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**ENDANGERED SPECIES AND
CULTURAL RESOURCES PROGRAM
NAVAL PETROLEUM RESERVES IN
CALIFORNIA**

ANNUAL REPORT FY95

MASTER

LAS VEGAS AREA OPERATIONS

2621 Losee Road

North Las Vegas, Nevada, 89030

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**ENDANGERED SPECIES AND
CULTURAL RESOURCES PROGRAM
NAVAL PETROLEUM RESERVES IN
CALIFORNIA**

ANNUAL REPORT FY95

April 1996

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Naval Petroleum Reserves in California, and
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Nevada Operations Office under DOE contract No. DE-AC08-93NV11265

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EXECUTIVE SUMMARY

In FY95, EG&G Energy Measurements, Inc. (EG&G/EM) continued to support efforts to protect endangered species and cultural resources at the Naval Petroleum Reserves in California (NPRC). These efforts are conducted to ensure NPRC compliance with regulations regarding the protection of listed species and cultural resources on federal properties.

Population monitoring activities are conducted annually for San Joaquin kit foxes, giant kangaroo rats, blunt-nosed leopard lizards, and Hoover's woolly-star. Kit fox abundance and distribution was assessed by live-trapping over a 329-km² area. Kit fox reproduction and mortality were assessed by radiocollaring and monitoring 24 adults and one pup. Reproductive success and litter size were determined through live-trapping and den observations. Rates and sources of kit fox mortality were assessed by recovering dead radiocollared kit foxes and conducting necropsies to determine cause of death. Abundance of coyotes and bobcats, which compete with kit foxes, was determined by conducting scent-station surveys. Kit fox diet was assessed through analysis of fecal samples collected from live-trapped foxes. Abundance of potential prey for kit foxes was determined by conducting transect surveys for lagomorphs, and by live-trapping small mammals. Small mammal trapping also provided information on the abundance and distribution of several rodent species that are candidates for federal listing.

Giant kangaroo rats and blunt-nosed leopard lizards are monitored using methodologies that are consistent with those employed by other researchers to facilitate comparisons of results. Giant kangaroo rat abundance and demographics were assessed by live-trapping in spring and late summer on a monitoring plot, and by monitoring the size of selected giant kangaroo rat colonies. Blunt-nosed leopard lizard population trends are tracked on two monitoring plots. Surveys were conducted in spring for adult lizards and in late summer for juvenile lizards. Hoover's woolly-star populations were assessed at six monitoring sites. Additionally, Hoover's woolly-star abundance was measured on study plots established to assess the effects of disturbance and the efficacy of topsoil conservation on this species. This study was concluded and a manuscript was prepared for publication. Also in FY95, an effort was initiated to survey NPRC for listed and candidate plants. Full-coverage transect surveys were conducted in seven sections. Numerous additional populations of Hoover's woolly-star were located along with five populations of the candidate species recurved larkspur and three populations of the candidate species oil nest-straw. Monitoring efforts for all listed species will continue in FY96, and floristic surveys will be conducted in additional sections of NRPC.

To mitigate impacts of oil field activities on listed species, 674 preactivity surveys covering approximately 211 hectares (521 acres) were conducted in FY95. Mitigation measures implemented as a result of survey findings resulted in avoidance of incidental takes of listed species during construction activities. EG&G/EM also assisted with mitigating effects from third-party projects, primarily by conducting biological and cultural resource consultations with regulatory agencies. Third-party projects in FY95 included two pipeline projects and two sump

abandonment/clean-up projects. Cultural resource support provided to NPRC consisted primarily of conducting preliminary surveys for cultural resources, and finalizing a draft Cultural Resource Management Plan and Programmatic Agreement for NPR-1. EG&G/EM also provided endangered species and cultural resources compliance support in the planning process for a proposed 3-D seismic survey to be conducted on NPR-1 in 1996.

EG&G/EM has conducted an applied habitat reclamation program at NPRC since 1985. In FY95, an evaluation of revegetation rates on reclaimed and non-reclaimed disturbed lands was completed, and the results will be used to direct future habitat reclamation efforts at NPRC. In FY95, reclamation success was monitored on 50 sites reclaimed in 1985.

