongued bat
Macrotus californicus		California leaf-nosed bat
Vespertilionidae		
Antrozous pallidus		pallid bat
	Antrozous pallidus pacificus	
	Antrozous pallidus pallidus	
Corynorhinus townsendii		Townsend big-eared bat
	Corynorhinus townsendii pacificus	
	Corynorhinus townsendii pallescens	
Eptesicus fuscus		big brown bat
	Eptesicus fuscus bernardinus	
	Eptesicus fuscus pallidus	
Euderma maculatum		spotted bat
Lasionycteris noctivigans		silver-haired bat
Lasiurus blossevillii		western red bat
Lasiurus cinereus		
	Lasiurus cinereus cinereus	hoary bat
Lasiurus xanthinus (=*L. ega*)		southern yellow bat
Myotis californicus		
	Myotis californicus californicus	California myotis
	Myotis californicus caurinus	
	Myotis californicus stephensi	
Myotis ciliolabrum (=*M. leibii ciliolabrum*)		western small-footed myotis
Myotis evotis		long-eared myotis
	Myotis evotis evotis	
	Myotis evotis pacificus	
Myotis lucifugus		little brown myotis
	Myotis lucifugus alascensis	
	Myotis lucifugus carissima	
	Myotis lucifugus relictus *	Mammoth little brown myotis
Myotis occultus (=*M. lucifugus occultus*)		Arizona myotis

Myotis thysanodes		
	Myotis thysanodes thysanodes	fringed myotis
Myotis velifer		cave myotis
	Myotis velifer velifer (includes *M. v. brevis*)	
Myotis volans		long-legged myotis
	Myotis volans interior	
	Myotis volans longicrus	
Myotis yumanensis		Yuma myotis
	Myotis yumanensis oxalis *	San Joaquin myotis
	Myotis yumanensis saturatus	
	Myotis yumanensis sociabilis	
	Myotis yumanensis yumanensis	
Pipistrellus hesperus		western pipistrelle
	Pipistrellus hesperus hesperus	
Molossidae		
Eumops perotis		California mastiff bat
	Eumops perotis californicus	
Nyctinomops femorosaccus		pocketed free-tailed bat
Nyctinomops macrotis		big free-tailed bat
Tadarida brasiliensis		Brazilian free-tailed bat
	Tadarida brasiliensis mexicana	
Ochotonidae		
Ochotona princeps		pika
	Ochotona princeps albata *	
	Ochotona princeps muiri	
	Ochotona princeps schisticeps	
	Ochotona princeps sheltoni	
	Ochotona princeps taylori	
Leporidae		
Brachylagus idahonensis		pygmy rabbit
Lepus americanus		snowshoe hare
	Lepus americanus klamathensis	Oregon snowshoe hare
	Lepus americanus tahoensis	Sierra Nevada snowshoe hare
Lepus californicus		

	Lepus californicus bennettii	San Diego black-tailed jackrabbit
	Lepus californicus californicus	
	Lepus californicus deserticola	
	Lepus californicus richardsonii	
	Lepus californicus wallawalla	
Lepus townsendii		western white-tailed hare
	Lepus townsendii townsendii	
Sylvilagus audubonii		desert cottontail
	Sylvilagus audubonii arizonae	
	Sylvilagus audubonii audubonii *	
	Sylvilagus audubonii sanctidiegi	
	Sylvilagus audubonii vallicola *	
Sylvilagus bachmani		brush rabbit
	Sylvilagus bachmani bachmani	
	Sylvilagus bachmani cinerascens	
	Sylvilagus bachmani macrorhinus *	
	Sylvilagus bachmani mariposae *	
	Sylvilagus bachmani riparius *	riparian brush rabbit
	Sylvilagus bachmani tehamae	
	Sylvilagus bachmani ubericolor	
	Sylvilagus bachmani virgulti *	
Sylvilagus nuttallii		Nuttall cottontail
	Sylvilagus nuttallii grangeri	
	Sylvilagus nuttallii nuttallii	
Aplodontidae		
Aplodontia rufa		
	Aplodontia rufa californica	Sierra Nevada mountain beaver
	Aplodontia rufa humboldtiana *	
	Aplodontia rufa nigra *	Point Arena mountain beaver

