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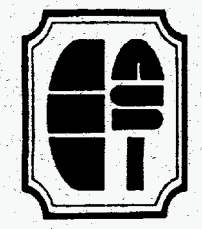

Enterprise Advisory Services, Inc.
NPRC Endangered Species and Cultural Resources Program

EASI 97-2

CONSERVATION PLAN FOR PROTECTED SPECIES ON NAVAL PETROLEUM RESERVE NO. 1, KERN COUNTY, CALIFORNIA

July 1997

Naval Petroleum Reserves in California
P.O. Box 178, Tupman, California 93276

DISCLAIMER

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Mark R. M. Otten and Brian L. Cypher

July 1997

Naval Petroleum Reserves in California
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ABSTRACT

Habitats in and around Naval Petroleum Reserve No. 1 (NPR-1) support populations of various vertebrates and plants, including a number of threatened and endangered species. Adequate conservation of habitats and species, particularly protected species, can be facilitated through development and implementation of management plans. This document provides a comprehensive plan for the conservation of protected species on NPR-1, through compliance with terms and conditions expressed in Biological Opinions rendered by the U. S. Fish and Wildlife Service for NPR-1 activities. Six conservation strategies by which threatened and endangered species have been, and will be, protected are described: population monitoring, mitigation strategies, special studies, operating guidelines and policies, information transfer and outreach, and the endangered species conservation area. Population monitoring programs are essential for determining population densities and for assessing the effects of oil field developments and environmental factors on protected species. Mitigation strategies (preactivity surveys and habitat reclamation) are employed to minimize the loss of important habitats components and to restore previously disturbed lands to conditions more suitable for species' use. A number of special studies were undertaken between 1985 and 1995 to investigate the effectiveness of a variety of population and habitat management techniques with the goal of increasing the density of protected species. Operating guidelines and policies governing routine oil field activities continue to be implemented to minimize the potential for the incidental take of protected species and minimize damage to wildlife habitats. Information transfer and outreach activities are important means by which technical and non-technical information concerning protected species conservation on NPR-1 is shared with both the scientific and non-scientific public. By November 1998, an endangered species conservation area will be established on approximately 3,000 ha of NPR-1 and protected in perpetuity against major oil-related developments and managed for listed species.

ACKNOWLEDGMENTS

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CONTENTS

ILLUSTRATIONS

1. INTRODUCTION

Naval Petroleum Reserve No. 1 (NPR-1) is an active oil and natural gas field, producing approximately 23 million barrels of crude oil and 120 trillion cubic feet of natural gas annually. Production on such a scale requires a well developed road system, large refining and storage facilities, and numerous support buildings. The resultant disturbance to land surfaces can be considerable in some areas. Nevertheless, the NPR-1 environment supports populations of many vertebrate and plant species. Included among these are several species protected under the Endangered Species Act of 1973 (Public Law 93-205). Adequate conservation of plant and animal species, particularly protected species, calls for a comprehensive management plan. Two such plans have been previously prepared, one in 1963 and one in 1987 (O'Farrell and Scrivner, 1987). The conservation plan detailed in this document has been constructed from the framework and efforts of those previous plans. This document provides a comprehensive plan for the conservation of protected species on NPR-1 through a revision to the 1987 Wildlife Management Plan (O'Farrell and Scrivner, 1987). Specific purposes of this document are to (1) document the strategy employed on NPR-1 for the conservation of protected species, (2) describe the policies and methods by which the plan objectives are achieved, and (3) describe future strategies by which the continued conservation of protected species is ensured.

1.1 Background

On September 2, 1912, President William H. Taft issued an executive order establishing NPR-1 on approximately 15,400 ha in southwestern Kern County, California. An additional 2,700 ha were added to NPR-1 via executive order by President Franklin D. Roosevelt in 1942. These lands were initially set aside specifically to provide a fuel source for the Navy's oil-powered warships. Except for a brief period during World War II (1942-1945), production on NPR-1 was maintained at a low level until 1976. In 1976, the U. S. Congress passed the Naval Petroleum Production Act (Public Law 94-248) directing the Secretary of the Navy to recover petroleum products at the maximum efficient rate (MER) consistent with sound engineering practices. Under Public Law 94-258, MER was defined as "The maximum sustainable daily oil or gas rate from a reservoir which will permit economic development and depletion of that reservoir without detriment to ultimate recovery." Control of NPR-1 was transferred from the U. S. Department of the Navy to the U. S. Department of Energy (DOE) in 1977. An intensive drilling and construction program to comply with Public Law 94-248 (U. S. Department of Energy, 1979) was begun in the same year and has continued through 1997.

Lands on and adjacent to NPR-1 are known to support populations of a number of plant and animal species protected by the Endangered Species Act of 1973. Four endangered vertebrate species are known to occur on or adjacent to NPR-1: the San Joaquin kit fox (*Vulpes macrotis mutica*), the giant kangaroo rat (*Dipodomys ingens*), the Tipton kangaroo rat (*Dipodomys nitratoides nitratoides*), and the blunt-nosed leopard lizard (*Gambelia silus*). Section 3(6) of the Endangered Species Act defines an endangered species as one that ". . . is in danger of extinction

throughout all or a significant portion of its range . . ." One threatened plant species is known to occur on NPR-1: Hoover's wooly-star (*Eriastrum hooveri*). Section 3(20) of the Endangered Species Act defines a threatened species as one ". . . which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." Throughout this document, the terms "listed species" and "protected species" will be used synonymously with the term "threatened and endangered species" and to describe, as a group, all plants and animals protected by the Endangered Species Act.

In addition to the threatened and endangered species listed above, 13 other vertebrate and plant species known to occur on or adjacent to NPR-1 were formerly federally listed candidate 2 (C2) species. In 1996, the U. S. Fish and Wildlife Service (FWS) eliminated the C2 species designation, and preserved the candidate 1 (C1) species designation as simply "candidate species." A candidate species is defined as one for which there is ". . . sufficient information on biological vulnerability and threat(s) to support issuance of a proposed rule to list but issuance of the proposed rule is precluded." (Federal Register Vol. 61, No. 40, pp 7595-7613). Potential exists, however, for FWS to redesignate one or more of the former C2 species as a candidate species in the future or to designate other species as candidates should new information and/or listing petitions warrant such action. The former C2 species known to occur on or adjacent to NPR-1 are listed below.

Former Vertebrate Candidate 2 Species
San Joaquin antelope squirrel (*Ammospermophilus nelsoni*)
Short-nosed kangaroo rat (*Dipodomys nitratoides brevinasus*)
San Joaquin pocket mouse (*Perognathus inornatus*)
Tulare grasshopper mouse (*Onychomys torridus tularensis*)
Western burrowing owl (*Speotyto cunicularia hypugea*)
San Joaquin thrasher a.k.a. Le Conte's thrasher (*Toxostoma lecontei*)
Ferruginous hawk (*Buteo regalis*)
Loggerhead shrike (*Lanius ludovicionus*)
Tricolored blackbird (*Agelaius tricolor*)
California horned lizard (*Phrynosoma coronatum frontale*)

Former Plant Candidate 2 Species
Oil nestraw (*Stylocline citroleum*)
Recurved larkspur (*Delphinium recurvatum*)
Heartscale (*Atriplex cordulata*)

The vegetation association on NPR-1 exhibits little variability and is classified as belonging to the Allscale Series (Sawyer and Keeler-Wolf, 1995). Trees occur rarely and plant associations show only small variation due to topography. Nearly all of the land area consists of an annual grassland/saltbush scrub habitat. Some alkali sink habitat is also present, occupying small areas of NPR-1 and existing exclusively on flat, well drained soils at low elevations. Annual grassland/saltbush scrub is characterized by vegetation that consists primarily of winter annual

grasses and forbs, many of which are not native. Perennial plants are uncommon and the only shrub that is widely distributed is desert saltbush (*Atriplex polycarpi*) (Twisselmann, 1967). Alkali sink habitat occurs on fully mineralized soils, and is dominated by halophytic annual and perennial plants. The most diagnostic plant of alkali sink habitat is sueda (*Sueda fruticosa*), with alkaline-tolerant forbs such as recurved larkspur and goldfields (*Lasthenia californica*) also occurring (Twisselmann, 1967).

1.2 DOE Mission on NPR-1 and Formal Consultations with FWS

As the federal agency responsible for the operation of NPR-1, DOE's primary mission is to produce petroleum products at MER in compliance with Public Law 94-248. However, Section 2(c)(1) of the Endangered Species Act also requires DOE, as an agency of the Federal Government, to ". . . seek to conserve endangered species and threatened species and . . . [to] utilize their authorities in furtherance of the purposes of the [endangered species] act." In compliance with Section 7(a) of the Endangered Species Act, DOE entered into formal consultations with FWS. The objective of these consultations were to allow petroleum production at MER on NPR-1 while avoiding detrimental effects on resident listed species.

From 1980 to 1995, three separate Section 7 consultations were completed between DOE and FWS. The initial Biological Opinion, completed in February 1980, addressed the effects of DOE Project 12 on San Joaquin kit foxes and blunt-nosed leopard lizards. Project 12 was one of 14 major construction projects needed to complete "open-up" activities under Public Law 94-248. These major projects were initially required for the site to achieve production operations at MER. It involved construction and operation of an 11-mile liquid products pipeline and a storage and railroad loading facility for the liquid products. The FWS determined that proposed Project 12 activities jeopardized the continued existence of both the San Joaquin kit fox and the blunt-nosed leopard lizard (U. S. Department of the Interior, 1980). Based on a commitment from DOE to complete an additional consultation examining all aspects of production at MER, FWS offered six reasonable and prudent alternatives by which the likelihood of jeopardy could be avoided. These alternatives included: conducting basic research on endangered species, preparation of a master plan for completing developments constructing a mitigation plan to offset the impacts of production at MER, and avoiding disturbance to kit fox dens, when possible. Subsequent correspondence committed DOE to implementing protective measures for listed species on NPR-1.

The second Biological Opinion, which was completed in December 1987, addressed the effects of the petroleum development program under MER on San Joaquin kit foxes, giant kangaroo rats, and blunt-nosed leopard lizards. Specifically, the impact of the ongoing MER production program and the success of implementation of the reasonable and prudent measures offered in the 1980 Biological Opinion were examined. The FWS determined that continued development of NPR-1 was not likely to jeopardize the continued existence of the San Joaquin kit fox, giant kangaroo rat, or blunt-nosed leopard lizard (U. S. Department of the Interior, 1987). This opinion was concluded based on a commitment by DOE to continue implementing protective measures for the listed species. In addition, FWS specified three reasonable and prudent measures for minimizing the incidental take of protected species; specified three terms and conditions for meeting the reasonable and prudent measures; and proposed three conservation recommendations.

The third Biological Opinion, which was completed in November 1995, resulted from a re-initiation of formal consultation on the effect of continued petroleum development on listed species on NPR-1. Specifically, the opinion addressed the impact of the ongoing petroleum development program to the San Joaquin kit fox, giant kangaroo rat, Tipton kangaroo rat, blunt-nosed leopard lizard, and Hoover's wooly-star. Based on DOE's commitment to continue implementing mitigation measures and the rarity of listed species in the proposed development area, FWS concluded that continuation of the MER program was not likely to jeopardize the continued existence of any of these species (U. S. Department of the Interior, 1995). In addition, FWS specified three reasonable and prudent measures for minimizing incidental take of protected species; specified three terms and conditions for implementing the reasonable and prudent measures; and proposed five conservation recommendations.

Subsequent to the issuance of the November 1995 Biological Opinion, the National Defense Authorization Act of 1996 (Public Law 104-106) was enacted which requires DOE to sell all of the Government's interests in NPR-1. In addition to requiring the divestiture of NPR-1, another provision of Public Law 104-106 amended the Public Law 94-258 requirement to produce the Reserve under MER constraints (i.e., "without detriment to ultimate recovery"). This requirement was dropped and replaced with a requirement to produce at the maximum daily oil or gas rate from a reservoir, which will permit "maximum economic development of the reservoir consistent with sound engineering practices." This related method of production has been commonly referred to as maximum economic development rate, or MED. Endangered species program compliance requirements for potential new owners may be subject to change from those contained in the November 1995 Biological Opinion. The future direction of the endangered species program at NPR-1 is the subject of ongoing discussions between DOE and the Department of Interior. The outcome of these discussions will be addressed in the Supplemental Environmental Impact Statement for the sale of NPR-1 which is being developed at this time. Potential bidders will also be advised of the outcome of these discussions when information becomes available. Given this dynamic situation, future program requirements under a private owner will not be dealt with in this document.

1.3 1987 Wildlife Management Plan and Purpose of this Document

One of the reasonable and prudent alternatives specified by FWS in the 1980 Biological Opinion was for DOE to ". . . commit to the carrying out of a compensation/mitigation plan which will be developed . . . to offset impacts resulting from MER" (U. S. Department of the Interior, 1980). In compliance with this alternative, DOE directed EG&G Energy Measurements, Inc. (EG&G/EM), its endangered species contractor between 1979 and 1995, to develop a wildlife management plan for NPR-1. The objectives of the resultant Wildlife Management Plan were to (1) synthesize information on wildlife species on NPR-1, (2) suggest management goals for creating and maintaining healthy wildlife populations, and (3) re-initiate agreements between conservation agencies and DOE for wise management of wildlife populations on NPR-1(O'Farrell and Scrivner, 1987). To achieve these objectives, the Wildlife Management Plan emphasized conducting pre-disturbance surveys for all projects, revegetation of disturbed habitats, endangered

species population monitoring, control of coyote populations to ease predation pressure on kit foxes, implementation of operation guidelines, development of habitat restoration methods, development of educational programs for NPR-1 employees, and participation in endangered species recovery (O'Farrell and Scrivner, 1987).