An investigation of factors influencing the distribution and abundance of kit foxes at NPRC was initiated in FY94. Factors being examined include habitat disturbance, topography, grazing, coyote abundance, lagomorph abundance, and shrub density. This investigation continued in FY95 and a manuscript on this topic will be completed in FY96. Also, EG&G/EM completed collection of field data to evaluate the effects of a well blow-out on plant and animal populations. A final report will be prepared in FY96. Finally, EG&G/EM completed a life table analysis on San Joaquin kit foxes at NPRC.

In FY95, EG&G/EM continued to assist NPRC with environmental compliance documentation. Support was provided in two formal Section 7 consultations with the U.S. Fish and Wildlife Service (FWS) for continuing oil and gas operations on Naval Petroleum Reserve No. 1 (NPR-1) and Naval Petroleum Reserve No. 2 (NPR-2). Also, 13 additional consultations were conducted for specific projects.

EG&G/EM also engaged in a number of outreach activities. Technical outreach included participation at scientific meetings, completion of six scientific manuscripts and two technical reports, and initiation of work on seven other manuscripts and reports. Other technical outreach included reports on progress at quarterly Endangered Species Advisory Committee meetings, presentations of results at an annual program review attended by approximately 75 individuals from government and private organizations, and participation in regional conservation efforts such as recovery planning meetings, San Joaquin Valley Biotechnical Committee meetings, and Lokern Natural Area management meetings. Educational outreach activities included the preparation of numerous articles for the *Elk Hills Weekly*, on-site tours, presentations to students, and participation in the annual Elk Hills Earth Day celebration, Coles Levee Ecosystem Preserve educational program, Derricks-to-Desks program, and Department of Energy Science Bowl. EG&G/EM also provided support for two graduate students from University of California at Berkeley; one student completed a Master of Science thesis on kit foxes and the other initiated a study of bobcats at NPRC.

Beginning in FY96, the NPRC Endangered Species and Cultural Resources Program will be conducted by Enterprise Advisory Services, Inc. However, program scope and staff will remain the same to ensure consistency in the protection and conservation of cultural resources and endangered species at NPRC.

ACKNOWLEDGEMENTS

Permission to conduct research on endangered and threatened species was granted by the U. S. Fish and Wildlife Service through permit PRT-683011, and a Memorandum of Understanding between the California Department of Fish and Game and EG&G Energy Measurements, Inc.

This is a continuing program and interpretation of facts contained in this report may change as new data are acquired and analyzed. Results should not be cited without prior consultation.

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1. INTRODUCTION

1.1 BACKGROUND

The NPRC are operated by the U. S. Department of Energy (DOE) and Chevron U.S.A. Production Company (CPDN). Four federally endangered animal species and one federally threatened plant species are known to occur on NPRC: San Joaquin kit fox (*Vulpes macrotis mutica*), blunt-nosed leopard lizard (*Gambelia silus*), giant kangaroo rat (*Dipodomys ingens*), Tipton kangaroo rat (*Dipodomys nitratoideus*), and Hoover's woolly-star (*Eriastrum hooveri*). All five are protected under the Endangered Species Act (ESA) of 1973 (as amended) (Public Law 93-205), which declares that it is "... the policy of Congress that all federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of the Act." DOE/NPRC is also obliged to determine whether actions taken by their lessees on NPR-2 will have any effects on endangered species or their habitats.

NPR-1 and NPR-2 are located approximately 40 km southwest of Bakersfield, Kern County, California (Figure 1). NPR-1 encompasses 19,186 hectares (47,409 acres) in seven townships and is located just north of NPR-2. DOE/NPRC owns approximately 14,994 hectares (37,049 acres) on NPR-1, while CPDN owns the remaining 4,193 hectares (10,360 acres). NPR-2 consists of 12,173 hectares (30,080 acres) in five townships. DOE/NPRC administers 4,209 hectares (10,400 acres) on NPR-2, while the remainder is privately owned. The city of Taft occupies 518 hectares (1,280 acres) in the southern portion of NPR-2.

1.2 OBJECTIVES

The primary objective of the Endangered Species and Cultural Resource Program (ESCRP) on NPRC is to provide DOE/NPRC with the scientific expertise necessary for compliance with the ESA, the National Environmental Policy Act (NEPA), and the National Historic Preservation Act (NHPA). The specific objective of this report is to summarize progress, results, and accomplishments of the ESCRCP during fiscal year 1995 (FY95).