	Aplodontia rufa pacifica	
	Aplodontia rufa phaea *	Point Reyes mountain beaver
	Aplodontia rufa rufa	
Sciuridae		
Ammospermophilus leucurus		white-tailed antelope squirrel
Ammospermophilus leucurus leucurus		
Ammospermophilus nelsoni *		Nelson antelope squirrel
Glaucomys sabrinus		northern flying squirrel
	Glaucomys sabrinus californicus *	San Bernardino flying squirrel
	Glaucomys sabrinus flaviventris *	
	Glaucomys sabrinus fuliginosus	
	Glaucomys sabrinus lascivus	
	Glaucomys sabrinus stephensi	
Marmota flaviventris		yellow-bellied marmot
	Marmota flaviventris flaviventris	
	Marmota flaviventris fortirostris	
	Marmota flaviventris sierrae	
Sciurus griseus		western gray squirrel
	Sciurus griseus anthonyi *	
	Sciurus griseus griseus	
	Sciurus griseus nigripes *	
Spermophilus beecheyi		California ground squirrel
	Spermophilus beecheyi beecheyi *	
	Spermophilus beecheyi douglasii	
	Spermophilus beecheyi fisheri *	
	Spermophilus beecheyi nesioticus *	Catalina Island ground squirrel
	Spermophilus beecheyi nudipes	
	Spermophilus beecheyi	

	parvulus *	
	Spermophilus beecheyi sierrae *	
Spermophilus beldingi		Belding ground squirrel
	Spermophilus beldingi beldingi	
	Spermophilus beldingi oregonus	
Spermophilus lateralis		golden-mantled ground squirrel
	Spermophilus lateralis bernardinus *	San Bernardino g-m ground squirrel
	Spermophilus lateralis chrysodeirus	
	Spermophilus lateralis mitratus *	
	Spermophilus lateralis trepidus	
	Spermophilus lateralis trinitatis	
Spermophilus mohavensis *		Mohave ground squirrel
Spermophilus mollis		Townsend ground squirrel
Spermophilus tereticaudus		round-tailed ground squirrel
	Spermophilus tereticaudus chlorus *	Palm Springs r-t ground squirrel
	Spermophilus tereticaudus tereticaudus	
Spermophilus variegatus grammurus		rock squirrel
Tamias alpinus *		alpine chipmunk
Tamias amoenus		yellow-pine chipmunk
	Tamias amoenus amoenus	
	Tamias amoenus monoensis	
	Tamias amoenus ochraceus	
Tamias merriami		Merriam chipmunk
	Tamias merriami kernensis *	
	Tamias merriami merriami *	
	Tamias merriami pricei *	
Tamias minimus		least chipmunk
	Tamias minimus scrutator	
Tamias obscurus		Baja California chipmunk
	Tamias obscurus davisi *	
	Tamias obscurus obscurus	
Tamias ochrogenys *		redwood chipmunk

Tamias panamintinus		Panamint chipmunk
	Tamias panamintinus acrus *	Kingston Mountain chipmunk
	Tamias panamintinus panamintinus	
Tamias quadrimaculatus		long-eared chipmunk
Tamias senex		California chipmunk
Tamias siskiyou		Siskiyou chipmunk
Tamias sonomae		Sonoma chipmunk
	Tamias sonomae alleni *	
	Tamias sonomae sonomae	
Tamias speciosus		lodgepole chipmunk
	Tamias speciosus callipeplus *	Mt. Pinos chipmunk
	Tamias speciosus frater	
	Tamias speciosus sequoiensis *	
	Tamias speciosus speciosus *	
Tamias umbrinus		Uinta chipmunk
	Tamias umbrinus inyoensis	
Tamiasciurus douglasii		Douglas squirrel
	Tamiasciurus douglasii albolimbatus	
	Tamiasciurus douglasii mollipilosus	

Geomyidae

Thomomys bottae		Botta pocket gopher
	Thomomys bottae albatus	
	Thomomys bottae alpinus	
	Thomomys bottae awahnee	
	Thomomys bottae bottae	
	Thomomys bottae canus	
	Thomomys bottae laticeps	
	Thomomys bottae leucodon	
	Thomomys bottae mewa	
	Thomomys bottae navus	
	Thomomys bottae nigricans	
	Thomomys bottae operarius	
	Thomomys bottae pascalis	
	Thomomys bottae perpallidus	
	Thomomys bottae riparius	
	Thomomys bottae saxatilis	