Several important developments occurred between 1987 and 1996 which rendered parts of the 1987 Wildlife Management Plan inadequate or obsolete. For example, since 1987 two species known to occur on NPR-1 (Tipton kangaroo rat and Hoover's wooly-star) were listed, several projects advocated by the management plan were completed, and organizational responsibilities changed. Therefore, revisions to the plan were necessary to effectively protect all listed species on NPR-1. The purpose of this document is provide a comprehensive plan for the conservation of protected species on NPR-1 through revision to the 1987 Wildlife Management Plan. Data presented in this document are current through December 31, 1995.

2. ELK HILLS ENVIRONMENT

2.1 Location, Climate, Geology, and Physiography

NPR-1 is located in the southwestern portion of Kern County, California, approximately 40 km west/southwest of Bakersfield and 14 km north of Taft (Figure 1). NPR-1 encompasses approximately 19,116 ha in 81 sections and spans portions of seven townships. Lands on NPR-1 are owned by DOE and by Chevron U. S. A. Production Company (CPDN), but are operated as a single entity by a contract Unit Operator. The DOE owns approximately 15,006 ha (78.5%) of NPR-1, while CPDN owns approximately 3,916 ha (20.5%). The remaining 194 ha (1%) are privately-owned inholdings. Elevations on NPR-1 range from approximately 90 m along the northeastern perimeter to approximately 470 m in the central portion of the Reserve.

Long-term, site-specific climatological data are not available for NPR-1. As a result, the information presented has been summarized from data collected at nearby Bakersfield (National Oceanic and Atmospheric Administration, 1994). The climate of the NPR-1 region is generally described as Mediterranean in nature and is characterized by hot, arid summers and mild, humid winters (Major, 1977). The mean annual precipitation is 15.04 cm, 75% of which falls between November and April. Precipitation, though occasionally heavy, is rarely sufficient on a yearly basis to bring soils to field capacity (Major, 1977). Thunderstorms and snow are infrequent at elevations below 900 m. The mean annual temperature is 18.3°C, the mean annual maximum temperature is 25.7°C, and the mean annual minimum temperature is 10.9°C. On average, July and August are the hottest months, while December and January are the coldest months.

The topography of NPR-1 consists of low-relief valley lands along the northern and southern Reserve perimeters and mid to high-relief ridge slopes in the Reserve's interior. The dominant physiographic feature of NPR-1 is a large, east-west oriented formation known as Elk Hills. Elk Hills is a 27-km long, 11-km wide foothill spur of the Temblor Range and is the surface expression of a compound anticline formed during the Pliocene and Pleistocene (Maher et al., 1975). The Elk Hills formation is characterized by high-relief slopes with rounded crests and steep draws. Soils are well drained sandy loams of varying thickness, are of granitic origin, and are classified as Elk Hills and Torriorthent Series (U. S. Department of Agriculture, 1986). Lands surrounding the Elk Hills, but within and adjacent to the boundaries of NPR-1, are characterized by low-relief valley lands and gently rolling hills. These areas occur primarily along NPR-1's northern perimeter (north flank), and in Buena Vista Valley along NPR-1's southern perimeter. Soils in low-relief terrain are very deep, well drained, alluvial sandy loams, are of granitic origin, and are classified as Cajon and Kimberlina Series (U. S. Department of Agriculture, 1986).

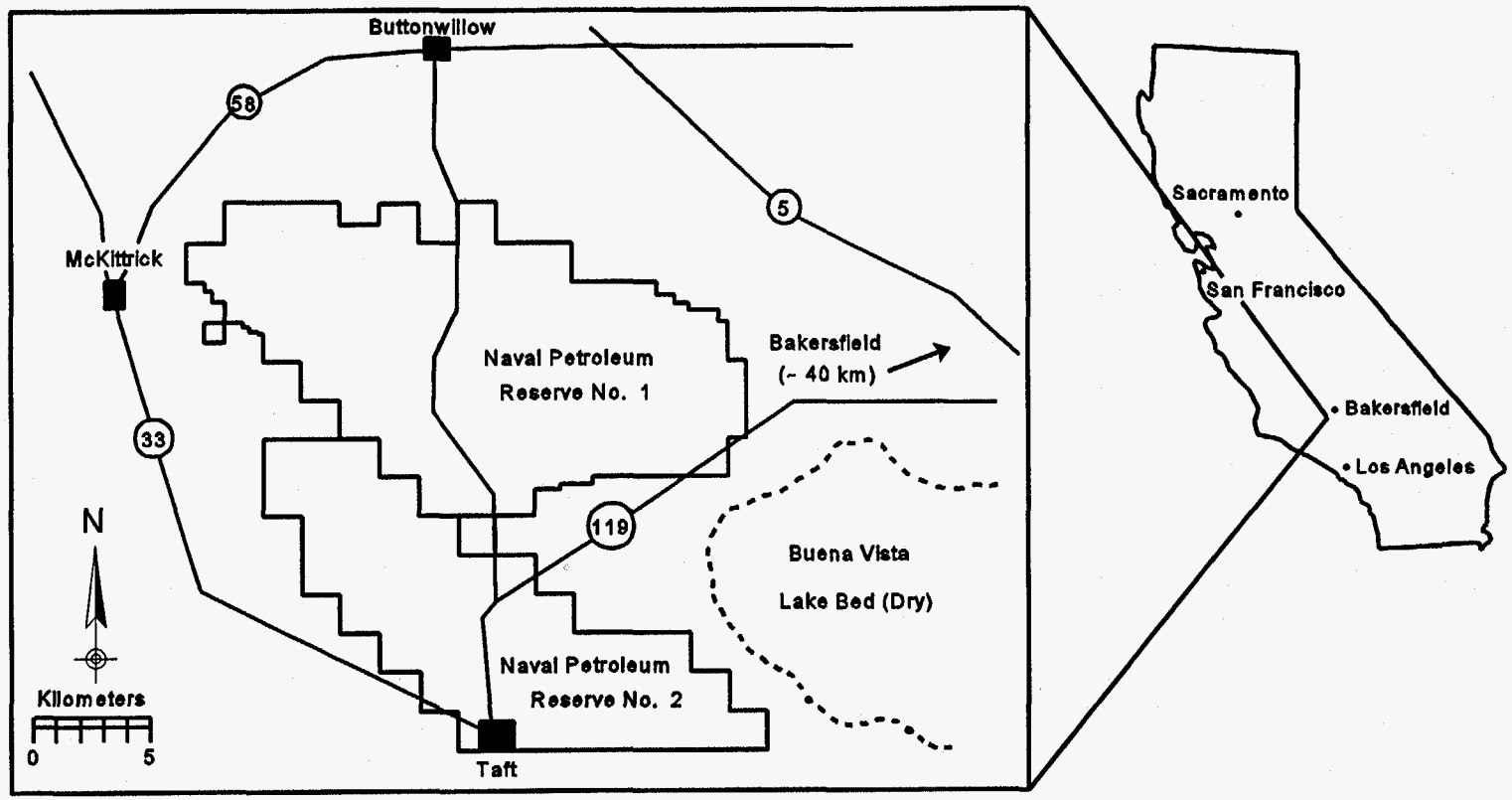

Figure 1. Location of Naval Petroleum Reserves No. 1 and No. 2, Kern County, California.

2.2 Land Uses

NPR-1 is among the 10 largest petroleum producing fields in the 48 contiguous United States. Production at NPR-1 in 1995 averaged approximately 63,000 barrels of crude oil per day and approximately 330 million cubic feet of natural gas per day. Of the 19,116 ha encompassed by NPR-1, approximately 15% has been developed for petroleum production. The remaining land area is either undeveloped or is naturally revegetated. The California Aqueduct, which conducts water from the Sacramento Valley in central California to southern California, occupies approximately 39 ha in five sections along NPR-1's northern boundary. The town of Tupman occupies approximately 13 ha of land along NPR-1's northeastern boundary. Some trespass grazing by livestock occurs on lands within the NPR-1 boundary.

Lands surrounding NPR-1 are dedicated to a variety of uses. Naval Petroleum Reserve No. 2 (NPR-2), Midway-Sunset oil field, Cymric oil field, and South Bellridge oil field are petroleum producing areas located south, southwest, west, and northwest of NPR-1. Agriculture and livestock grazing occur on lands located north, northeast, east, and southeast of NPR-1. Two habitat conservation areas, Lokern Road Natural Area and Coles Levee Ecosystem Preserve, are located north and east of NPR-1, respectively. Six small towns (Buttonwillow, Derby Acres, Dustin Acres, Fellows, McKittrick, and Valley Acres) and one moderate-sized town (Taft) are also located near NPR-1.

2.3 Biota

2.3.1 Vegetative Association

The vegetative association present on NPR-1 is broadly described as belonging to the Allscale Series (Sawyer and Keeler-Wolf, 1995). Historically this association extended over much of the western half of the San Joaquin Valley, but has more recently been reduced in extent. The native, pre-Columbian composition of this association is uncertain. The most widely held view is that perennial bunchgrasses, such as purple needlegrass (*Stipa pulchra*), one-sided bluegrass (*Poa scabrella*), and nodding needlegrass (*Stipa cernica*) were the dominant species, with perennial and annual herbs of the carrot, daisy, legume, mint, mustard, and pink families also commonly occurring. An analysis of historical landscape descriptions, however, lead Wester (1981) to conclude that the native San Joaquin grassland was likely dominated by annual forbs, such as red-stemmed filaree (*Erodium cicutarium*), and xerophytic shrubs. According to Wester (1981), perennial bunchgrasses were probably uncommon, except on well-watered soils.

Currently, the composition of the Allscale Series is dominated by annual grasses and forbs (Heady, 1977). Xerophytic shrubs are locally common, but trees are rare (Heady, 1977). Red brome (*Bromus madritensis*) is the most common grass on NPR-1. Other common grasses include zorro fescue (*Festuca megalura*), slender oats (*Avena barbata*), foxtail (*Hordeum murinum*), and Mediterranean grass (*Schismus barbatus*) (O'Farrell and Mitchell, 1985). Red-stemmed filaree and fiddleneck (*Amsinckia intermedia*) are the most common forbs on NPR-1. Other common

forbs include pepperweed (*Lepidium dictyotum*), crassula (*Crassula erecta*), tansy phacelia (*Phacelia tanacetifolia*), Russian thistle (*Salsola kali*), and wild buckwheat (*Eriogonum ordii*). Desert saltbush is the dominant shrub on NPR-1, particularly on previously disturbed lands. Other common shrubs include bladderpod (*Isomeris arborea*), cheesebush (*Hymenoclea salsola*), valley saltbush (*Atriplex lentiformis*), and winterfat (*Krascheninnikovia lanata*) (O'Farrell and Mitchell, 1985). A complete list of plant species known to occur on NPR-1 can be found in Appendix A.

2.3.2 Animal Community

The animal community of NPR-1 is composed primarily of species adapted to semi-arid grassland/scrub habitats. Some generalist species not specifically adapted to semi-arid grassland/scrub, such as coyotes (*Canis latrans*) and ravens (*Corvus corax*), are also common. Species are both nocturnal and diurnal and typically establish subterranean dens and burrows or are ground nesters. O'Farrell and Scrivner (1987) reported observations of 25 mammalian species, 92 avian species, eight reptilian species, and two amphibian species on NPR-1. Roughly half of the avian species observed were considered resident, while the rest were considered transient or migratory (O'Farrell and Scrivner, 1987). A complete list of vertebrates known to occur on NPR-1 can be found in Appendix A.

The most common mammal observed during a 1984 diurnal transect survey of NPR-1 was the black-tailed jackrabbit (*Lepus californicus*) (O'Farrell and Mathews, 1987). Other species observed include: desert cottontail (*Sylvilagus audubonii*), San Joaquin antelope squirrel, and San Joaquin kit fox (O'Farrell and Mathews, 1987). Other mammalian species known to exist on NPR-1, but not observed on transect surveys, include: badger (*Taxidea taxus*), three species of kangaroo rat (*Dipodomys* spp.), coyote, bobcat (*Felis rufus*), and several species of mice (O'Farrell and Scrivner, 1987).

The most common bird observed during a 1984 diurnal transect survey of NPR-1 was the California quail (*Lophortyx californicus*) (O'Farrell and Mathews, 1987). Other species observed include: mourning dove (*Zenaida macroura*), western meadowlark (*Sturnella neglecta*), and horned lark (*Eremophila alpestris*) (O'Farrell and Mathews, 1987). Other avian species known to reside on, or migrate through, NPR-1, but not observed on transect surveys, include: American kestrel (*Falco sparverius*), northern flicker (*Colaptes auratus*), American robin (*Turdus migratorius*), cedar waxwing (*Bombycilla cedrorum*), yellow-rumped warbler (*Dendroica coronata*), and fox sparrow (*Passerella iliaca*) (O'Farrell and Scrivner, 1987).

The most common reptile observed during a 1984 diurnal transect survey of NPR-1 was the side-blotched lizard (*Uta stansburiana*) (O'Farrell and Mathews, 1987). Other reptile species either observed on transect surveys or otherwise known to occur on NPR-1 include: western whiptail lizard (*Cnemidophorus tigris*), blunt-nosed leopard lizard, coachwhip snake (*Masticophis flagellum*), glossy snake (*Arizona elegans*), gopher snake (*Pituophis melanoleucus*), and western rattlesnake (*Crotalus viridis*) (O'Farrell and Mathews, 1987; O'Farrell and Scrivner, 1987). The two amphibian species known to occur on NPR-1 are the western toad (*Bufo boreas*) and the pacific treefrog (*Hyla regilia*) (O'Farrell and Scrivner, 1987).

2.3.3 Threatened and Endangered Species

This section provides descriptions of the natural history and the current and historic distributions of the four endangered animals and one threatened plant species known to occur on NPR-1. Recovery plans have been published for the San Joaquin kit fox (U. S. Department of the Interior, 1983) and the blunt-nosed leopard lizard (U. S. Department of the Interior, 1988) and are cited where appropriate. All of the species discussed below (including San Joaquin kit fox and blunt-nosed leopard lizard) are considered in a multi-species recovery plan for the arid upland and riparian areas of the San Joaquin Valley (Williams et al., In Prep.). This plan includes species-specific conservation efforts, recovery strategies, and recovery criteria.