Figure 1. Location of U. S. Department of Energy's Naval Petroleum Reserves in California, Kern County, California.

2. ENDANGERED SPECIES MONITORING PROGRAM

2.1 MONITOR POPULATIONS OF SAN JOAQUIN KIT FOXES ON NPRC

I. INTRODUCTION

An essential aspect of all endangered species research is some knowledge of the size or density of the population. San Joaquin kit foxes have been trapped annually on NPRC since winter 1981 to provide continuous information on kit fox population trends. The information gathered during this project is also useful in understanding the factors that most strongly affect kit fox populations on NPRC. Knowledge of how these factors influence fox numbers can ultimately be used to help formulate species recovery strategies.

II. METHODS AND MATERIALS

Annual San Joaquin kit fox population monitoring was conducted during November and December 1994 over approximately 329-km² on and adjacent to NPRC. NPRC was divided into a number of smaller trap areas, the most important of which are the NPR-1 study area and NPR-2. The NPR-1 study area is a 117-km² area located in the south central portion of NPR-1 and the northern portion of NPR-2. One 38-cm x 38-cm x 107-cm collapsible wire-mesh live-trap was placed in each quarter section and operated for four consecutive nights. A total of 712 trap-nights of effort were expended on the NPR-1 study area, while 676 trap-nights of effort were expended on NPR-2. Captured kit foxes were individually marked, sexed, weighed, measured, and released at the capture location. The number of foxes captured was tallied for both the NPR-1 study area and NPR-2 and compared with the results of previous trapping sessions.

III. RESULTS

A total of 61 San Joaquin kit foxes were captured 80 times on the NPR-1 study area, while 182 kit foxes were captured 247 times on NPR-2 (Table 1). Compared with 1993, 153% and 169% more individuals were captured on the NPR-1 study area and NPR-2, respectively.

Fox captures were more numerous on both NPR-1 and NPR-2 during 1994 than during both 1992 and 1993. On NPR-1, foxes were primarily captured within or near Buena Vista Valley and along the northern boundary (Figure 2). Kit foxes were captured throughout most of NPR-2 during the 1994 session.

Figure 2. Location of San Joaquin kit fox captures during winter 1994, Naval Petroleum Reserves in California, Kern County, California.

Table 1. Number of trap-nights, total captures, and individual San Joaquin kit foxes captured on the Naval Petroleum Reserves in California, during winter live-trapping sessions, 1981-1994 (NPR-1 study area) and 1983-1994 (NPR-2).

Year	Trap-nights		Captures		Individuals	
	NPR-1	NPR-2	NPR-1	NPR-2	NPR-1	NPR-2
1981	711		209		141	
1982	710		117		87	
1983	712	674	17	88	17	73
1984	711	659	51	133	42	113
1985	708	673	31	106	26	80
1986	712	675	25	124	22	100
1987	712	676	27	99	23	76
1988	712	676	27	125	23	100
1989	712	676	27	77	26	66
1990	712	676	28	91	18	64
1991	712	671	2	28	2	24
1992	712	676	20	63	16	58
1993	712	676	50	131	40	108
1994	712	676	80	247	61	182

IV. CONCLUSIONS

Data collected in 1994 indicate that the kit fox populations on the NPR-1 study area and NPR-2 continued to increase from lows in 1991. The number of individual foxes trapped was the highest since 1982 on the NPR-1 study area, and the highest ever recorded on NPR-2. Kit fox captures were well distributed in 1994, particularly on the perimeter of NPR-1 and throughout NPR-2.

2.2 MONITOR REPRODUCTION AND MORTALITY OF KIT FOXES

I. INTRODUCTION

Kit fox reproduction and mortality were assessed on and adjacent to NPR-1. The use of radio telemetry to monitor kit fox reproduction and mortality is a useful tool to help explain changes in population size. The objectives of monitoring reproduction and mortality are to determine: 1) the proportion of adult females that wean pups, 2) the average litter size, 3) the proportion of juveniles that enter the breeding population, and 4) the sources and rates of mortality of juvenile and adult kit foxes.