Thomomys mazama		Mazama pocket gopher
	Thomomys mazama mazama	
	Thomomys mazama premaxillaris *	
Thomomys monticola		mountain pocket gopher
Thomomys talpoides		northern pocket gopher
	Thomomys talpoides fisheri *	
	Thomomys talpoides monoensis *	
	Thomomys talpoides quadratus	
Thomomys townsendii		Townsend pocket gopher
Heteromyidae		
Chaetodipus baileyi		
	Chaetodipus baileyi hueyi	Bailey pocket mouse
Chaetodipus californicus		California pocket mouse
	Chaetodipus californicus bensoni *	
	Chaetodipus californicus bernardinus *	
	Chaetodipus californicus californicus *	
	Chaetodipus californicus dispar *	
	Chaetodipus californicus femoralis	Dulzura pocket mouse
	Chaetodipus californicus marinensis *	
	Chaetodipus californicus ochrus *	
Chaetodipus fallax		San Diego pocket mouse
	Chaetodipus fallax fallax	northwestern San Diego pocket mouse
	Chaetodipus fallax pallidus *	pallid San Diego pocket mouse
Chaetodipus formosus		long-tailed pocket mouse
	Chaetodipus formosus melanurus	
	Chaetodipus formosus mesembrinus *	
	Chaetodipus formosus mohavensis	
Chaetodipus penicillatus		desert pocket mouse

	Chaetodipus penicillatus angustirostris	
	Chaetodipus penicillatus stephensi *	
Chaetodipus spinatus		spiny pocket mouse
	Chaetodipus spinatus rufescens	
	Chaetodipus spinatus spinatus	
Dipodomys agilis		Pacific kangaroo rat
	Dipodomys agilis agilis *	
	Dipodomys agilis cabezonae	
	Dipodomys agilis fuscus *	Point Conception kangaroo rat
	Dipodomys agilis perplexus *	
	Dipodomys agilis simulans	
Dipodomys californicus		California kangaroo rat
	Dipodomys californicus californicus	
	Dipodomys californicus eximius *	Marysville kangaroo rat
	Dipodomys californicus saxatilis *	
Dipodomys deserti		desert kangaroo rat
	Dipodomys deserti deserti	
Dipodomys elephantinus *		big-eared kangaroo rat
Dipodomys heermanni		Heermann kangaroo rat
	Dipodomys heermanni arenae *	
	Dipodomys heermanni berkeleyensis *	Berkeley kangaroo rat
	Dipodomys heermanni dixoni *	Merced kangaroo rat
	Dipodomys heermanni goldmani *	
	Dipodomys heermanni heermanni *	
	Dipodomys heermanni jolonensis *	
	Dipodomys heermanni morroensis *	Morro Bay kangaroo rat
	Dipodomys heermanni swarthi *	
	Dipodomys heermanni tularensis *	

Dipodomys ingens *		giant kangaroo rat
Dipodomys merriami		Merriam kangaroo rat
	Dipodomys merriami arenivagus *	
	Dipodomys merriami collinus *	
	Dipodomys merriami merriami	
	Dipodomys merriami parvus *	San Bernardino kangaroo rat
	Dipodomys merriami trindadensis	
Dipodomys microps		chisel-toothed kangaroo rat
	Dipodomys microps levipes *	
	Dipodomys microps microps *	
	Dipodomys microps occidentalis	
Dipodomys nitratoides *		
	Dipodomys nitratoides brevinasus	short-nosed kangaroo rat
	Dipodomys nitratoides exilis	
	Dipodomys nitratoides nitratoides	Tipton kangaroo rat
Dipodomys ordii		Ord kangaroo rat
	Dipodomys ordii columbianus	
	Dipodomys ordii monoensis	
Dipodomys panamintinus		Panamint kangaroo rat
	Dipodomys panamintinus argusensis *	Argus Mountain kangaroo rat
	Dipodomys panamintinus caudatus	
	Dipodomys panamintinus leucogenys	
	Dipodomys panamintinus mohavensis *	
	Dipodomys panamintinus panamintinus *	Panamint kangaroo rat
Dipodomys stephensi *		Stephens kangaroo rat
Dipodomys venustus		narrow-faced kangaroo rat
	Dipodomys venustus sanctiluciae *	
	Dipodomys venustus venustus *	Santa Cruz kangaroo rat
Microdipodops megacephalus		dark kangaroo mouse