San Joaquin Kit Fox

The San Joaquin kit fox (*Vulpes macrotis mutica*) was listed as an endangered species by the federal government in 1967 and as a threatened species by the state of California in 1971. The kit fox, of which the San Joaquin kit fox is a subspecies, is the smallest of all North American canids and is closely associated with arid grassland/scrub and steppe habitats (McGrew, 1979). Physically, the San Joaquin kit fox is characterized by small size, narrow body, large and conspicuous ears, and long, bushy tail (~ 40% of body length). Dorsal pelage is light buff to buffy gray in summer and grizzled gray in winter, ventral pelage is light buff to white, and the tail is black-tipped (U.S. Department of the Interior, 1983).

San Joaquin kit foxes inhabit the grassland/saltbush scrub habitat of the San Joaquin Valley floor and surrounding foothills. Dens are typically established in excavated burrows, but may be established in culverts, pipes, or under structures. Kit fox diets are composed primarily of nocturnal rodents and leporids, but may also include fruits, birds, and insects (Morrell, 1972). Mated pairs are typically seasonally monogamous, with vixens whelping three to six pups in late February or early March.

The historic distribution of the San Joaquin kit fox encompassed much of the San Joaquin Valley floor and the bordering foothills. Originally stretching from Contra Costa and Stanislaus Counties in the north to Kern County in the south, the kit fox's range has since been much restricted. Currently the San Joaquin kit fox is primarily distributed in remnant grassland/saltbush scrub habitat in the western portions of Fresno, Kern, and Kings Counties. Small populations are also located in valleys of the interior coast ranges of Monterey and San Luis Obispo Counties. On NPR-1, San Joaquin kit foxes occur primarily in the low-relief terrain along the north flank (northern perimeter) and in Buena Vista Valley, and less commonly in the moderate to high relief terrain near the Reserve's center. Low-relief lands on and adjacent to NPR-1 have been identified as sustaining one of the three core kit fox populations which must be conserved to achieve species recovery (P. Kelly, San Joaquin Valley Endangered Species Recovery Planning Program (SJVESRPP), pers. commun.).

The U. S. Department of the Interior (1983) identified loss of habitat, particularly conversion of wildlands to agriculture, as the primary cause of kit fox declines over the past 50 years. Industrialization, mining, and urbanization have also contributed to the loss of important kit fox habitats. Human activities such as control of pests species, direct shooting, trapping, increased vehicle strikes, and off-road vehicle use have also been implicated in kit fox declines (U. S. Department of the Interior, 1983).

Giant Kangaroo Rat

The giant kangaroo rat (*Dipodomys ingens*) was listed as an endangered species by both the federal government and the state of California in 1987. The giant kangaroo rat is the largest of all kangaroo rat species and is distinguished from other large kangaroo rats by having five toes on its hind feet (Williams and Kilburn, 1991). Giant kangaroo rats have large hind legs in comparison to their fore legs, have large heads and short necks, and have long, thickened tails ending in a prominent tuft (Williams and Kilburn, 1991). Like all heteromyid rodents (Family Heteromyidae), giant kangaroo rats possess large fur-lined pouches above the cheeks which open near the mouth. Pelage on dorsal and lateral surfaces is tan to light brown, while ventral surface pelage is white. A distinct white stripe extends from below the knee, across the hip, and to the base of the tail (Williams and Kilburn, 1991).

Giant kangaroo rats are nocturnal and inhabit flat to gently sloping terrain in semi-arid grassland/scrub habitat (Grinnell, 1932). Individuals excavate a system of burrows (called a precinct) in varying soil types (Williams and Kilburn, 1991), but probably prefer sandy loams (Grinnell, 1932). Precincts typically have three entrances (but may have as many as five) and all tunnels usually extend to about the same depth. Congregations of individual precincts established in close proximity are called colonies. Giant kangaroo rats feed primarily on seeds and seed heads, but may also eat non-seed plant parts when available (Williams and Kilburn, 1991). Giant kangaroo rats appear to be either promiscuous or polygynous in their mating habits (Jones, 1993). Females typically give birth to four young (but as many as six) between February and May (Williams and Kilburn, 1991).

Description of the historic and current distribution of the giant kangaroo rat is taken from Williams and Kilburn (1991). The historic distribution of the giant kangaroo rat encompassed a fairly narrow band of grassland/scrub habitat along the western edge of the San Joaquin Valley in Fresno, Kern, and Kings Counties, and most of the Carrizo Plain and upper Cuyama Valley in San Luis Obispo County. Subsequent loss of habitat, primarily to agriculture, has since restricted the distribution of the species to less than 2% of its original range. Currently, the giant kangaroo rat is distributed in isolated colonies in parts of Fresno, Kern, and San Luis Obispo Counties. On NPR-1 giant kangaroo rats occur almost exclusively in and adjacent to the low-relief terrain of the north flank and Buena Vista Valley. Because little natural habitat remains in Kern County, protection of low-relief terrain on and adjacent to NPR-1 has been identified as critical for future species recovery (P. Kelly, SJVESRPP, pers. commun.).

Loss of habitat has been identified as the primary cause of giant kangaroo rat declines, particularly since 1970 (P. Kelly, SJVESRPP, pers. commun.). Most of this habitat loss is attributed to the conversion of wildlands to intensive agriculture. Use of rodenticides for controlling agricultural-pest species may also have contributed to giant kangaroo rat declines in some rangeland areas. Other factors which may have reduced giant kangaroo rat habitat quality or availability include overgrazing of rangelands and petroleum exploration activities (P. Kelly, SJVESRPP, pers. commun.).

Tipton Kangaroo Rat

The Tipton kangaroo rat (*Dipodomys nitratoides nitratoides*) is one of three recognized subspecies of the San Joaquin kangaroo rat (*Dipodomys nitratoides*) (Best, 1991). It was listed as an endangered species by the federal government in 1988 and by the state of California in 1989. The other two subspecies, the short-nosed kangaroo rat (*D. n. brevinasus*) and the Fresno kangaroo rat (*D. n. exilis*) are also protected. The subspecies, whose ranges abut and overlap, are very difficult to distinguish from each other. Although identification may be made based on cranial measurements, it is typically made based on location and topography. Tipton kangaroo rats are one of the smallest of the kangaroo rats. They have large heads and short necks, a long, thickened tail, and large hind feet adapted for bipedal locomotion (Best, 1991). Pelage is chestnut brown to tan on dorsal and lateral surfaces and white on ventral surfaces. Patches of white also occur across the hind legs at the hip and above the eyes.

Tipton kangaroo rats are nocturnal and inhabit the arid, sparsely vegetated (and often strongly alkali) plains of the southern San Joaquin Valley (Best, 1991). Burrow systems are typically established on slightly raised areas, with individual burrows slanting down or descending vertically from openings at the base of low shrubs. Burrows systems can have few (2 or 3) to many (9 or 10) openings, some of which may be backfilled. One opening typically connects to a vertical burrow and acts as an escape exit (Best, 1991). Tipton kangaroo rats feed primarily on the seeds and seed heads of grasses, forbs, and shrubs, although some green plant parts may be eaten (Eisenberg, 1963). Tipton kangaroo rats are either promiscuous or polygynous in their mating habits (Jones, 1993). Females may give birth at almost anytime during the year, producing two or three young after a 32-day gestation period (Best, 1991).

Description of the historic and current distribution of the Tipton kangaroo rat is taken from Best (1991). Historically, populations of Tipton kangaroo rats were distributed in the flat terrain of the southern San Joaquin Valley. Populations occurred from eastern Kings and southwestern Tulare counties in the north to western Kern County in the south. Wide scale conversion of wildlands to agriculture during the 1900s, however, has severely limited the current distribution of the species. At present only about 3% of the original range is suitable for use by Tipton kangaroo rats (P. Kelly, SJVESRPP, pers. commun.). Currently Tipton kangaroo rats are distributed in isolated patches east of the California Aqueduct in eastern Kings County, southwestern Tulare County, and western Kern County. Tipton kangaroo rats occur on a small area of NPR-1 along the northeastern perimeter and east of the California Aqueduct. This area encompasses alkali sink habitat and is characterized by low-relief terrain adjacent to agricultural fields.

Since the early 1970s, the amount of native habitat put under cultivation in the San Joaquin Valley has increased dramatically, profoundly affecting populations of Tipton kangaroo rats. This conversion of native wildlands to intensive agriculture is the primary cause of Tipton kangaroo rat declines, particularly in alkaline sink habitat (P. Kelly, SJVESRPP, pers. commun.). Other human activities which have likely contributed, albeit on a much smaller scale, to the endangerment of the Tipton kangaroo rat include: widespread use of rodenticides, urban developments, extraction of petroleum products, and industrial developments (P. Kelly, SJVESRPP, pers. commun.).

Blunt-Nosed Leopard Lizard

The blunt-nosed leopard lizard (*Gambelia silus*) was listed as an endangered species by the federal government in 1967 and by the state of California in 1971. Once considered a subspecies of the leopard lizard (*Gambelia wislizenii*), the blunt-nosed leopard lizard was afforded full species status in 1970 (Montanucci, 1970). Compared to other sympatric species, the blunt-nosed leopard lizard is a relatively large and long-lived lizard (Chesemore, 1980). Physically, the blunt-nosed leopard lizard is characterized by a short and broad head, a short and blunt-tipped snout, and a rounded body. Tails are typically about twice as long as the body and is detachable (U. S. Department of the Interior, 1988). Dorsal coloration is pale brown to slate gray with distinct cream-colored cross bars and dark spots. Ventral surfaces are white. Males, which are noticeably larger than females, develop a salmon-colored wash along the flanks and belly during and after the breeding season. Females develop red to orange spots on the sides of the head and body and under the tail during and after courtship (U. S. Department of the Interior, 1988).

Blunt-nosed leopard lizards inhabit flat to gently sloping terrain in the semi-arid grassland/scrub habitat of the southern San Joaquin Valley (Germano and Williams, 1992). They appear to prefer sparsely vegetated low foothills, alkali sinks, canyon floor, and large washes (Chesemore, 1980). Rarely are blunt-nosed leopard lizards observed in areas of dense vegetation or on slopes greater than 30% (Chesemore, 1980). Adult lizards emerge from hibernation in late March and April, breed from early May to mid-June, and re-enter hibernation by mid-August (Chesemore, 1980). Females deposit one to six eggs in an excavated chamber at the end of a small mammal burrow (Montanucci, 1965). Hatchlings appear above ground by mid-August and may remain active through mid-October (Chesemore, 1980). Blunt-nosed leopard lizards are primarily insectivorous, but may also consume vegetation and other small lizards (Chesemore, 1980).

The historic distribution of the blunt-nosed leopard lizard probably included much of the San Joaquin Valley and adjacent foothills and valleys. The species occurred as far north as Merced County and as far south as Kern County (Montanucci, 1965). Blunt-nosed leopard lizards also occurred west of the San Joaquin Valley on the Kettleman Plain and the Carrizo Plain in San Luis Obispo County, and the Cuyama Valley in Santa Barbara County (Montanucci, 1965). By the late 1950s, as much as 50% of the blunt-nosed leopard lizard's historic range had been lost to developments. By 1979, only about 7% of suitable wildland remained undeveloped (Tollestrup,

1979). The current distribution of the blunt-nosed leopard lizard is restricted to isolated locations along the western margin of the San Joaquin Valley, and on the Kettleman and Carrizo Plains. Most remaining available habitat occurs in western Kern County and eastern San Luis Obispo County (U. S. Department of the Interior, 1988). On NPR-1, blunt-nosed leopard lizards occur exclusively in habitat with sparse ground cover in the low-relief terrain of the north flank and Buena Vista Valley. Protection of these lands has been identified as important for species recovery, particularly if they can be interconnected with other existing natural lands capable of supporting blunt-nosed leopard lizard populations (P. Kelly, SJVESRPP, pers. commun.).

The U. S. Department of the Interior (1988) attributes the decline in blunt-nosed leopard lizard numbers and distribution to ". . . a rapid increase in leveling and cultivating of arid lands in the San Joaquin Valley." Between 1958 and 1974, the amount of undeveloped wildland in the southern San Joaquin Valley declined from 1,518,000 ha to about 269,000 ha, primarily due to agricultural expansion (U. S. Department of the Interior, 1988). Livestock grazing, mining, agricultural pest control, and off-road vehicle use have also likely contributed to blunt-nosed leopard lizard declines (U. S. Department of the Interior, 1988). The extent to which these factors have influenced lizard populations, however, is not known.

Hoover's Wooly-Star

Hoover's wooly-star (*Eriastrum hooveri*) was listed as a threatened species by the federal government in 1990, but has not been listed by the state of California. Hoover's wooly-star is a small, erect, annual herb of the phlox family (Polemoniaceae) (Munz and Keck, 1973). Hoover's wooly-star is characterized by small size (10-20 cm high), grayish-green color, thin and rigid stems, and small white to pale blue flowers (Taylor and Davilla, 1986). Leaves are alternate (Moe, 1995) and entire or cleft with two small basal lobes and one large central lobe (Munz and Keck, 1973).

Hoover's wooly-star occurs in the semi-arid grassland/scrub habitat of the western San Joaquin Valley and is strongly colonial in distribution. Although it can be found at locations with varying amounts of vegetative cover, it is most closely associated with patches of cryptogamic crust, where annual plants tend to be less dense. However, it is rarely encountered in alkali sink habitats or on regularly grazed sites (Taylor and Davilla, 1986). The germination and reproduction of Hoover's wooly-star appears to be heavily dependant on rainfall (Twisselmann, 1967). Above average rainfall years yield large plants that produce a maximum of seeds, while poor rainfall years may suppress germination altogether. Hoover's wooly-star typically germinates in mid-March and flowers from June to August (Taylor and Davilla, 1986). Hoover's wooly-star appears to be self-pollinating and autogamous. Production of the small, dust-like seeds is limited by flower number, with each flower producing six to 12 seeds each.