II. METHODS AND MATERIALS

Kit foxes were radiocollared and monitored to determine reproductive success, causes of mortality, and mortality rates. During annual trapping sessions conducted in November and December of 1993 and 1994 (see Section 2.1 for details concerning live-trapping and handling techniques), selected adult foxes were fitted with 50-g radiocollars equipped with mortality sensors (MOD-80, Telonics, Mesa, AZ). In May, pups were trapped at dens and fitted with radiocollars that weighed 25 to 30-g (Model 2A, Telonics). All radiocollared foxes were monitored two to three times per week. Attempts were made to adjust and change collars as needed.

Radiocollared female foxes were monitored to assess reproduction. In the spring, fox reproduction was assessed by conducting den observations and through live-trapping. Each den inhabited by a radiocollared vixen was observed at dusk to count the number of pups present. Beginning in May, traps were placed at these dens to capture and individually mark the pups. If juvenile foxes were captured or observed at a den inhabited by a radiocollared vixen, or the vixen showed signs of recent lactation when captured, it was assumed that she had produced pups. Litter size for each family group was determined as the maximum number of pups trapped or observed at the vixens' dens.

Sources and rates of kit fox mortality were assessed by monitoring the fate of radiocollared adult and juvenile foxes. Animals transmitting a mortality signal were immediately recovered and necropsied to determine cause of death. Deaths caused by predators were identified by tooth-puncture wounds to the skin and skeleton and by associated hemorrhaging. Death due to vehicle impact was assumed when foxes were recovered in close proximity to roads and evidence of massive trauma was apparent. Foxes were classified as having died of indeterminate causes if the cause of death could not be determined because the carcass was too badly scavenged, decomposed, desiccated, or only the radiocollar was recovered. The cause of death was classified as unknown if carcass was recovered intact, but no evidence indicating the cause of death could be found.

III. RESULTS AND CONCLUSIONS

Reproduction

Of 24 radiocollared adult foxes (10 males, 14 females) monitored in FY95, 15 foxes were alive during the pup rearing season (March - July). The dens of four female radiocollared foxes were observed. Two pups were observed at the den of one vixen, while no pups were observed at the other dens. No pups were captured during live-trapping efforts at the dens of these radiocollared vixens. Because of the apparent low reproductive success of radiocollared vixens, an aerial survey was conducted in late May to identify potential pupping dens. Five dens were located from the air; one exhibited evidence of being an active pupping den at which one female pup was captured and radiocollared.

The proportion of radiocollared vixens successfully raising pups was considerably lower in 1995 (25%) compared to 1994 (100%, $n = 9$). This low reproductive rate combined with the low number of pupping dens observed on and adjacent to NPR-1 during aerial surveys suggest that few juveniles from 1995 may be recruited into the breeding population.

Mortality

Of 24 adult foxes radiocollared prior to or during the 1994 annual trapping session and monitored until September 1995, 16 (66.7%) were recovered dead and two (8.3%) were lost because their radiocollars either malfunctioned or expired. Of the 16 foxes that died, eight (50.0%) were killed by predators, four (25.0%) were killed by vehicles on a public road, and the cause of death for four (25.0%) could not be determined. Mortality sources for adult radiocollared foxes appeared consistent with that observed for previous years. In late July, only the radiocollar of the female pup was recovered and a cause of death could not be determined.

2.3 MONITOR TRENDS OF CARNIVORE ABUNDANCE

I. INTRODUCTION

Coyote (*Canis latrans*) predation is the primary source of mortality for kit foxes on NPRC. Coyotes may also compete with kit foxes for food resources. As a result, scent-station surveys were established in 1984 to estimate the relative abundance of carnivores, particularly coyotes.

II. METHODS AND MATERIALS

Scent-station surveys were conducted in late March. Surveys included 25 scent-station lines (15 on NPR-1 and 10 on NPR-2). Each line contained 10 scent-stations placed on alternate sides of secondary roads and spaced at 0.5-km intervals. Each scent-station consisted of a circular 0.9-m diameter area cleared of all vegetation and debris. A thin layer of fine dust (approximately 2 mm)

attractant was placed in the center. Scent-stations were prepared in the afternoon and then examined the following morning for the presence of coyote and other carnivore prints. The presence of at least one print at a station constituted a visit. Visitation indices were then calculated as the proportion of operable stations (those not disturbed by wind, rain, or human-related factors) visited multiplied by 1,000. Wilcoxon signed-rank tests were used to measure differences in visitation indices between years for NPR-1 and NPR-2.