	Microdipodops megacephalus ambiguus	
	Microdipodops megacephalus californicus	Sierra Valley kangaroo mouse
	Microdipodops megacephalus oregonus	
	Microdipodops megacephalus polionotus *	
Microdipodops pallidus		
	Microdipodops pallidus pallidus	pale kangaroo mouse
Perognathus alticola *		
	Perognathus alticola alticola	white-eared pocket mouse
	Perognathus alticola inexpectatus	Tehachapi pocket mouse
Perognathus inornatus *		
	Perognathus inornatus inornatus	San Joaquin pocket mouse
	Perognathus inornatus neglectus	McKittrick pocket mouse
	Perognathus inornatus psammophilus	Arroyo Seco pocket mouse
Perognathus longimembris		
	Perognathus longimembris bangsi *	Palm Springs pocket mouse
	Perognathus longimembris bombycinus	
	Perognathus longimembris brevinasus *	Los Angeles pocket mouse
	Perognathus longimembris internationalis	Jacumba pocket mouse
	Perognathus longimembris longimembris	
	Perognathus longimembris pacificus *	Pacific pocket mouse
	Perognathus longimembris panamintinus	
	Perognathus longimembris salinensis *	
	Perognathus longimembris tularensis *	
Perognathus parvus	*Perognathus parvus mollipilosus*	
	Perognathus parvus olivaceus	
Perognathus xanthonotus *		yellow-eared pocket mouse

Muridae

Arborimus albipes		white-footed vole
Arborimus pomo		California red tree vole
Clethrionomys californicus		California red-backed mouse
	Clethrionomys californicus californicus	
	Clethrionomys californicus mazama	
	Clethrionomys californicus obscurus	
Lemmiscus curtatus		
	Lemmiscus curtatus curtatus	sagebrush vole
	Lemmiscus curtatus intermedius	sagebrush vole
Microtus californicus		California meadow mouse
	Microtus californicus aestuarinus *	
	Microtus californicus californicus *	
	Microtus californicus constrictus *	
	Microtus californicus halophilus *	Monterey vole
	Microtus californicus kernensis *	
	Microtus californicus mariposae *	
	Microtus californicus mohavensis *	Mohave River vole
	Microtus californicus paludicola *	
	Microtus californicus sanctidiegi	
	Microtus californicus sanpabloensis *	San Pablo vole
	Microtus californicus scirpensis *	Amargosa vole
	Microtus californicus stephensi *	south coast marsh vole
	Microtus californicus vallicola	Owens Valley vole

	*	
Microtus longicaudus		long-tailed meadow mouse
	Microtus longicaudus augusticeps	
	Microtus longicaudus bernardinus *	San Bernardino vole
	Microtus longicaudus longicaudus	
	Microtus longicaudus sierrae	
Microtus montanus		montane vole
	Microtus montanus dutcheri	
	Microtus montanus montanus	
Microtus oregoni		
	Microtus oregoni adocetus	
	Microtus oregoni bairdi	
	Microtus oregoni oregoni	
Microtus townsendii		Townsend vole
	Microtus townsendii townsendii	
Neotoma albigula		white-throated woodrat
	Neotoma albigula venusta	Colorado Valley wood rat
Neotoma cinerea		bushy-tailed woodrat
	Neotoma cinerea acraia	
	Neotoma cinerea alticola	
	Neotoma cinerea lucida	
	Neotoma cinerea pulla	
Neotoma fuscipes		
	Neotoma fuscipes annectens *	San Francisco dusky-footed woodrat
	Neotoma fuscipes bullatior *	
	Neotoma fuscipes fuscipes *	
	Neotoma fuscipes luciana *	Monterey dusky-footed woodrat
	Neotoma fuscipes macrotis	
	Neotoma fuscipes monochroura	
	Neotoma fuscipes perplexa *	
	Neotoma fuscipes riparia *	San Joaquin Valley woodrat
	Neotoma fuscipes simple * *	