The historic distribution of Hoover's wooly-star is not well known. Field records and collection site descriptions indicate that the plant was discontinuously distributed in the western portion of the southern San Joaquin Valley, low elevations of the Temblor range, the Carrizo Plain (San Luis Obispo County), and the Cuyama Valley (Santa Barbara County) (Taylor and Davilla, 1986). The discontinuous nature of this distribution makes delineating the true extent of the historic range difficult. Currently, Hoover's wooly-star is distributed on native habitat in very discontinuous, isolated colonies of varying sizes throughout part of its historic range. Most known colonies are located in western Kern County, with additional colonies still extant in Fresno, Kings, Santa Barbara, San Benito, San Luis Obispo, and Tulare Counties (Taylor and Davilla, 1986; California Native Plant Society, 1994). Hoover's wooly-star occurs at numerous locations throughout NPR-1. Distribution appears to depend more on site-specific conditions than on topography or elevation, and to correspond with soil disturbance. Recovery strategies for Hoover's wooly-star emphasize protection of existing populations until the region-wide distribution of the species is more clearly understood (P. Kelly, SJVESRPP, pers. commun.).

Taylor and Davilla (1986) listed three human-use activities as the principle threats to existing Hoover's wooly-star populations: conversion of native arable wildlands to agriculture, use of native wildlands for ground-water recharge and agricultural effluence, and oil and gas developments. Of these, conversion of wildlands to intensive agriculture has contributed most significantly to wooly-star population declines. The actual impact of the remaining threats are not well known, but may become more pronounced if effluence disposal and energy needs intensify (Taylor and Davilla, 1986).

3. CONSERVATION STRATEGIES

Conservation of threatened and endangered species on NPR-1 is the responsibility of the DOE and CPDN. Since 1979, however, conservation strategies for listed species have been developed and implemented primarily through a contractor-operated Endangered Species Program. The NPR-1 Endangered Species Program was operated by EG&G Energy Measurements, Inc. (EG&G/EM) from 1979 to 1995 and by Enterprise Advisory Services, Inc. from 1995 to the present. Although the program operator changed in 1995, support by DOE and CPDN has allowed for a smooth contractor transition and for continuity in the implementation of developed conservation strategies.

The primary purpose of the following conservation strategies is to ensure compliance with terms and conditions of Biological Opinions rendered by FWS for NPR-1 activities. Secondary purposes of these conservation strategies are, to further conserve or enhance threatened and endangered species on NPR-1, to obtain additional information on the natural history of listed species, and to evaluate the potential benefit of strategies for conserving threatened and endangered species on NPR-1 to fulfill Section 7 (a)(1) obligations for a federal site under the Endangered Species Act. Where possible, conservation strategies and techniques on NPR-1 are consistent with regional recovery efforts.

3.1 Population Monitoring

Population monitoring is an integral part of DOE's commitment to the conservation of endangered and threatened species. Monitoring programs are essential to determine the population status of protected species on NPR-1. Other objectives of the population monitoring program are to (1) assess the effect of oil field developments on listed species, (2) assess the effect of fluctuating environmental factors (weather, prey abundance, vegetation characteristics, predator abundance) on listed species, and (3) obtain information necessary to support other biological studies and listed species recovery efforts.

The first wildlife population monitoring effort on NPR-1 was a Reserve-wide transect survey (O'Farrell, 1980), with little emphasis on differences between developed and undeveloped areas. Rendering of the 1980 Biological Opinion, however, made this type of monitoring insufficient. Reasonable and prudent alternative 1 of the 1980 Biological Opinion directed DOE to ". . . further define oil development impacts, methods of increasing carrying capacity, and methods to promote the conservation of [threatened and endangered] species" (U. S. Department of the Interior, 1980). Thus, there was to be a future emphasis on determining the effects of petroleum-related developments on protected species. To accomplish this, a study area encompassing both developed habitats and adjacent undeveloped habitats was established. This area, termed the NPR-1 study area, was established in 1981, and encompasses approximately the southern two-thirds of NPR-1 and portions of NPR-2 (Figure 2). The remaining portion of NPR-1 is termed the NPR-1 supplemental area.

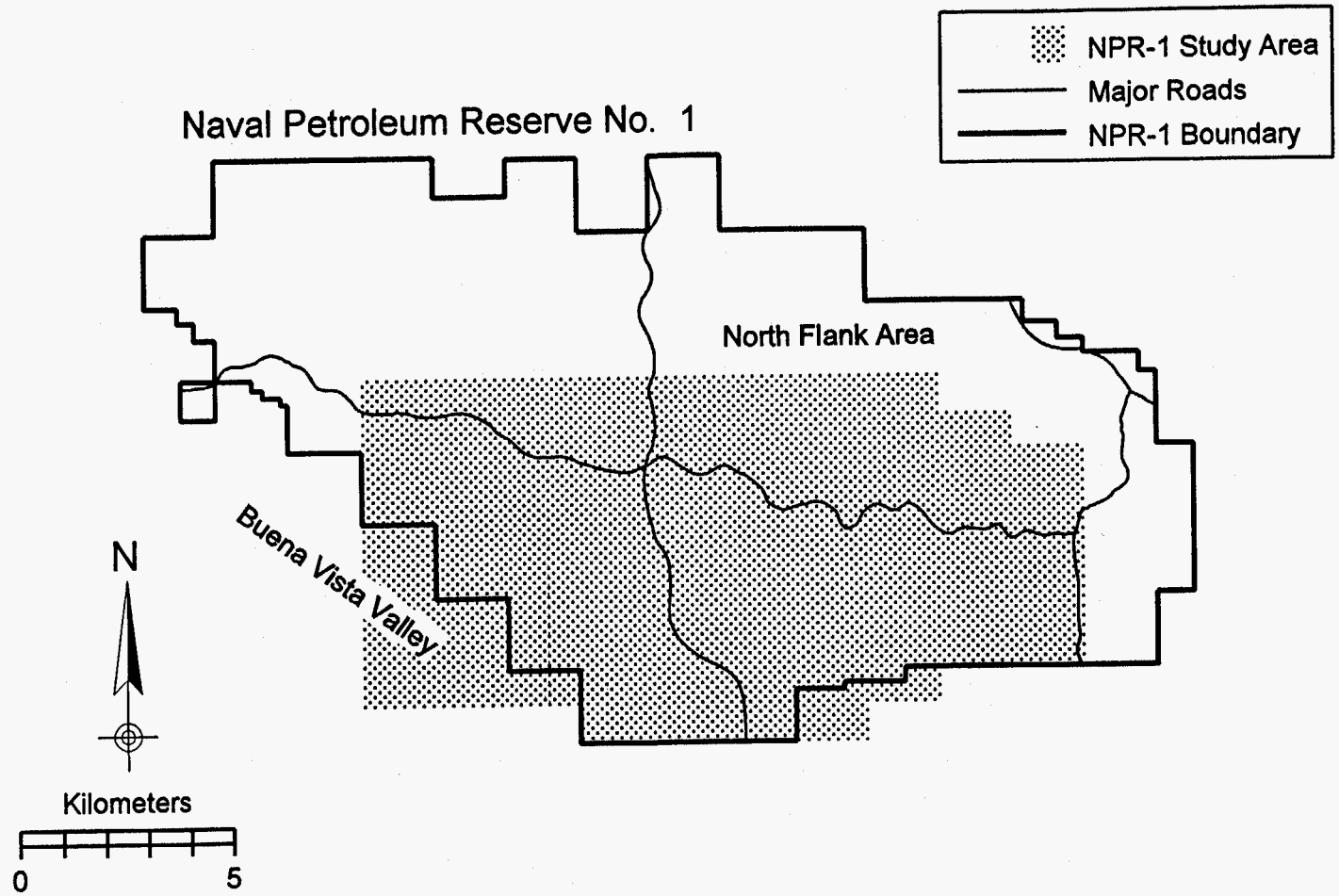

Figure 2. Location of the NPR-1 study area, the north flank area, and Buena Vista Valley on Naval Petroleum Reserve No. 1, Kern County, California.

The major tasks associated with endangered and threatened species population monitoring are briefly described below. The following information is provided in each task description: specific task objectives, monitoring methodology, history of activities, and projected future activities. Several of the tasks listed do not involve direct monitoring of a protected species, but were initiated to provide information on factors potentially influencing threatened and endangered species.

3.1.1 San Joaquin Kit Fox Population Monitoring

Population Trends

The objective of San Joaquin kit fox monitoring is to collect annual information on the size and distribution of the kit fox population on NPR-1. This information is useful in determining the factors that most strongly influence fox populations, and may be useful in developing or evaluating future species recovery strategies. Kit foxes are trapped over a five week period once each year during the breeding season (November and December). Live-traps are placed in each quarter-section of NPR-1 and operated for four consecutive nights. Traps are covered with a canvas tarp, baited with mackerel, and left open overnight. Traps are checked each morning no later than four hours after sunrise. Captured kit foxes are individually marked with numbered eartags, sexed, weighed, measured, and released at the capture location. Data collected during each capture is entered into a computerized relational database. Population estimates are made by calculating the number of foxes known to be alive during the trapping session and, given an adequate number of captures, via a capture-recapture model.

The San Joaquin kit fox population on NPR-1 was first monitored in July and August 1981. Between 1981 and 1991, trapping sessions were conducted twice each year, once in summer and once in winter. Beginning in 1992, trapping effort was reduced to once a year, in winter. Between 1981 and 1987, kit fox trapping on NPR-1 was limited to the NPR-1 study area. Beginning in 1988, all of NPR-1, including the supplemental area, was trapped. Beginning in 1996, and continuing through the foreseeable future, kit fox population monitoring will again be restricted to the NPR-1 study area.

Reproduction and Mortality Monitoring

The objectives of monitoring San Joaquin kit fox reproduction and mortality were to: (1) determine the proportion of adult females that wean pups, (2) determine the average litter size, (3) determine the proportion of juveniles that enter the breeding population, and (4) determine the source and rates of mortality of juvenile and adult kit foxes. Adult vixens captured during November and December were fitted with radiocollars and subsequently monitored. Dens occupied by at least one radiocollared vixen were observed on multiple occasions in spring to determine breeding success and average litter size. Live-trapping was conducted at successful natal dens during spring. Captured juvenile foxes were individually marked, sexed, weighed, measured, fitted with radiocollars, and subsequently monitored to assess the proportion of

juveniles entering the breeding population. Foxes were considered to have entered the breeding population if they survived into the following December. Sources and rates of kit fox mortality were assessed by monitoring the fate of radiocollared adult and juvenile foxes. Dead kit foxes were immediately recovered and necropsied to determine the cause of death.

Monitoring of kit fox reproduction and mortality on NPR-1 began in 1980 and was initially limited to lands on the NPR-1 study area. Kit foxes occurring on or moving to other parts of NPR-1 were monitored in subsequent years. Information on reproduction and mortality of kit foxes was not collected between mid-1991 and late 1993, resuming in November 1993. Monitoring of reproduction and mortality was discontinued after 1996.

Viral Disease Monitoring

The objective of monitoring viral disease in San Joaquin kit foxes was to collect information on the prevalence of three (3) viral diseases in the NPR-1 kit fox population, and assess its potential impact on fox survival and reproduction. Samples of venous blood were extracted from selected kit foxes during annual live-trapping using 10-ml syringes, transferred to sterile vacutainers and refrigerated. Samples were subsequently centrifuged, and the serum withdrawn and transmitted to a diagnostic laboratory for analysis. Serum samples were analyzed for parvovirus and canine distemper using an indirect fluorescent antibody test and for infectious hepatitis using a serum neutralization test. The presence of antibodies to any of the diseases indicated that the sampled kit fox had been previously exposed to the virus. Antibody test results were reported as titer level, and as prevalence (percent of samples testing positive) in EG&G/EM annual reports.

Monitoring of viral diseases in kit foxes on NPR-1 was initially conducted in 1981, 1982, and 1984. Between 1985 and 1988 only kit foxes used during the relocation study were tested for antibodies against selected diseases, and were not considered part of the viral disease monitoring program. Viral disease monitoring resumed in 1989 and continued through 1992.

Monitoring of Trends in Carnivore Abundance

Coyotes are the primary source of mortality among kit foxes on NPR-1. As a result, information on coyote population trends can be very useful for understanding kit fox population dynamics and habitat selection. The objective of carnivore population monitoring was to collect information on trends in the abundance of carnivores, particularly coyotes. Carnivores were monitored annually by conducting scent station surveys in late winter. Surveys were conducted along a series of 5-km long lines located throughout NPR-1. Each line consisted of 10 individual stations spaced at approximately 0.5-km intervals on alternating sides of secondary roads. Each station consisted of a 1-m diameter circle cleared of vegetation and debris. A thin layer of dust was sifted onto each station and a scent attractant was placed in the center. Scent station lines were prepared during an evening and checked for evidence of visitation by a carnivore the following morning. A visitation index was calculated based on the number of stations visited.

Monitoring of carnivores on NPR-1 began in June 1984. Initially, scent station lines were established only on the NPR-1 study area. Beginning in 1988, surveys were expanded to include lines on the NPR-1 supplemental area. Between 1984 and 1991, scent station surveys were conducted three times a year (March, June, and September). Beginning in 1992, the frequency of scent station surveys was reduced to once a year. Biological evidence suggested that the most appropriate time for annual monitoring of coyotes was early spring (March), just prior to annual pup recruitment. As a result, June and September scent station surveys were discontinued in favor of annual March surveys. Scent station surveys for monitoring carnivore populations were discontinued after 1996.