III. RESULTS AND CONCLUSIONS

On NPR-1, the visitation index for coyotes was 161. This suggests that the relative abundance of coyotes has continued to increase following a three year decline prior to 1993 (Figure 3). This is the highest spring index obtained for coyotes on NPR-1 since 1986 but is not significantly higher than the spring 1994 coyote index ($W = 40, p = 0.24$). On NPR-2, the visitation index for coyotes was 51, which was slightly less than the 1994 index of 61. Coyote visits on NPR-2 did not change significantly from 1994 to 1995 ($W = 6, p = 0.78$) (Figure 3).

Figure 3. Spring visitation indices for coyotes on the Naval Petroleum Reserves in California, Kern County, California, 1985-1995.

2.4 MONITOR LAGOMORPH POPULATIONS

I. INTRODUCTION

Lagomorphs, including black-tailed jackrabbits (*Lepus californicus*) and desert cottontails (*Sylvilagus audubonii*), are an important prey item for kit foxes. Lagomorph abundance is monitored annually to determine whether fluctuations in lagomorph density directly affect the kit fox population.

II. METHODS AND MATERIALS

Lagomorph populations were monitored in June using line-transect surveys conducted in 78 sections on, and adjacent to, NPR-1 and NPR-2. On NPR-1, 24 of 42 transects were located in developed sections, while 18 were located in undeveloped sections. "Developed" sections were those in which more than 15% of the land was disturbed by oil field development and "undeveloped" sections were those in which 15% or less of the land was disturbed. On NPR-2, 24 of 36 transects were located in developed sections, while 12 were located in undeveloped sections.

Transects were 1.6 km (1 mi) long and consisted of four 400-m legs that formed a square. Observers walked transects between 9:00 am and 4:00 pm and recorded lagomorph species, lagomorph behavior, and the perpendicular distance of observed lagomorphs to the transect line. A Fourier Series model (program DISTANCE) was used to calculate density estimates from recorded perpendicular distances. Estimated densities were compared using z-tests.

Figure 4. Lagomorphs observed during summer transects on the Naval Petroleum Reserves in California, Kern County, California, 1995.

III. RESULTS AND CONCLUSIONS

A total of 29 lagomorphs were observed on NPR-1: 22 in developed sections and seven in undeveloped sections (Figure 4). This is 80% lower than the number of lagomorphs observed in summer 1994 on NPR-1 when 145 were observed. The estimated density of lagomorphs on NPR-1 was $10/\text{km}^2$ ($\text{SE} = 3.3$) and was significantly less ($z = 4.29$, $p < 0.001$) than the 1994 density estimate of $43/\text{km}^2$ ($\text{SE} = 6.8$). Estimated lagomorph density for developed sections was $14/\text{km}^2$ ($\text{SE} = 5.4$) and was not significantly different ($z = 1.64$, $p = 0.101$) than the estimated density on undeveloped sections, which was $5/\text{km}^2$ ($\text{SE} = 1.7$).

One hundred and seven lagomorphs were observed on NPR-2: 79 in developed sections and 28 in undeveloped sections (Figure 4). This represents a 40% decrease in observations from summer 1994, when 180 lagomorphs were observed. The estimated density of lagomorphs was $75/\text{km}^2$ ($\text{SE} = 12.7$) for all of NPR-2 and was not significantly higher ($z = 0.81$, $p = 0.418$) than the 1994 density estimate of $63/\text{km}^2$ ($\text{SE} = 8.4$). Estimated lagomorph density for developed sections was $83/\text{km}^2$ ($\text{SE} = 13.7$) and was not significantly different ($z = 0.99$, $p = 0.322$) than the estimated density on undeveloped sections, which was $55/\text{km}^2$ ($\text{SE} = 24.5$). The estimated lagomorph density for NPR-2 was 86% higher than that for NPR-1 in 1995.