	Neotoma fuscipes streatori *	
Neotoma lepida		desert woodrat
	Neotoma lepida californica *	
	Neotoma lepida gilva	
	Neotoma lepida grinnelli	
	Neotoma lepida intermedia	San Diego desert woodrat
	Neotoma lepida lepida	
	Neotoma lepida nevadensis	
	Neotoma lepida petricola *	
Ondatra zibethica		muskrat
	Ondatra zibethica bernardi	
	Ondatra zibethica mergens	
Onychomys leucogaster		
	Onychomys leucogaster brevicaudus	
	Onychomys leucogaster fuscogriseus	
Onychomys torridus		southern grasshopper mouse
	Onychomys torridus longicaudus	
	Onychomys torridus pulcher	
	Onychomys torridus ramona	Ramona grasshopper mouse
	Onychomys torridus tularensis *	Tulare grasshopper mouse
Peromyscus boylii		
	Peromyscus boylii boylii	brush mouse
	Peromyscus boylii rowleyi	
Peromyscus californicus		California mouse
	Peromyscus californicus californicus *	
	Peromyscus californicus insignis	
Peromyscus crinitus		canyon mouse
	Peromyscus crinitus crinitus *	
	Peromyscus crinitus stephensi	
Peromyscus eremicus		cactus mouse
	Peromyscus eremicus eremicus	
	Peromyscus eremicus fraterculus	
Peromyscus maniculatus		deer mouse

	Peromyscus maniculatus anacapae *	Anacapa Island deer mouse
	Peromyscus maniculatus catalinae *	Catalina Island deer mouse
	Peromyscus maniculatus clementis *	San Clemente deer mouse
	Peromyscus maniculatus elusus *	
	Peromyscus maniculatus exterus *	
	Peromyscus maniculatus gambelii	
	Peromyscus maniculatus rubidus	
	Peromyscus maniculatus sanctaerosae *	
	Peromyscus maniculatus santacruzae *	
	Peromyscus maniculatus sonoriensis	
	Peromyscus maniculatus streatori *	
Peromyscus truei		pinyon mouse
	Peromyscus truei chlorus *	
	Peromyscus truei dyselius *	
	Peromyscus truei gilberti	
	Peromyscus truei martirensis	
	Peromyscus truei montipinorus *	
	Peromyscus truei sequoiensis	
	Peromyscus truei truei	
Phenacomys intermedius		heather vole
	Phenacomys intermedius celsus	
	Phenacomys intermedius intermedius	
Reithrodontomys megalotis		western harvest mouse
	Reithrodontomys megalotis distichlis *	Salinas harvest mouse
	Reithrodontomys megalotis longicaudus	
	Reithrodontomys megalotis megalotis	
Reithrodontomys raviventris *		salt-marsh harvest mouse
	Reithrodontomys raviventris halicoetes	

	Reithrodontomys raviventris raviventris	
Sigmodon arizonae		
	Sigmodon arizonae plenus	Colorado River cotton rat
Sigmodon hispidus		
	Sigmodon hispidus eremicus	Yuma hispid cotton rat
Zapus princeps		western jumping mouse
	Zapus princeps curtatus	
	Zapus princeps oregonus	
	Zapus princeps pacificus	
Zapus trinotatus		Pacific jumping mouse
	Zapus trinotatus eureka *	
	Zapus trinotatus orarius *	Pt. Reyes jumping mouse
	Zapus trinotatus trinotatus	
Castoridae		beaver
Castor canadensis		
	Castor canadensis repentinus	Sonora beaver
	Castor canadensis shastensis	
	Castor canadensis subauratus	golden beaver
Erethizontidae		
Erethizon dorsatum		porcupine
	Erethizon dorsatum couesi	
	Erethizon dorsatum epixanthum	
Canidae		
Canis latrans		coyote
	Canis latrans clepticus	
	Canis latrans lestes	
	Canis latrans mearnsi	
	Canis latrans ochropus	
Urocyon cinereoargenteus		gray fox
	Urocyon cinereoargenteus californicus	
	Urocyon cinereoargenteus scottii	
	Urocyon cinereoargenteus townsendi	
Urocyon littoralis *		Island gray fox
	Urocyon littoralis catalinae	