Lagomorph Population Monitoring

Black-tailed jackrabbits and desert cottontail rabbits (lagomorphs) are major prey species for the San Joaquin kit fox. Regular determination of lagomorph population size was important for assessing how fluctuations in prey availability affected kit fox population parameters. The objective of lagomorph population monitoring was to annually estimate the density of black-tailed jackrabbits and desert cottontail rabbits on NPR-1. Lagomorphs were monitored annually in early summer using a series of 1.6-km line transect surveys. Biologists walked transects between 9:00 a.m. and 4:00 p.m. and recorded the species, behavior, and perpendicular distance from the transect line to each lagomorph observed. Perpendicular distances were used to estimate lagomorph density (lagomorphs/square mile) on NPR-1 using a standard computer model.

Lagomorph monitoring on NPR-1 began in fall 1983 and was conducted three times each year (March, June, and September). Initially, line transects were established within 24 randomly selected developed and undeveloped sections. In fall 1985, transects were established in an additional 18 sections to more precisely estimate lagomorph abundance when densities were low (Harris, 1986). Between 1983 and 1991, lagomorph monitoring was conducted three times each year. Beginning in summer, 1991 lagomorph monitoring effort was reduced to once a year (June). June was selected as the most appropriate month for monitoring because prey availability is critical during this period for kit fox pup survival. Lagomorph population monitoring was discontinued after 1996.

Small Mammal Population Monitoring

Small mammals are important prey species for the San Joaquin kit fox, and some species that were former C2 candidates may be considered for federal protection in the future along with other species as new information becomes available or as listing petitions warrant. The objectives of small mammal population monitoring were to (1) assess prey availability for kit foxes, (2) evaluate the effects of slope, aspect, and vegetation characteristics on small mammals, and (3) assess population trends and habitat preferences of sensitive species. Small mammals were monitored annually using 20 permanently established trap transects. Five transects were located in each of four physiographic types: flat terrain on north-facing aspects, flat terrain on south-facing aspects, hilly terrain on north-facing aspects, and hilly terrain on south-facing aspects.

Each trap transect consisted of 25 trap stations with two live-traps per station. Traps were supplied with seed food and nesting material, baited with an oat and peanut butter mixture, and operated for five consecutive nights. Captured small mammals were identified to species, ventrally marked with a non-toxic pen, sexed, weighed, and released at the capture location. Vegetation was characterized annually in each physiographic type by measuring percent plant cover, and herbaceous production along transects placed parallel and adjacent to each trap transect.

Small mammal population monitoring was first conducted on NPR-1 in 1980. Between September 1980 and December 1983, small mammals were trapped monthly on four trap transects. In February 1984, trapping frequency was reduced to four times a year (February, May, August, and November). Small mammal monitoring was discontinued after the November 1984 trapping session. Small mammal live-trapping was re-initiated as an annual effort in September 1993 (vegetation characterization began in spring 1993). Small mammal population monitoring was discontinued after 1996.

Analysis of Kit Fox Diet

One of the major objectives of lagomorph and small mammal population monitoring was to assess the availability of these species to San Joaquin kit foxes as prey. To evaluate actual use of these species, however, required an analysis of kit fox diet. The objective of kit fox diet analysis was to monitor annual changes in the frequency of occurrence of prey items in fox diets. Kit fox diet was determined by analyzing fecal samples collected at fox live-trapping sites. Fecal samples were dried and sent to a diagnostic laboratory for analysis. Analysis consisted of identifying non-soluble material, such as hair and bone fragments, from a portion of each sample collected. All non-soluble material was identified to the lowest taxonomic group possible. Diet was then expressed in terms of frequency of occurrence of each prey species.

Collection of fecal samples for kit fox diet analysis began in 1980. Because collection was associated with live-trapping, prior to 1988 most of the samples were obtained from the NPR-1 study area. Samples were collected from all areas of NPR-1 beginning in 1988, when the NPR-1 supplemental area was included in annual kit fox population monitoring. In 1980 and 1981, live-traps were baited with pieces of black-tailed jackrabbit and desert cottontail rabbit. It was assumed at this time that fecal samples subsequently collected from captured foxes would not be influenced by the lagomorph bait (Scrivner et al., 1987). When the validity of this assumption was questioned, in 1982, use of lagomorphs as bait was discontinued and was replaced by canned mackerel. Comparisons of frequency of occurrence of prey items among years were typically made only on data collected during 1982 and later. Analysis of kit fox diet on NPR-1 was discontinued after 1996.

3.1.2 Giant Kangaroo Rat Population Monitoring

The objectives of giant kangaroo rat monitoring are to (1) monitor annual trends in population size, (2) collect demographic information that may contribute to regional recovery of the species, and (3) assess the dynamics of a sample of giant kangaroo rat colonies. Monitoring of trends in population size and collection of demographics data are achieved through annual live-trapping on a grid established on a site occupied by giant kangaroo rats. Twelve rows of 12 traps each are pre-baited for three nights and operated for six consecutive nights. Traps are provided with nesting material, seed food, and baited with an oat and peanut butter mixture. Captured small mammals are identified to species, ventrally marked with a non-toxic pen, sexed, weighed, and released at the capture location. In addition, uniquely numbered eartags are applied to all kangaroo rats (including giant kangaroo rats). Monitoring of trends in population size and colony dynamics assessment are achieved using line transect surveys. Observers walk parallel transects through known colony locations counting and marking all active precincts as they are encountered. Colony dynamics are assessed by comparing the number and location of active precincts between years.

Giant kangaroo rat population monitoring, as it is currently conducted, was initiated in 1993 and is conducted annually. Prior to 1993, giant kangaroo rats were monitored, though less comprehensively and more indirectly, during a number of other activities (habitat manipulation to increase giant kangaroo rat carrying capacity, effects of seeding burned lands on the abundance of rodents and lagomorphs, small mammal monitoring). Giant kangaroo rat population monitoring will continue annually until 1999, and then be conducted every five (5) years thereafter.

3.1.3 Blunt-nosed Leopard Lizard Population Monitoring

The objectives of blunt-nosed leopard lizard monitoring are to (1) assess the annual abundance of blunt-nosed leopard lizards, (2) determine whether blunt-nosed leopard lizard population trends differ between a developed and an undeveloped area, (3) assess the effects of habitat features on blunt-nosed leopard lizard habitat use patterns, (4) collect demographic information that may contribute to region-wide conservation efforts, and (5) determine whether annual variation in vegetation characteristics influence blunt-nosed leopard lizard abundance. Blunt-nosed leopard lizards are monitored annually using repeated line transect surveys on two 16-ha study plots. Surveys are conducted during spring to assess the abundance of adult lizards and during late summer to assess the abundance of juvenile lizards. Locations of blunt-nosed leopard lizards observed during transect surveys are plotted to determine the effect of topography and disturbance on lizard abundance. Attempts are made to capture observed lizards with a hand-held pole fitted with a monofilament noose. Captured blunt-nosed leopard lizards are individually marked, sexed, weighed, measured, and released at the capture location. Recapture of marked lizards provides information on annual abundance.

Several blunt-nosed leopard lizard monitoring activities were conducted on NPR-1 before the current monitoring effort began in 1994. Beginning in 1980 and continuing to the present, incidental observations of blunt-nosed leopard lizards were recorded by field biologists engaged in other activities. Observations are recorded on data sheets and plotted on topographical maps to determine areas where blunt-nosed leopard lizards are most commonly encountered. In 1982 and 1984 studies to determine the diet and movement, abundance, and habitat use of blunt-nosed leopard lizards were conducted on two study plots in Buena Vista Valley. Blunt-nosed leopard lizard population monitoring will continue annually until 1999, and then be conducted every five years thereafter.

3.1.4 Hoover's Wooly-Star Population Monitoring

The objectives of Hoover's wooly-star monitoring is to annually assess the status of Hoover's wooly-star populations on NPR-1 and to evaluate the usefulness of conservation strategies. Hoover's wooly-star population status is assessed annually based on the density of plants at six reference sites located throughout NPR-1. Two reference sites are located in flat terrain on a north-facing aspect, two reference sites are located in flat terrain on a south-facing aspect, and two reference sites are located in hilly terrain (one on a north-facing aspect and one on a south-facing aspect). Population status is assessed on each reference site by measuring vascular plant cover and the density of Hoover's wooly-star along three permanent line transects.

Three Hoover's wooly-star population monitoring efforts were conducted on NPR-1 before reference site monitoring began in 1994. Floristic field surveys specifically for Hoover's wooly-star were conducted on areas likely to contain wooly-star populations in 1988 and 1991. Biologists conducting a floristic field survey for special status plant species in 1993 recorded Hoover's wooly-star population locations and plotted them on topographic maps. Beginning in 1991 and continuing to the present, incidental observations of Hoover's wooly-star populations are recorded by field biologists engaged in other activities. Monitoring of Hoover's wooly-star on reference sites, which began in 1994, will continue annually until 1999, and then be conducted every five years thereafter.

3.1.5 San Joaquin Antelope Squirrel Population Monitoring

The objectives of San Joaquin antelope squirrel monitoring on NPR-1 was to document population trends and to collect demographic information useful in determining the range-wide status of the species. This information was useful in determining whether protection under the Federal Endangered Species Act was warranted for this species. There were no specific tasks for the direct monitoring of San Joaquin antelope squirrel population trends on NPR-1. Information on antelope squirrel abundance, distribution, habitat relationships, longevity, reproduction, body-mass dynamics, and response to disturbance was collected during various other field activities, including small mammal trapping and biological surveys. San Joaquin antelope squirrel populations will continue to be monitored through the incidental capture of individuals during other monitoring activities. No new activities specific for antelope squirrel monitoring will be initiated.

3.1.6 Monitor Climatic Trends

Climatic conditions can have a profound influence on both the vegetative and animal communities in arid environments (McLaughlin and Bowers, 1982). Understanding these influences are particularly important for the conservation of species at risk. On NPR-1, climatic trends are monitored to better understand the effect of precipitation and temperature on populations of threatened and endangered species. Local climatological data is obtained from the nearby National Oceanic and Atmospheric Administration (NOAA) weather station at the Kern County air terminal in Bakersfield, California. Data obtained includes annual and daily summaries of precipitation, temperature, temperature extremes, relative humidity, and wind speed and direction.

Between March 1981 and August 1993, climatological data was collected at eight weather stations placed at various locations throughout NPR-1. The information collected included average daily temperature, daily temperature extremes, and relative humidity. Soil temperature data was also collected at three locations. Beginning in October 1993, monthly and annual climatological data summaries compiled by NOAA at Bakersfield were used to monitor climatic conditions on NPR-1. Climatic trends will continue to be monitored via NOAA summaries for the foreseeable future.

3.1.7 Special Status Plant Monitoring

The objective of special status plant monitoring is to collect information on the presence, distribution, and habitat requirements of protected and sensitive plant species on NPR-1. The presence of special status plant species is determined using a series of parallel line transect surveys through specific sections of NPR-1. Biologists conduct transect surveys when plants are most easily identified (spring flowering season), identify all special status plant species observed, and plot observation location on topographic maps. Samples of plant species that cannot be identified in the field are collected and keyed in the laboratory. A portion of NPR-1 is surveyed each year in which precipitation is at least normal (average).

The first effort to document the occurrence of special status plant species on NPR-1 was conducted in 1988. During this effort, parallel line transect surveys were conducted in selected sections of NPR-1 where four target plant species were most likely to occur. In 1993, a series of meandering surveys were conducted in an attempt to further document the presence of special status plant species. Surveys occurred primarily in the flat terrain areas along the northern and southern Reserve perimeters. Special status plant monitoring surveys will continue to be conducted during years of adequate precipitation until NPR-1 has been surveyed entirely.

3.2 Mitigation Strategies

3.2.1 Preactivity Surveys

The DOE has committed to conducting pre-project surveys as part of a six-point mitigation plan (O'Farrell et al., 1986; Kato and O'Farrell, 1986) and through subsequent formal consultations with FWS (U. S. Department of the Interior, 1987; U. S. Department of the Interior, 1995). EG&G/EM began conducting pre-project surveys on NPR-1 in December 1980. Between 1980 and 1986 these surveys were called preconstruction surveys and were renamed preactivity surveys in 1987. The process by which preactivity surveys are requested and conducted was formalized in 1987 (Kato and O'Farrell, 1987) and revised and supplemented in 1991 (EG&G Energy Measurements, Inc. 1991).

The objective of the preactivity survey program on NPR-1 was summarized by Kato and O'Farrell (1987) and is quoted in the following two sentences. "The primary purpose of preactivity surveys is to provide DOE with a management technique which minimizes or eliminates direct impacts of construction, maintenance, and operational activities on endangered species and their habitats. Results of the surveys can be used to avoid situations likely to result in incidental take of endangered species, and they can document if and when take has occurred." The basic strategy for achieving the preactivity survey objective involves systematically surveying locations prior to habitat disturbing activities, identifying and marking protected species and their habitat components within and around the activity area, and making recommendations by which disturbance or damage to resources can be avoided or minimized. A more detailed description of the preactivity survey process is given below.

Preactivity surveys are conducted by one or more qualified personnel. During the surveys, personnel examine the anticipated impact area and an adjacent buffer zone for evidence of threatened or endangered species. All observed known San Joaquin kit fox dens, potential kit fox dens, giant kangaroo rat burrows, blunt-nosed leopard lizard sighting locations, washes representing potential blunt-nosed leopard lizard habitat, and Hoover's wooly-star populations are identified and marked. An avoidance zone is established around each marked location. Qualified personnel formulate specific recommendations at each activity site to minimize the likelihood that ground-disturbing activities are conducted on or near protected species and their habitats. Follow-up surveys are conducted at each site where recommendations were made soon after activity at the site is completed. Follow-up surveys are used to document whether recommendations made by personnel were followed and whether identified sensitive areas were avoided.

3.2.2 Habitat Reclamation

Reasonable and prudent alternative 3 of the 1980 Biological Opinion (U. S. Department of the Interior, 1980) directed DOE to prepare a master plan for the restoration of disturbed habitats. Completion of the master plan in 1985 lead to large scale habitat reclamation beginning that year. The primary objective of the habitat reclamation program on NPR-1 is to ". . . establish a diverse, stable plant community on disturbed sites with the long-term goal of supporting a greater abundance and diversity of wildlife species" (Anderson, 1995).