Table.2. The number of lagomorphs observed during summer transects in developed and undeveloped sections on NPR-1 and NPR-2 from 1984 to 1995 on the Naval Petroleum Reserves in California, Kern County, California.

Year	NPR-1			NPR-2		
	Developed	Undeveloped	Total	Developed	Undeveloped	Total
1984	164	74	238	157	98	255
1985	66	49	118	141	44	185
1986	74	49	123	198	60	258
1987	59	29	88	54	20	74
1988	135	35	170	81	39	120
1989	74	41	115	74	18	92
1990	40	22	62	41	6	47
1991	8	7	15	26	6	32
1992	25	17	42	40	8	48
1993	107	54	161	112	33	145
1994	108	37	145	128	52	180
1995	22	7	29	79	28	107

2.5 MONITOR SMALL MAMMAL POPULATIONS

I. INTRODUCTION

A program was initiated in FY93 to monitor abundance and habitat relationships of small mammals on NPR-1. Information obtained from this effort may help explain observed kit fox population trends because small mammals, particularly kangaroo rats, are important prey of kit foxes. Also, understanding small mammal habitat relationships may help explain kit fox

distribution patterns on NPR-1. Finally, this monitoring program will provide an annual assessment of the abundance and habitat preferences of several species that are candidates for federal protection. Therefore, specific objectives of small mammal monitoring are to (1) assess the annual abundance and species composition of small mammals on NPR-1, (2) determine the effects of physiographic and vegetation characteristics on small mammal abundance and species composition, and (3) determine annual abundance of candidate small mammals.

II. METHODS AND MATERIALS

Small mammal abundance and habitat relationships were assessed by live-trapping at 20 permanent monitoring sites. Five sites were established in each of four physiographic regions (South-Flat, South-Hilly, North-Flat, and North-Hilly) based on slope orientation (north or south side of Elk Hills ridge) and terrain (flat terrain = 0-5° slope, hilly terrain = >5° slope). At each site, 25 trap stations were established at 7.5-m intervals along an east-west transect. Two Sherman live traps were placed at each station for a total of 50 traps per site. Traps were prebaited for three days prior to trapping. During trapping, traps were set in late afternoon, and then checked the next morning. Captured small mammals were identified to species, marked ventrally with a non-toxic marking pen, sexed, aged, weighed, and released at the capture site.

To examine the relationship between small mammals and vegetation characteristics, vegetation sampling transects were established at each monitoring site. These transects were 200-m long, and were placed 10 m south of and parallel to each small mammal trapping transect. Percent cover of grasses, forbs, and all vegetation was estimated by using an ocular point projection device. Five points were sampled at 5-m intervals along the transect for a total of 200 points per site. To estimate annual primary production on sites, 0.25-m² quadrats were established at 20-m intervals along sampling transects. On each quadrat, forbs and grasses were clipped and placed in separate bags. All samples were dried and weighed.

III. RESULTS

Small mammal trapping was conducted for five consecutive nights from September 25-29, 1995. During this period, 564 individuals of nine species were trapped 1,355 times in 4,946 trap-nights (Table 3). Heermann's kangaroo rat (*Dipodomys heermanni*) was the most frequently captured species. Mean capture rate (mean number of individuals captured per 100 trap-nights) for all species combined varied among regions ($F = 3.58$; 3,16 df; $p = 0.04$), and was highest on North-Hilly sites. On individual sites, capture rates were not correlated with either percent total cover or total production.

Mean percent cover did not vary significantly among regions for grass, forbs, or total plant cover (Table 4). Similarly, mean production also did not vary among regions for grass, forbs, or total production (Table 4).

Mean capture rate for all small mammals was significantly lower in 1995 compared to 1993 ($F = 4.38$; 2,57 df; $p = 0.02$), but did not differ significantly from the 1994 rate (Table 5). Conversely, mean vegetative cover was significantly higher in 1995 compared to 1993 and 1994 ($F = 134.8$; 2,57 df; $p < 0.01$), and mean vegetative production was significantly higher in 1995 compared to 1994 ($t = -15.7$, 39 df, $p < 0.01$) (Table 5).