	Urocyon littoralis clementae	
	Urocyon littoralis dickeyi	
	Urocyon littoralis littoralis	
	Urocyon littoralis santacruzae	
	Urocyon littoralis santarosae	
Vulpes macrotis		kit fox
	Vulpes macrotis arsipus	
	Vulpes macrotis macrotis	
	Vulpes macrotis mutica *	San Joaquin kit fox
	Vulpes macrotis nevadensis	
Vulpes vulpes		
	Vulpes vulpes necator	Sierra Nevada red fox
Felidae		
Lynx rufus		bobcat
	Lynx rufus baileyi	
	Lynx rufus californicus	
	Lynx rufus fasciatus	
	Lynx rufus pallescens	pallid bobcat
Felis concolor		mountain lion
	Felis concolor browni	Yuma mountain lion
	Felis concolor californica	
	Felis concolor kaibabensis	
Mustelidae		
Gulo gulo		wolverine
	Gulo gulo luteus	
Lutra canadensis		river otter
	Lutra canadensis pacifica	
	Lutra canadensis sonora	
		southwestern river otter
Martes americana		marten
	Martes americana humboldtensis	Humboldt marten
	Martes americana sierrae	
Martes pennanti		
	Martes pennanti pacifica	Pacific fisher

Mephitis mephitis		striped skunk
	Mephitis mephitis estor	
	Mephitis mephitis holzneri	
	Mephitis mephitis major	
	Mephitis mephitis occidentalis	
Mustela erminea		ermine
	Mustela erminea muricus	
	Mustela erminea streatori	
Mustela frenata		long-tailed weasel
	Mustela frenata inyoensis *	
	Mustela frenata latirostra	
	Mustela frenata munda *	
	Mustela frenata nevadensis	
	Mustela frenata nigriauris *	
	Mustela frenata oregonensis	
	Mustela frenata pulchra *	
	Mustela frenata saturata	
	Mustela frenata xanthogenys *	
Mustela vison		mink
	Mustela vison aestuarina	
	Mustela vison energumenos	
Spilogale putorius		spotted skunk
	Spilogale putorius amphiala	Channel Islands spotted skunk
	Spilogale putorius gracilis	
	Spilogale putorius phenax	
Taxidea taxus		badger
	Taxidea taxus berlandieri	
	Taxidea taxus jeffersonii	
Procyonidae		
Bassariscus astutus		ringtail
	Bassariscus astutus nevadensis	
	Bassariscus astutus octavus	
	Bassariscus astutus raptor	
	Bassariscus astutus willetti *	
	Bassariscus astutus yumanensis	
Procyon lotor		raccoon

	Procyon lotor pacificus	
	Procyon lotor pallidus	
	Procyon lotor psora	
Ursidae		
Ursus americanus		black bear
	Ursus americanus altifrontalis	
	Ursus americanus californiensis	
Antilocapridae		
Antilocapra americana		pronghorn
	Antilocapra americana americana	
Bovidae		
Ovis canadensis		bighorn sheep
	Ovis canadensis californiana	California bighorn sheep
	Ovis canadensis cremnobates	Peninsula big-horned sheep
	Ovis canadensis nelsoni	Nelson big-horned sheep
Cervidae		
Cervus elaphus		elk
	Cervus elaphus nannodes	
	Cervus elaphus roosevelti	
Odocoileus hemionus		mule deer
	Odocoileus hemionus californica *	
	Odocoileus hemionus columbiana	
	Odocoileus hemionus eremica	
	Odocoileus hemionus fuliginata	
	Odocoileus hemionus hemionus	
	Odocoileus hemionus inyoensis *	
Odocoileus virginianis ochroura		northwestern white-tailed deer

Appendix 2. List of Expected and Potential Special Concern Taxa Sent to Selected Specialists for Recommendations and Additional Information.

Species	MSSC[1]	Status Williams[2]	FWS
Mammals expected to be recommended for inclusion on the updated species of concern list			
SHREWS AND MOLES			
Sorex lyelli, Mt. Lyell shrew	X	X (4)	FC3C
Sorex ornatus relictus, Buena Vista Lake shrew	X	X (1)	FC1
Sorex ornatus sinuosus, Suisun shrew	X	X (1)	FC2
Sorex ornatus willettii, Santa Catalina shrew	X	X (1)	FC2
Sorex vagrans halicoetes, salt marsh vagrant shrew	X	X (1)	FC2
Sorex vagrans paludivagus		X (4)	
Scapanus latimanus insularis, Angel Island mole		X (4)	
BATS			
Macrotus californicus, California leaf-nosed bat	X	X (2)	FC2
Choeronycteris mexicana, Mexican long-tongued bat	X	X (4)	FC2
Myotis occultus (=*M. lucifugus occultus*), Arizona myotis	X	X (1)	FC2
Myotis thysanodes thysanodes, fringed myotis			FC2
Myotis velifer velifer, cave myotis	X	X (1)	FC2
Euderma maculatum, spotted bat	X	X (4)	FC2
Plecotus townsendii, Townsend big-eared bat	X	X (2)	FC2
Antrozous pallidus, pallid bat	X		
Nyctinomops macrotis, big free-tailed bat	X	X (3)	FC2
Eumops perotis californicus, California mastiff bat	X	X (2)	FC2
LAGOMORPHS			
Brachylagus idahonensis, pygmy rabbit	X	X (3)	FC2
Lepus americanus tahoensis, Sierra Nevada snowshoe hare		X (3)	FC2
RODENTS			