Early attempts to restore damaged habitats on NPR-1 were mostly unsuccessful (Anderson, 1995). Improvements in techniques in the late 1970s and early 1980s, however, made successful habitat reclamation possible in terrains and climates similar to NPR-1. As a result, and in accordance with reasonable and prudent alternative 3, DOE developed a habitat reclamation program. The first phase of the habitat reclamation program on NPR-1 occurred between 1981 and 1983. During this period, several field trials were conducted to test reclamation techniques on disturbances in both flat and steep terrain. The primary goal of these trials was to identify the most effective reclamation techniques for NPR-1. In 1985, the habitat reclamation master plan was developed (O'Farrell and Mitchell, 1985). This document reviewed the climatologic factors that affect habitat reclamation, synthesized the current knowledge of arid-land restoration techniques, and proposed a plan for reducing and compensating for the negative impacts of NPR-1 activities on endangered species habitats (O'Farrell and Mitchell, 1985).

Beginning in 1985, and continuing through 1993, habitat reclamation was conducted on a large scale on NPR-1 (Anderson, 1995). Reclamation procedures on NPR-1 included three steps: site preparation, seeding, and mulching. Site preparation included ripping of compacted soil, discing or harrowing to break up large soil aggregates, redistribution of topsoil from stockpiled sites, and the addition of soil nutrients when needed (Anderson, 1995). Beginning in 1987, reclaimed sites were evaluated to assess the effectiveness of the reclamation techniques and materials used. Information obtained during site evaluation was used to modify techniques to increase reclamation success. By fall 1994, all available disturbed sites had been reclaimed and all further habitat reclamation efforts were deferred pending an evaluation of reclamation strategies and the availability of additional disturbed sites. If abandoned sites become available, up to 147 ha may be reclaimed by FY98 (U. S. Department of the Interior, 1995).

In order to gauge the effectiveness of the habitat reclamation effort on NPR-1 and to evaluate the overall condition of reclaimed areas, a comprehensive site monitoring program was initiated. Beginning in 1987, all reclaimed sites were qualitatively monitored the first and second growing season after reclamation. During qualitative monitoring initial plant establishment is evaluated, sites requiring remedial reclamation are identified, and reclamation techniques are refined. Beginning in 1991, reclaimed sites were quantitatively monitored as well as qualitatively monitored. During quantitative monitoring, percent vegetative cover and the density of shrubs is determined on all sites five growing seasons after reclamation. Beginning in 1994, this aggressive monitoring effort was reduced to a qualitative evaluation of approximately 30% of the sites reclaimed to date.

3.3 Special Studies

Within each of the Biological Opinions rendered since 1980, FWS has encouraged DOE to initiate or continue funding scientific studies evaluating methods for increasing the density of listed species, defining oil developments effects, and evaluating methods that promote conservation of resident protected species. In response, DOE funded a number of special studies to investigate the effectiveness of a variety of population and habitat management techniques. The design, analysis, and conclusions of these special studies are summarized below as project descriptions. Source publications are identified where appropriate.

3.3.1 Studies Investigating the Effect of Oil Field Operation

Oil Well Blowout Effects

The following project description is summarized from Warrick et al. (1997). In June 1994, well 313H-26R blew out and deposited crude oil over a large area downwind of the well site. Soon after the well was capped, a study was initiated to investigate impacts to the plants and animals within the area that received the heaviest oil deposition. The main objectives were to assess the effects of crude oil on plants and wildlife within the affected area and to evaluate techniques for restoring areas sprayed with oil during the blowout. The most heavily oiled area was divided into three sites. Restoration techniques of surface modification and bioremediation were implemented on two of the sites, and the third area was left to recover naturally. Two trapping grids were established within each of the three oiled sites and within an adjacent control area. The following data were collected from each of the grid locations: population estimates of Heermann's kangaroo rats (*Dipodomys heermanni*), rodent species diversity, abundance of darkling beetles (*Eleodes* spp.) and ants, herbaceous cover and production, and shrub survival and vigor. Results indicated that some species of wildlife and plants may have been negatively affected by the oil released during the blowout, but populations recovered within one year. In general, restoration treatments did not accelerate recovery of the oiled areas. Because natural recovery was found to be successful, involves no costs, and causes no further soil disturbances, it was recommended for situations similar to those in this study.

Toxicological Effects of Oil Fields on San Joaquin Kit Foxes

The following project description is summarized from Suter et al. (1992). The San Joaquin kit fox population on NPR-1 declined sharply during the early 1980s; but because it had not been monitored before 1980, it was not known whether the decline was the result of natural processes or from human-related factors. Oil production on NPR-1 increased during the late 1970s and early 1980s, and it was hypothesized that toxic chemicals associated with production may have contributed to the kit fox decline. In 1988 a study was initiated to examine the possible impact toxic chemicals may have had on the NPR-1 kit fox population in the early 1980s. The objective of this study was to determine whether chemical analyses of fur, soil, and water could be used to make inferences about a possible cause for observed kit fox declines. Fur samples were collected from captured kit foxes on two adjacent oil fields: NPR-1 and NPR-2, and on two non-oil areas: Camp Roberts National Guard Training Center (San Luis Obispo and Monterey Counties) and the Elkhorn Plain (San Luis Obispo County) between 1981 and 1990. Soil samples were collected at seven locations for each of the four major soil types occurring on NPR-1 (28 samples total). Water samples were collected from three production water sumps and four production water tanks on NPR-1. Fur, soil, and water samples were analyzed for elemental content using neutron activation analysis. Results indicated that concentrations of oil field elements (arsenic, barium, and vanadium) were elevated in fox fur collected on oil fields, but that only arsenic was elevated enough to potential cause toxicity in some foxes. However, high arsenic concentrations occurred in less than 1% of oil field foxes, which was too few to account for the fox population decline observed on NPR-1 in the early 1980s.

3.3.2 Studies Investigating the Effect of Habitat Manipulations

Effects of Habitat Manipulation on Giant Kangaroo Rat Colonization

The following project description is summarized from Standley et al. (In Press). The endangered giant kangaroo rat most commonly occurs on sites with sparse vegetative ground cover and few shrubs (P. Kelly, SJVESRPP, pers. commun.). Lands adjacent to active giant kangaroo rat precincts that are unoccupied due to dense ground cover can potentially become available for colonization through habitat manipulation. Consequently, a study was conducted between 1988 and 1992 to investigate the habitat preferences of giant kangaroo rats by monitoring movement from an active colony to adjacent unoccupied lands where ground cover and shrub density had been modified through habitat manipulation. A secondary objective of this study was to investigate the effects of habitat manipulation on other nocturnal rodents. Four experimental plots not occupied by giant kangaroo rats were established adjacent to a known colony in March 1988, and manipulated the following June. Manipulation of experimental plots included removal of ground cover only (one plot), removal of shrubs only (one plot), removal of both ground cover and shrubs (one plot), and no manipulation (one plot). Percent ground cover and percent shrub cover were measured on all experimental plots and the adjacent colony each spring. Nocturnal rodent occurrence and abundance were sampled via live-trapping on all experimental plots and the adjacent colony during 13 three-day trapping sessions. Vegetation monitoring results indicated that manipulations were mostly effective in modifying habitats, though rainfall patterns may have minimized differences in ground cover on experimental plots. Live-trapping results indicated that no giant kangaroo rats moved from the existing colony onto any of the experimental plots and that the existing colony became extinct about halfway through the study, apparently due to extended drought conditions. The overall post-manipulation capture rate of nocturnal rodents was highest on the ground cover removal plot, followed by the no manipulation plot, and the shrub removal plot. No conclusions concerning giant kangaroo rat colonization of modified habitats could be reached as a result of this study. It did appear, however, that other nocturnal rodents preferred habitats with little ground cover.

Effect of Seeding Burned Lands on Rodent and Leporid Abundance

The following project description is summarized from Otten and Holmstead (1996). Rodents and leporids are important prey items for the endangered San Joaquin kit fox. Consequently, increasing the abundance of rodents and leporids on an area could be beneficial for kit foxes. Many of the rodent species and the two leporid species present on NPR-1 utilize shrubs for cover, cover that is often destroyed during wildfires. As a result, it was hypothesized that reestablishing shrubs and increasing plant diversity on large burned lands could have a beneficial effect on rodents and leporids. Between 1990 and 1993 a study was conducted on NPR-1 investigating the effects of seeding a large burned area on the abundance of rodents and leporids. In November 1990, approximately half of a 260-ha site that burned in 1988 was mechanically drill seeded with a mixture of three shrub species, three grass species, and three forb species. The other half of the burned site was not seeded. A 160-ha unburned control site was established

adjacent to the unseeded burn site in June 1991. Vegetation characteristics were monitored annually on each site by measuring vascular plant cover, live shrub density, herbaceous production, plant species richness, and plant community similarity along six line transects. Rodent abundance was monitored three times a year on each site through live-trapping along six transects. Leporid abundance was monitored on each site using four line transects and 90 pellet group plots. Data analysis revealed that live shrub density was consistently highest on the seeded burn site, but other vegetation characteristics were similar among sites or showed no consistent trend. Species richness and plant community similarity were similar on all sites by 1993. The abundance of rodents and leporids was not consistently higher on any of the sites in any year. Results indicated that seeding did not affect either rodent or leporid abundance on burned lands, and that vegetation characteristics may have been too similar to produce detectable differences in abundance.

Effect of Simulated Oil Field Disturbances on Hoover's Wooly-Star

The following project description is summarized from Hinshaw et al. (In Press). The range of the threatened Hoover's wooly-star encompasses areas under active oil and gas development. One strategy for conserving the species on NPR-1 sites where topsoil is to be removed or highly disturbed has been to stockpile seed-laden topsoil for subsequent redistribution at the same location or other suitable site. However, the effectiveness of this strategy was not known. Between 1993 and 1995 a study was conducted to evaluate the efficacy of topsoil conservation and redistribution, under simulated oil field disturbance, both prior to and following seed maturation and dispersal. In April 1993, two vicinal experimental sites were established, one (site 1) in an area of high Hoover's wooly-star density and one (site 2) in an area believed to be void of Hoover's wooly-star. Thirty plots were established at each site, with each plot receiving one of five treatments: discing in April (pre-seed maturation) with no topsoil replacement, discing in April with topsoil replacement, discing in July (post-seed maturation) with no topsoil replacement, discing in July with topsoil replacement, and no treatment (control). The density of Hoover's wooly-star plants was estimated for each treatment type annually by recording the number of individual plants observed in 10 1-m^2 quadrats placed systematically along a line transect in each plot. On site 1 (Hoover's wooly-star present before disturbance), the density of Hoover's wooly-star on disturbed plots were lower than on adjacent control plots. On site 2 (Hoover's wooly-star absent before disturbance), Hoover's wooly-star plants were observed on control plots and on topsoil replacement plots. Results indicated that Hoover's wooly-star quickly recolonizes relatively small previously occupied sites after disturbance and that it will colonize previously unoccupied sites upon receiving seed-laden topsoil. As a result, conservation and redistribution of topsoil may be an effective strategy for re-establishing the species after disturbance.

3.3.3 Studies to Determine Limiting Factors

Effect of Supplemental Feeding on San Joaquin Kit Fox Survival and Reproduction

The following project description is summarized from EG&G/EM (1993). Between 1981 and 1985, the San Joaquin kit fox population on NPR-1 declined sharply. A simultaneous decline in the abundance of lagomorphs suggested that prey availability may have somehow limited kit fox abundance. Increases in coyote (principle kit fox predator) abundance during the same period, however, complicated the kit fox-lagomorph interaction. Between 1988 and 1990 a study was conducted to investigate whether food availability could be a limiting factor for kit foxes. The specific objective of this study was to compare survival probabilities, sources of mortality, reproductive success, and dispersal rates between foxes receiving supplemental food and foxes not receiving supplemental food (controls). A total of 17 kit fox family groups were located on and adjacent to NPR-1 in 1988 and 1989. Eight family groups were identified as treatment groups and provided with supplemental food (commercial cat food) and nine family groups were identified as controls and not supplementally fed. Control groups were located at least 1.5 km from the nearest treatment group to minimize the likelihood that control foxes had access to supplemental food. Fed groups were provided with supplemental food three times per week for one year. The effect of supplemental feeding on kit foxes was determined by comparing survival probabilities, sources of mortality, dispersal rates and distances, and reproductive success between treatment (fed) foxes and control (non-fed) foxes. In general, results indicated that supplemental feeding had a positive influence on kit fox survival, reproduction, and dispersal. This research indicated that artificial feeding could positively affect kit fox populations in some years, but that it should be used with caution as artificial increases in fox numbers could impact the abundance of listed small mammal species that foxes utilize as prey.

San Joaquin Kit Fox Relocation Study

The following project description is summarized from Scrivner et al. (1993). Declines in the abundance of San Joaquin kit foxes during the 1980s led DOE to consider methods by which the fox population could be increased. While some areas on and adjacent to NPR-1 supported kit foxes in high densities, other areas of presumably suitable habitat were under-utilized. Consequently, a relocation effort was proposed by which kit foxes already residing on NPR-1 could be supplemented, and under-utilized habitat could be occupied. The NPR-1 kit fox relocation project was conducted between 1988 and 1990. The overall objective of this project was to develop techniques for the reintroduction of kit foxes, to assess the value and success of relocation, and to determine the best strategy for imprinting animals to release sites. Kit foxes were relocated to NPR-1, held in captivity, released, and subsequently monitored to assess survival and reproduction. Twelve foxes were released in 1989 after spending an average of 131 days in captivity. Twenty-eight foxes were released in 1990 after spending an average of 307 days in captivity. Distance traveled from the site of release to the site of death averaged 9.8 km for foxes released in 1989 and 4.3 km for foxes released in 1990. Annual survival of relocated foxes was 3%, and the number of days foxes survived after release averaged 32. All pups reared in

captivity and released died within 17 days. Results indicated that relocated kit foxes generally stayed in the vicinity of NPR-1, but that survival was low after release. Future relocation efforts should be considered only if environmental conditions and predator/prey abundance are favorable.