Community composition varied among physiographic regions in 1995 (Table 3). Heermann's kangaroo rat was the most abundant species on hilly sites. Compared to previous years, relatively few short-nosed kangaroo rats (*D. nitratoides*) or San Joaquin antelope squirrels (*Ammospermophilus nelsoni*), both candidate species, were captured (Table 5). San Joaquin pocket mice (*Perognathus inornatus*), also a candidate species, were captured frequently in all regions, but were most abundant in flat terrain. Five other species were infrequently captured. The deer mouse (*Peromyscus maniculatus*) was captured only in hilly regions while the grasshopper mouse (*Onychomys torridus*), also a candidate species, was captured in all regions except North-Flat. Only one federally endangered giant kangaroo rat (*D. ingens*) was captured. Finally, two western harvest mice (*Reithrodontomys megalotis*) and a house mouse (*Mus musculus*) were captured. Mean Shannon diversity index varied among regions ($F = 3.93$; 3,16 df; $p = 0.03$), and was highest for the South-Hilly region and lowest for the North-Flat region (Table 4). Diversity on individual sites was not correlated to either total cover or total production.

Kangaroo rats are the small mammals most frequently preyed upon by kit foxes. Therefore, kangaroo rat abundance may influence kit fox distribution and abundance. Mean capture rate for all kangaroo rat species combined varied significantly among regions ($F = 10.44$; 3,16 df; $p < 0.01$). Kangaroo rat capture rates were significantly higher in hilly regions. Mean ($\pm$ SE) capture rates were 11.8 ± 3.0 and 8.6 ± 1.6 in the North-Hilly and South-Hilly regions, respectively, and 1.5 ± 0.7 and 0.2 ± 0.2 in the South-Flat and North-Flat regions, respectively. Kangaroo rat capture rates on individual monitoring sites were not significantly correlated with either percent total cover or total production. Kangaroo rat captures consisted primarily of Heermann's kangaroo rats. Compared to previous years, relatively few short-nosed kangaroo rats were captured in 1995. Mean ($\pm$ SE) kangaroo rat capture rate was significantly lower in 1995 (5.5 ± 1.4) compared to 1993 (11.3 ± 1.0) or 1994 (14.1 ± 0.8) ($F = 16.34$; 2,57 df; $p < 0.01$).

Table 3. Small mammal captures and diversity indices within four physiographic regions on Naval Petroleum Reserve No. 1, California, 1995.

Treatment	Individuals ^a								Trap-nights	Mean ^b Capture Rate (SE)	Mean ^c Shannon Diversity Index (SE)
	SNKR	HKR	GKR	SJPM	DM	SGM	SJAS	Total			
South-Flat	13	5	1	82	0	3	7	111	1,120	9.2AB ^d (1.3)	0.29A (0.12)
South-Hilly	6	101	0	44	1	10	4	168 ^e	1,250	13.4AB (1.4)	0.42AB (0.06)
North-Flat	2	1	0	83	0	0	2	89 ^e	1,250	7.1B (1.5)	0.08B (0.03)
North-Hilly	0	148	0	36	5	5	2	196	1,246	15.7A (3.3)	0.30AB (0.03)

^a

SNKR = Short-nosed kangaroo rat

HKR = Heermann's kangaroo rat

GKR = Giant kangaroo rat

SJPM = San Joaquin pocket mouse

DM = Deer mouse

SGM = Southern grasshopper mouse

SJAS = San Joaquin antelope squirrel

^b Mean number of individuals captured per 100 trapnights.

^c $H' = \frac{n \log n - \sum f_i \log f_i}{n}$, where f_i is number of individuals of the i th species.

^d Means with the same letter within a column were not significantly different.

^e South-Hilly total includes one western harvest mouse and one house mouse. North-Flat total includes one western harvest mouse.

Table 4. Mean percent cover and mean herbaceous production estimated in four physiographic regions on Naval Petroleum Reserve No. 1, Kern County, California, 1995.