Aplodontia rufa phaea, Point Reyes mountain beaver	X	X (3)	FC2
Spermophilus tereticaudus chlorus, Palm Springs ground squirrel	X	X (4)	FC2
Glaucomys sabrinus californicus, San Bernardino flying squirrel	X	X (4)	FC2
Dipodomys merrriami parvus, San Bernardino kangaroo rat	X		FC1
Dipodomys nitratoides brevinasus, short-nosed kangaroo rat	X	X (3)	FC2
Perognathus alticola alticola, white-eared pocket mouse	X	X (2)	FC2
Perognathus alticola inexpectatus, Tehachapi pocket mouse	X	X (3)	FC2
Perognathus inornatus, San Joaquin pocket mouse			FC2
Perognathus longimembris bangsi, Palm Springs pocket mouse	X		FC2

Perognathus longimembris brevinasus, Los Angeles pocket mouse	X	X (1)	FC2
Arborimus albipes, white-footed vole	X	X (2)	FC2
Arborimus pomo, California red tree vole	X	X (3)	FC2
Microtus californicus halophilus, Monterey vole		X (4)	
Microtus californicus mohavensis, Mohave River vole	X	X (4)	FC2
Microtus californicus stephensi, south coast marsh vole	X	X (4)	FC2
Neotoma fuscipes riparia, San Joaquin Valley woodrat	X	X (2)	FC1
Onychomys torridus ramona, southern grasshopper mouse	X		FC2
Onychomys torridus tularensis, Tulare grasshopper	X		FC2
Sigmodon arizonae plenus, Colorado River cotton rat	X	X (1)	FC2
Zapus trinotatus orarius, Pt. Reyes jumping mouse	X	X (2)	FC2
CARNIVORES			
Spilogale gracilis amphiala, Channel Islands spotted skunk	X	X (3)	FC2
Martes americana humboldtensis, Humboldt marten	X	X (4)	
Martes pennanti pacifica, Pacific fisher	X	X (3)	FC2
Felis concolor browni, Yuma mountain lion	X	X (1)	FC2

Mammals for which additional information is being collected

SHREWS AND MOLES			
Sorex ornatus salarius, Salinas ornate shrew	X	X (4)	FC2
Sorex ornatus salicornicus, Southern California salt-marsh shrew	X	X (2)	FC2
Scapanus latimanus parvus, Alameda Island mole	X	X (4)	FC2
BATS			
Myotis ciliolabrum (=*M.leibii ciliolabrum*), western small-footed myotis			FC2
Myotis yumanensis oxalis, San Joaquin myotis		X (4)	
Myotis lucifugas carissima			
Myotis lucifugas relictus, Mammoth little brown myotis		X (4)	FC2
Myotis volans, long-legged myotis			FC2
Myotis evotis, long-eared myotis			FC2