Factors Affecting the Distribution and Abundance of Kit Foxes

Information collected during annual live-trapping of San Joaquin kit foxes (see 3.1.1) is useful not only for monitoring fox abundance but also for determining where foxes most commonly occur. Although the reasons are not known, kit foxes appear to prefer areas of low topographic relief. Consequently, a project was initiated in 1995 to examine which factors most strongly influence the distribution of kit foxes on NPR-1. Multivariate analysis was used to determine whether and to what degree selected factors have influenced kit fox distribution. Initially, many factors were identified as potentially affecting kit fox distribution. The factors identified as most likely to influence kit fox distribution were oil field development, fire, sheep grazing, coyote abundance, lagomorph abundance, and urban development. Data required to perform analyses had been previously collected during other activities on NPR-1 or were obtained from existing sources. Preliminary results indicated a strong inverse relationship between terrain ruggedness and kit fox captures. Further analysis indicated that kit fox preference for low-relief terrain may be most strongly related to predator distributions. Coyotes, the main predator of kit foxes, occur most commonly in areas of mid to high relief terrain. As a result, kit foxes may prefer low-relief terrain as a means of predator avoidance.

San Joaquin Kit Fox Life Table Analysis

A life table analysis conducted by Argonne National Laboratory for the Supplemental Environmental Impact Statement (U. S. Department of Energy, 1993) indicated that the San Joaquin kit fox population on NPR-1 declined by about 30% annually between 1981 and 1988. Argonne concluded that although reproduction by vixens was fairly high during this period, survival of pups was low, resulting in the observed population decline. Examination of kit fox capture trends, however, indicated that the period of greatest decline occurred between 1981 and 1984, followed by a period of relative population stability between 1985 and 1988. To better understand why trends in kit fox abundance may have differed between the 1981-1984 period and the 1985-1988 period, DOE tasked EG&G/EM with conducting additional life table analyses. The objective of these analyses, which were completed in 1995, was to estimate kit fox population parameters separately for the two time periods (1981-1984 and 1985-1988) and to compare the results. Life table parameters were estimated using juvenile and adult vixens radiocollared between 1981 and 1988. Only foxes whose year of birth and date of death were known were used in the analyses. Estimates of fecundity (reproductive success) were calculated from data collected during pup trapping and observations at natal dens. Conventional life table analysis methods were used to estimate kit fox survival, mortality, fecundity, generation time, and intrinsic rate of population change for both time periods. Results indicated that rates of survival and mortality were similar for most age classes between the time periods examined. However, results also indicated that the NPR-1 kit fox population declined about 27% annually between 1981 and 1984,

but only about 6% annually between 1985 and 1988. Fecundity was lower and generation time was higher (longer) during the 1981-1984 period than the 1985-1988 period. The combination of these two parameters likely contributed heavily to the higher rate of decline estimated for the 1981-1984 period.

Summary and Evaluation of the Coyote Control Program

The following project description is summarized from Scrivner and Cypher (1993). Coyote predation is the primary cause of kit fox mortalities on NPR-1. Declines in kit fox captures during the early 1980s, combined with a concurrent increase in coyote abundance led DOE to conclude that coyote predation may be limiting kit fox abundance. In an effort to minimize coyote predatory pressure, a coyote control program was conducted on and adjacent to NPR-1 between 1985 and 1990. An evaluation of the efficacy of coyote control in achieving its objective of reducing coyote predation on kit foxes was conducted upon termination of the program. Effectiveness of the program was evaluated using carnivore scent station data, lagomorph density data, and physiologic data collected from dead kit foxes and coyotes. Morphologic measurements collected from dead coyotes while the control program was in operation were also summarized and are presented in Scrivner and Cypher (1993). Results indicated that although coyote abundance on NPR-1 declined during the control period, the contribution the control effort made to the decline was unclear. Contrary to what was expected, reproduction rates among female coyotes did not increase to compensate for decreased density. Kit fox capture rates remained fairly stable after coyote control was begun, but fox survival rates and the proportion of fox deaths due to predation did not decrease. It appeared, therefore, that the coyote control program had little effect on the abundance of kit foxes on NPR-1. Further analysis revealed a strong relationship between lagomorph density and coyote and kit fox abundance. These results indicated that the availability of food was probably the primary factor influencing the population dynamics of both species and that coyote predation was probably not limiting kit fox abundance. Consequently, it was recommended that the coyote control program be suspended on NPR-1 until new evidence was obtained warranting further control efforts.

3.4 NPR-1 Operating Guidelines and Policies

The DOE and the NPR-1 Unit Operator have established and implemented the following operational guidelines and policies for the protection of threatened and endangered species and their habitats. Guidelines and policies govern activities associated with routine operation of the oil field, and are intended to minimize the potential for the incidental take of listed species and to minimize damage to wildlife habitat. These guidelines and policies will continue to be followed and modified as needed to conserve species. Published policies are referenced where appropriate.

Vehicle Traffic

Vehicle traffic on NPR-1 is controlled via access control gates, enforcement of speed limits, and security patrols. Speed limits on paved roads is maintained at 40 miles per hour (mph) or less. Safe speeds on secondary and unimproved roads is 25 mph or less based on road conditions, traffic use, visibility, and terrain. Unauthorized off-road travel by wheeled or tracked vehicles is prohibited. Speed limits are enforced to minimize accidental vehicle strikes to wildlife, while off-road travel is prohibited to minimize disturbances to wildlife habitats. Vehicle traffic on State Highway 119 and Elk Hills Road is controlled by the appropriate state agencies, not DOE nor its contractor.

Sumps

Sumps on NPR-1 pose a significant risk to resident listed species. As a result, all sumps on NPR-1 which may receive or contain oil, water, or a combination of oil and water are covered with protective netting to prevent the accidental entrapment or drowning of wildlife (Unit Operator Policy 409-016P.ESG). Protective coverings are regularly inspected and repaired or replaced if necessary. Sumps are not constructed in natural drainages or where groundwater contamination may occur.

Fire Suppression

Wildfires commonly occur on and adjacent to NPR-1. The effect of wildfires on resident wildlife are variable depending on species, time of year, and intensity of burn. For protected species, however, most wildfires are not harmful. Most fire suppression activities on NPR-1 focus on worker safety and facility protection. These activities include but are not limited to: water system inspection, issuance of welding permits, weed control, fire response team training, and firebreak maintenance. Firebreaks are maintained only in facility and office areas and near the town of Tupman. Wildfires occurring in remote locations on or adjacent to NPR-1 are controlled as needed by fire response teams.

Security and Public Access

Access to NPR-1 is permitted only for registered permanent and temporary employees and authorized visitors (Unit Operator Policy 409-002P.SEG). Unauthorized public access is prohibited and controlled via perimeter fences, guarded primary entry gates, and padlocked secondary gates. Routine security patrols, perimeter fence maintenance, and personnel verification are employed to minimize the likelihood of unauthorized access.

Proscribed Activities

DOE and Unit Operator guidelines and policies prohibit the following activities on NPR-1: hunting, trapping, livestock grazing (Unit Operator 1880-006), transportation of live animals (Unit Operator Policy 409-002P.SEG), agricultural activities, and casual public access (Unit Operator Policy 409-002P.SEG). These procedures are implemented to prevent the illegal take of protected species and to minimize damage to wildlife habitats.

Employee Education Program

All permanent and temporary employees of DOE, CPDN, the Unit Operator, and subcontractors are required to attend a training session on the conservation of threatened and endangered species on NPR-1. Employees view a mandatory film entitled "Conserving Endangered Species on NPR-1", receive an Endangered Species and Environmental Awareness Handbook, and are briefed on all site policies, regulations, and procedures pertaining to protected species. Measures to eliminate or minimize impacts to listed species during specific projects may also be reviewed with employees during special pre-performance meetings and training sessions. The employee education program also includes periodic updates and news items concerning wildlife on NPR-1 via Environmental Management News Bulletins, distributed by the Unit Operator's Environmental Services Department.

3.5 Information Transfer and Outreach

An important part of the Endangered Species Program on NPR-1 is the summary, preparation, dissemination, and presentation of technical and non-technical information. To accomplish this, DOE has sponsored an ongoing information transfer and outreach effort. The objectives of information transfer and outreach are (1) to transmit information to organizations outside of NPR-1 through publication and presentation of pertinent scientific research, (2) to participate in the conservation of protected species in the southern San Joaquin Valley region by attending professional meetings and planning sessions, and (3) to share scientific expertise with non-technical publics by participating in local community educational programs and other outreach projects.

Technical information collected from the Endangered Species Program on NPR-1, such as research study results and technique development, are routinely shared with other professionals. Technical information is typically transmitted in two ways: through manuscripts published in journals or as DOE Topical Reports, and through presentations at professional meetings, conferences, and symposia. As of June 15, 1997, 23 manuscripts have been published or are in press in peer-reviewed journals, and an additional 11 have been submitted. An additional 73 manuscripts have been published or are in press as DOE Topical Reports. Appendix B contains a complete list of manuscripts related to the NPR-1 Endangered Species Program that have been published, are in press, or have been submitted. As of June 15, 1997, 29 presentations have been given at professional meetings, conferences, or symposia (Appendix B).

Biologists from the NPR-1 Endangered Species Program routinely attend and participate in professional meetings, scientific conferences, and regional conservation planning activities. Attendance at professional meetings and scientific conferences allows staff biologists to become familiar with research studies conducted by other organizations, learn new methods and techniques for monitoring species, and to meet with other professionals. Participation in regional conservation activities allow staff biologists to share information collected on NPR-1 and help formulate region-wide protected species conservation strategies. Biologists from NPR-1 have participated in the following regional conservation planning activities: the San Joaquin Valley Biotechnical Committee, the Kern County Habitat Conservation Plan, the Lokern Natural Area Planning Committee, and the San Joaquin Valley Endangered Species Recovery Planning Program.

Participation in community educational programs and other outreach activities allow NPR-1 staff biologists to share scientific information and expertise with the local public. Some of these activities are associated with special events or are held in conjunction with other organizations. These types of activities include: Earth Day activities held at NPR-1 and in nearby Bakersfield, student environmental education at the Coles Levee Ecosystem Preserve, and Project Wildlife in Learning Design (WILD) training sessions and presentations. Other educational activities (e. g., presentations, classroom visits) are conducted upon request.

3.6 Endangered Species Conservation Area

In the course of the formal consultations between DOE and FWS that resulted in a non-jeopardy Biological Opinion in 1995, DOE agreed to establish a 2,863-ha (7,075 acres) conservation area to mitigate for potential impacts to resident listed species due to continued MER developments (U. S. Department of the Interior, 1995). Establishment of the conservation area is to be concluded within three years of the date of the opinion (November 8, 1995) and to comprise ". . . undisturbed endangered species habitat within, or adjacent to, NPR-1,. . . preferably along the north side of NPR-1 adjacent to the Lokern Road area" (U. S. Department of the Interior, 1995). In addition, habitats within the conservation area are to be protected in perpetuity against major oil field developments and be managed in a manner mutually agreed upon by DOE and FWS.

The type and extent of activities to be conducted on the established conservation area have not yet been identified. Activities are likely to include some level of annual population monitoring for threatened and endangered species occurring on the area. Lands on the NPR-1 conservation area may also be utilized for a variety of research studies gauging the effect of habitat management and manipulation on protected species. Lands on the NPR-1 conservation area may also be utilized as a mitigation bank, in which habitat losses due to off-site developments are mitigated using portions of the conservation area. The precise land uses and activities permitted on the NPR-1 conservation area will be specified in the joint DOE/FWS management agreement.

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APPENDIX A

VERTEBRATE AND PLANTS SPECIES OBSERVED ON OR ADJACENT TO NAVAL PETROLEUM RESERVE NO. 1

MAMMALS

Family Canidae (Dog Family)	
Canis latrans	coyote
Urocyon cinereoargenteus	gray fox
Vulpes macrotis mutica	San Joaquin kit fox
Family Cervidae (Deer Family)	
Odocoileus hemionus	mule deer
Family Cricetidae (New World Mouse Family)	
Onychomys torridus	southern grasshopper mouse
Peromyscus maniculatus	deer mouse
Reithrodontomys megalotis	western harvest mouse
Family Didelphidae (Opposum Family)	
Didelphis viginiana	opossum
Family Felidae (Cat Family)	
Felis concolor	mountain lion
Felis rufus	bobcat
Family Geomyidae (Pocket Gopher Family)	
Thomomys bottae	Botta's pocket gopher
Family Heteromyidae (Pocket Mouse Family)	
Dipodomys heermanni	Heerman's kangaroo rat
Dipdomys ingens	giant kangaroo rat
Dipodomys nitrotoides brevinasus	short-nosed kangaroo rat
Dipodomys nitrotoides nitratoides	Tipton kangaroo rat
Perognathus inornatus	San Joaquin pocket mouse
Family Leporidae (Hare Family)	
Lepus californicus	black-tailed jackrabbit
Sylvilagus audubonii	desert cottontail

Family Muridae (Old World Mouse Family)

Mus musculus	house mouse

Family Mustelidae (Weasel Family)

Mustela frenata	long-tailed weasel
Mephitis mephitis	striped skunk
Spilogale gracilis	western spotted skunk
Taxidea taxus	badger

Family Procyonidae (Raccoon Family)

Procyon lotor	raccoon

Family Sciuridae (Squirrel Family)

Ammospermophilus nelsoni	San Joaquin antelope squirrel
Spermophilus beecheyi	California ground sqirrel

BIRDS

Family Accipitridae (Hawk Family)

Accipiter cooperi	Cooper's hawk
Aquila chrysaetos	golden eagle
Buteo jamaicensis	red-tailed hawk
Buteo regalis	ferruginous hawk
Circus cyaneus	marsh hawk

Family Alaudidae (Lark Family)

Eremophila alpestris	horned lark

Family Anseridae (Goose Family)

Anas platyrhynchos	mallard

Family Ardeidae (Heron Family)

Casmerodius albus	common egret

Family Bombycillidae (Waxwing Family)

Bombycilla cedrorum	cedar waxwing
Phainopepla nitens	phainopepela

Family Caprimulgidae (Goatsucker Family)

Chordeiles acutipennis	lesser nighthawk

Family Cathartidae (Vulture Family)

Cathartes aura	turkey vulture

Family Certhiidae (Creeper Family)

Salpinctes obsoletus	rock wren
Troglodytes aedon	house wren

Family Charadriidae (Plover Family)

Charadrius montanus	mountain plover
Charadrius vociferus	killdeer

Family Columbidae (Dove Family)

Columba livia	rock dove
Zenaida macroura	mourning dove

Family Corvidae (Crow Family)

Corvus brachyrhynchos	American crow
Corvus corax	common raven

Family Cuculidae (Cuckoo Family)

Geococcyx californianus	roadrunner

Family Falconidae (Falcon Family)

Falco mexicanus	prairie falcon
Falco sparverius	American kestrel

Family Fringillidae (Finch Family)

Agelaius tricolor	tri-colored blackbird
Amphispiza belli	sage sparrow
Carduelis psaltria	lesser goldfinch
Carpodacus mexicanus	house finch
Dendroica coronata	yellow-rumped warbler
Dendroica nigrescens	black-throated gray warbler
Euphagus cyanocephalus	Brewer's blackbird
Icterus galbula	northern oriole
Icterus parisorum	Scott's oriole
Junco hyemalis	dark-eyed junco
Oporonis tolmiei	MacGillivary's warbler
Passerella iliaca	fox sparrow
Pheucticus melanocephalus	black-headed grosbeak
Pipilo erythrophthalmus	rufous-sided towhee
Piranga ludoviciana	western tanager
Sturnella neglecta	western meadowlark

Family Fringillidae (cont.)	
Wilsonia pusila	Wilson's warbler
Zonotrichia atricapilla	golden-crowned sparrow
Zonotrichia leucophrys	white-crowned sparrow
Family Gruidae (Crane Family)	
Grus canadensis	sandhill crane
Family Hirundinidae (Swallow Family)	
Hirundo pyrrhonota	cliff swallow
Hirundo rustica	barn swallow
FamilyLaniidae (Shrike Family)	
Lanius ludovicianus	loggerhead shrike
Family Muscicapidae (Thrush Family)	
Catharus guttatus	hermit thrush
Ixoreus naevius	varied thrush
Turdus migratorius	American robin
Family Pandionidae (Osprey Family)	
Pandion haliaetus	osprey
Family Paridae (Chickadee Family)	
Parus rufescens	chestnut-backed chickadee
Psaltriparus minimus	bushtit
Family Passeridae (Old World Sparrow Family)	
Passser domesticus	house sparrow
Family Phasianidae (Pheasant Family)	
Alectoris chukar	chuckar
Callipepla californica	California quail
Phasianus colchicus	ring-necked pheasant
Family Picidae (Woodpecker Family)	
Picoides pubescens	downy woodpecker
Family Rallidae (Rail Family)	
Fulica americana	American coot

Family Recurvirostridae (Avocet Family)

Himantopus mexicanus	black-necked stilt
Recurvirostra americana	American avocet

Family Regulidae (Kinglet Family)

Regulus calendula	ruby-crowned kinglet
Regulus satrapa	golden-crowned kinglet

Family Sittidae (Nuthatch Family)

Sitta canadensis	red-breasted nuthatch

Family Strigidae (Owl Family)

Speotyto cunicularia	burrowing owl
Bubo virginianus	great horned owl

Family Sturnidae (Starling Family)

Mimus polyglottos	northern mockingbird
Sturnus vulgaris	European starling
Toxostoma lecontei	LeConte's thrasher

Family Trochilidae (Hummingbird Family)

Calypte anna	Anna's hummingbird

Family Tyrannidae (Flycatcher Family)

Nuttallornis boealis	olive-sided flycatcher
Sayornis nigricans	black phoebe
Sayornis saya	Say's phoebe
Tyrannus verticalis	western kingbird

Family Tytonidae (Barn Owl Family)

Tyto alba	barn owl

Family Vireonidae (Vireo Family)

Vireo gilbus	warbling vireo
Vireo huttoni	Hutton 's vireo

REPTILES AND AMPHIBIANS

Family Bufonidae (Toad Family)

Bufo boreas	western toad

Family Colubridae (Colubrid Snake Family)

Arizona elegans	glossy snake
Masticophis flagellum	coachwhip snake
Pituophis melanoleucus	gopher snake

Family Hylidae (Treefrog Family)

Hyla regilla	Pacific treefrog

Family Iguanidae (Iguana Family)

Gambelia silus	blunt-nosed leopard lizard
Phyrnosoma coronatum	coast horned lizard
Uta stansburiana	side-blotched lizard

Family Teiidae (Whiptail Family)

Cnemidophorus tigris	western whiptail lizard

Family Viperidae (Viper Family)

Crotalus viridis	western rattlesnake

PLANTS

Family Amaranthaceae (Amaranth Family)

Amaranthus albus	amaranth

Family Asteraceae (Sunflower Family)

Achillea millefolium	western yarrow
Achyrachaena mollis	
Ambrosia acanthicarpa	ragweed
Centaurea melitensis	star thistle
Chaenactis fremontii	Fremont's pincushion
Chamomilla occidentalis	pineappleweed
Chrysanthemum coronarium	
Conyza coulteri	
Coreopsis calliopsidea	
Cotula australis	
Eastwoodia elegans	eastwoodia
Filago californica	filago
Filago galica	
Gnaphaleum stramineum	cudweed
Gnaphalium luteo-album	cudweed
Gutierrezia californica	snakeweed
Helianthus annuus	sunflower

Family Asteraceae (cont.)	
Hemizonia pallida	San Joaquin tarweed
Hemizonia pungens	stinkweed
Hymenoclea salsola	cheesebush
Isocoma acradenia bracteata	goldenbush
Lactuca serriola	prickly lettuce
Lasthenia californica	goldfields
Lasthenia ferrisiae	
Layia glandulosa	white layia
Layia platyglossa	tidy tips
Lessingia glandulifera	
Malacothrix coulteri	snake heads
Malicothrix californica	wild marigold
Monolopia lanceolata	hilltop daisy
Monolopia stricta	
Senecio flaccidus	
Senecio vulgaris	common groundsel
Sonchus asper asper	
Sonchus oleraceus	sow thistle
Stebbinsoseris heterocarpa	
Stephanomeria pauciflora	milk-aster
Stylocline citroleum	oil nest straw
Stylocline gnaphaloides	
Family Boraginaceae (Borage Family)	
Amsinckia eastwoodiae	
Amsinckia menziesii menziesii	fiddleneck
Amsinckia tessellata	
Heliotropium curassavicum	
Pectocarya linearis ferocula	
Pectocarya penicillata	
Plagiobothrys canescens	popcorn flower
Family Brassicaceae (Mustard Family)	
Athysanus pusilus	
Capsella bursa-pastoris	shepherd's purse
Caulanthus inflatum	desert candle
Gullenia lasiophylla	
Hirschfeldia incana	
Lepdium dictyotum	pepperweed
Lepidium nitidum nitidum	
Sisymbrium altissimum	tall mustard
Sisymbrium irio	London rocket

Family Brassicaceae (cont.)	
Sisymbrium orientale	oriental mustard
Tropidocarpum gracile gracile	
Family Cappaceae (Caper Family)	
Isomeris arborea	bladderpod
Family Caryophyllaceae (Pink Family)	
Loeflingia squarrosa squarrosa	loeflingia
Spergularia marina	sand-spurrey
Stellaria nitens	shiny chickweed
Family Chenopodiaceae (Goosefoot Family)	
Atriplex cornata	crownscale
Atriplex lentiformis	quailbush
Atriplex phyllostegia	arrowscale
Atriplex polycarpa	desert saltbush
Atriplex rosea	redscale
Atriplex serenana serenana	
Atriplex spinifera	spiny saltbush
Bassia hyssopifolia	firehook
Chenopodium berlandieri	slender lamb's quarters
Krascheninnikovia lanata	winterfat
Monolepis nuttalliana	
Salsola tragus	Russian thistle
Sueda moquinii	iodine bush
Family Crassulaceae (Stonecrop Family)	
Crassula connata	sand pigmy weed
Family Euphorbiaceae (Spurge Family)	
Chamaesyce ocellata ocellata	spurge
Eremocarpus setigerus	doveweed/turkey mullein
Family Fabaceae (Legume Family)	
Astragalus gambelianus	Gambel loco
Astragalus lentiginosus	black loco
Lotus wrangelianus	bird's foot trefoil
Lupinus bicolor	bi-colored lupine
Lupinus densiflorus	golden lupine
Lupinus nanus	sky lupine
Trifolium hirtum	rose clover
Trifolium wildenovii	

Family Frankeniaceae (Frankenia Family)

Frankenia salina	alkali heath

Family Geraniaceae (Geranium Family)

Erodium brachycarpum	
Erodium cicutarium	redstem filaree
Erodium macrophyllum	roundleaf filaree
Erodium texanum	

Family Hydrophyllaceae (Waterleaf Family)

Nemophila menziesii	baby blue-eyes
Phacelia ciliata	
Phacelia douglasii	
Phacelia tanacetifolia	tansy phacelia

Family Lamiaceae (Mint Family)

Marrubium vulgare	horehound
Salvia carduacea	thistle sage
Salvia columbariae	chia
Trichostema ovatum	bluecurls

Family Liliaceae (Lily Family)

Allium crispum	wild onion
Dichelostemma capitatum	common brodiaea

Family Loasaceae (Loasa Family)

Mentzelia affinis	valley stickseed
Mentzelia pectinata	San Joaquin blazing star

Family Malvaceae (Mallow Family)

Eremalche parryi	Parry's mallow

Family Nyctaginaceae (Four O'Clock family)

Abronia pogonantha	sand verbena

Family Onagraceae (Evening-Primrose Family)

Camissonia boothii	camissonia
Camissonia campestris	sun cups
Clarkia cylindrica cylindrica	farewell-to-spring
Clarkia temblorensis	temblor clarkia

Family Papaveraceae (Poppy Family)

Eschscholzia cespitosa	
Eschscholzia lemmoni kernensis	Lemmon's poppy
Platystemon californicus	cream cups
Stylomecon heterophylla	wind poppy

Family Plantaginaceae (Plantain Family)

Plantago ovata	valley indian wheat

Family Poaceae (Grass Family)

Avena barbata	slender wild oats
Bromus diandrus	rip-gut brome
Bromus hordeaceus	soft chess
Bromus madritensis rubens	red brome
Bromus trinii	Chilean brome
Hordeum murinum glaucum	wild barley
Koeleria phleoides	junegrass
Lolium multiflorum	Italian rye grass
Phalaris aquatica	Harding grass
Phalaris minor	lesser canary grass
Poa secunda	pine bluegrass
Polypogon monspeliensis	annual beard grass
Schismus barbatus	Mediterranean grass
Vulpia bromoides	flag fescue
Vulpia myuros hirsuta	mousetail fescue

Family Polygonaceae (Buckwheat Family)

Eriogonum fasciculatum	California buckwheat
Eriogonum gossypinum	St. Catherine's lace
Eriogonum gracillimum	
Eriogonum nudum	
Eriogonum ordii	wild buckwheat
Eriogonum viridescens	slender eriogonium
Hollisteria lanata	
Mucronea perfoliata	perfoliate spineflower
Oxytheca perfoliata	saucer plant

Family Polemoniaceae (Phlox Family)

Eriastrum hooveri	Hoover's wooly-star
Eriastrum pluriflorum	Tehachapi wooly-star
Gilia tricolor	bird's eye gilia
Linanthus dichotomous	evening snow
Linanthus liniflorus	Lewis' flax

Family Portulacaceae (Purselane Family)	
Calandrinia cilata	red maids
Claytonia perfoliata	miner's lettuce
Family Ranunculaceae (Buttercup Family)	
Delphinium gypsophilum	gypsum-loving larkspur
Delphinium recurvatum	recurved larkspur
Family Resedaceae (Mignonette Family)	
Oligomerus linifolia	oligomerus
Family Scrophulariaceae (Figwort Family)	
Castilleja brevistyla	
Castilleja exserta	purple owl's clover
Collinsia bartsiifolia davidsonii	
Mimulus guttatus	common monkey flower
Triphysaria eriantha eriantha	
Family Solanaceae (Nightshade Family)	
Lycium cooperi	wolfberry
Nicotiana glauca	tobacco tree
Solanum rostratum	buffalo berry
Family Tamaricaceae (Tamarisk Family)	
Tamarix aphylla	salt cedar
Family Zygophyllaceae (Caltrop Family)	
Larrea tridentata	creosotebush

APPENDIX B

MANUSCRIPTS, REPORTS, AND PRESENTATIONS

Published/In press

Cypher, B. L. 1995. Coyote morphometric characteristics and mass dynamics in the San Joaquin Valley, California. The Southwestern Naturalist 40:32-37.

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McCue, P. M., and T. P. O'Farrell. 1992. Serum chemistry of the endangered San Joaquin kit fox *Vulpes macrotis mutica*. Journal of Wildlife Diseases 28:414-418.

O'Farrell, T. P. 1985. The kit fox *Vulpes macrotis*. Pages 423-431 in Novak, M., J. A. Baker, M. E. Obbard, and B. Mallock, eds. Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Ottawa, Ontario.

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Anderson, D. C. and G. L. Holmstead. Characterization of *Eriasturm hooveri* habitat on the Naval Petroleum Reserves in California. Madrono. Submitted.

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