Lasiurus blossvillii teliotus (= *L. borealis teliotus*), western red bat			
Nyctinomops femorosaccus, pocketed free-tailed bat	X	X (2)	
LAGOMORPHS			
Lepus americanus klamathensis, Oregon snowshoe hare	X	X (3)	
RODENTS			
Spermophlus laterlis bernardinus, San Bernardino ground squirrel		X (4)	
Tamias speciosus callipeplus, Mt. Pinos chipmunk		X (4)	
Tamias speciosus speciosus, lodgepole chipmunk			FC2
Thomomys bottae operarius, Owens Lake pocket gopher			
Dipodomys agilis fuscus, Point Conception kangaroo rat		X (4)	
Dipodomys californicus eximius, Marysville kangaroo rat	X	X (4)	FC2
Dipodomys californicus saxatilis, California kangaroo rat			
Dipodomys elephantinus (=*D.venustus elephantinus*), big-eared kangaroo rat	X	X (4)	FC3B
Dipodomys heermanni berkeleyensis, Berkeley kangaroo rat		X (4)	FC2
Dipodomys heermanni dixoni, Merced kangaroo rat		X (4)	FC2
Dipodomys merriami collinus			FC2
Dipodomys panamintinus argusensis, Argus Mountain kangaroo rat		X (4)	
Dipodomys panamintinus panamintinus, Panamint kangaroo rat		X (4)	
Dipodomys venustus venustus, Santa Cruz kangaroo rat		X (4)	
Microdipodops megacephalus californicus, Sierra Valley kangaroo mouse		X (4)	
Microdipodops pallidus pallidus, pale kangaroo mouse		X (4)	
Perognathus longimembris internationalis, Jacumba pocket mouse	X		FC2
Perognathus longimembris tularensis			
Perognathus longimembris salinensis			
Perognathus xanthonotus, yellow-eared pocket mouse		X (4)	
Microtus californicus vallicola, Owens Valley vole	X	X (4)	FC2
Neotoma fuscipes annectens, San Francisco dusky-footed woodrat	X		FC2
Reithrodontomys megalotis distichilis, Salinas harvest mouse		X (4)	
Reithrodontomys megalotis longicaudus, Santa Cruz harvest mouse (Santa Cruz Island population, formerly *santacruzae*)		X (4)	FC3B
Sigmodon hispidus eremicus, Yuma hispid cotton rat	X	X (4)	FC2

Erethizon dorsatum, porcupine

CARNIVORES

Lutra canadensis sonora, southwestern otter	X	FC2
Spilogale gracilis gracilis, spotted skunk		
Spilogale gracilis phenax, spotted skunk		
Mustela vison, mink		
Taxidea taxus, badger	X (3)	

UNGULATES

Odocoileus virginianis ochroura, northwestern white-tailed deer	X (4)

$MSSC_1$, X indicates the species as a current CSC Working Species of Concern List
$Williams_2$, X (1) - X (4) indicates treatment in Williams (1985)

Appendix 3. List of museums contacted for specimen records of California terrestrial mammals.

Code	Museum Name
AMNH	American Museum of Natural History
CMNH	Carnegie Museum of Natural History
CAS	California Academy of Sciences
CPP	California State Polytechnic University, Pomona
CSUC*	California State University, Chico
CSUFR*	California State University, Fresno
CSUF*	California State University, Fullerton
CSUH	California State University, Humboldt
CSULB	California State University, Long Beach
CSULA	California State University, Los Angeles
CSUN	California State University, Northridge
CSUS	California State University, Sacramento
CSUSJ*	California State University, San Jose
CSUSO	California State University, Sonoma
CSLO	California State University, San Luis Obispo
CSST	California State University, Stanislaus
DMNH	Denver Museum of Natural History
DVM	Death Valley Museum, Death Valley National Monument
FMNH	Field Museum of Natural History
LACM	Los Angeles County Museum of Natural History
LSU	Louisiana State University
MSU	Michigan State University
MCZ	Museum of Comparative Zoology, Harvard University
MVZ	Museum of Vertebrate Zoology, University of California, Berkeley
MZ	Museum of Zoology, University of Michigan
NMNH	National Museum of Natural History
OC	Occidental College, Moore Laboratory of Zoology
OMNH	University of Oklahoma, Museum of Natural History
PUC	Pacific Union College
PSM*	Palm Springs Desert Museum

PANS	Philadelphia Academy of Natural Sciences
ROM	Royal Ontario Museum
SBCMNH*	San Bernardino County Museum of Natural History*
SDMNH	San Diego Museum of Natural History
SDSU	San Diego State University
SBMNH	Santa Barbara Museum of Natural History
TAM	Texas A & M University
TTU	Texas Tech University
UOA	University of Arizona, Tucson
UCD	University of California, Davis
UCLA	University of California, Los Angeles
UCSB	University of California, Santa Barbara
UI	University of Illinois, Museum of Natural History
UK	University of Kansas
UM	University of Montana, Missoula
UNM*	University of New Mexico, Museum of Southwestern Biology
UNLV*	University of Nevada, Las Vegas
UPS	University of Puget Sound, Puget Sound Museum of Natural History
UWBM	University of Washington, Burke Museum
YM	Yosemite Museum, Yosemite National Park

* No specimen records received