Treatment	Mean Percent Cover (SE)			Mean Production (kg/ha) (SE)		
	Total	Grass	Forb	Total	Grass	Forb
South-Flat	85.5 (3.2)	50.4 (4.8)	34.5 (5.8)	1742.0 (319.6)	1119.4 (258.5)	622.7 (170.9)
South-Hilly	84.3 (3.4)	53.9 (3.4)	27.5 (1.7)	1790.7 (75.6)	1124.2 (91.1)	666.5 (37.1)
North-Flat	86.6 (2.2)	57.1 (0.8)	27.1 (2.7)	1589.7 (125.1)	1124.3 (137.2)	465.4 (68.5)
North-Hilly	86.8 (3.5)	53.2 (1.5)	31.1 (3.5)	1809.0 (137.0)	1185.8 (139.2)	623.2 (36.7)

Table 5. Annual comparison of small mammal capture rates, vegetative cover and production, and small mammal diversity indices on Naval Petroleum Reserve No. 1, Kern County, California, 1993-95.

Year	Individuals ^a									Mean ($\pm$ SE) Capture Rate ^b	Mean ($\pm$ SE) Cover (%)	Mean ($\pm$ SE) Prod. (kg/ha)	Mean ($\pm$ SE) Diversity Index
	SNKR	HKR	GKR	SJPM	DM	SGM	SJAS	Other	Total				
1993	190	375	1	7	51	19	75	-	718	14.4AB ^c (1.0)	70.5B (2.9)	-	0.38 (0.02)
1994	278	418	5	10	12	16	41	-	780	15.6A (0.9)	27.2C (2.3)	269B (29.2)	0.30 (0.03)
1995	21	255	1	245	6	18	15	3	564	11.4B (1.2)	85.8A (1.5)	1733A (88.8)	0.27 (0.04)

^a

SNKR = Short-nosed kangaroo rat
HKR = Heermann's kangaroo rat
GKR = Giant kangaroo rat
SJPM = San Joaquin pocket mouse

DM = Deer mouse
SGM = Southern grasshopper mouse
SJAS = San Joaquin antelope squirrel
Other = House mouse and western harvest mouse

^b Mean number of individuals captured per 100 trapnights.

^c Means with the same letter within a column were not significantly different.

IV. CONCLUSIONS

Small mammal abundance was significantly lower in 1995 despite relatively high vegetative production resulting from above-average annual precipitation. Total annual precipitation was the fourth highest ever recorded in nearby Bakersfield. This abundant precipitation may actually have had a negative impact on small mammals, as has been reported in other arid environments. The causal mechanism resulting in the reduced abundance is not known but could include increased disease prevalence or spoilage of subterranean food caches. Kangaroo rats, particularly short-nosed kangaroo rats, appear to have been significantly impacted.

In addition to lower abundance, a shift in small mammal community composition was observed in 1995. Concomitant with the decline in kangaroo rat abundance was a marked increase in the number of San Joaquin pocket mice captured. This increase may have resulted from competitive release associated with lower kangaroo rat abundance, particularly because pocket mice were captured frequently in all regions but were most abundant in flat terrain where kangaroo rat abundance was lowest. A similar increase in pocket mice was observed in 1991-92 when kangaroo rat abundance also was depressed following several years of below-average precipitation.

Small mammal abundance patterns on NPRC do not appear to explain observed patterns of kit fox abundance. Kit foxes are most abundant in the areas of NPRC with relatively flat terrain. However, within areas of flat terrain, small mammal abundance may influence kit fox demographics. Kangaroo rats are a primary item in kit fox diets (see Section 2.6), and kangaroo rat abundance was relatively low in areas with flat terrain in 1995. This low abundance of kangaroo rats in conjunction with reduced lagomorph abundance (see Section 2.4) may have caused the low reproductive success observed among radiocollared kit foxes in 1995 (see Section 2.2).

2.6 DETERMINE DIET OF KIT FOXES

I. INTRODUCTION

Kit fox scats were collected throughout FY95 to assess the diet of kit foxes on NPRC. Changes in frequency of occurrence of prey items in fox scat may reflect changes in the availability of prey species.

II. METHODS AND MATERIALS

Kit fox diet was determined by analyzing scats. Fresh scats were collected from live-trapped foxes, dried, and sent to a diagnostic laboratory for analysis (Global Ecosystem Managers, Baton Rouge, LA). Differences in the frequency of occurrence for prey items between NPR-1 and NPR-2 were compared using Chi-square tests.

III. RESULTS AND CONCLUSIONS

Of 454 scats collected and analyzed during FY95, kangaroo rat remains occurred in 59.7% of the scats and continued to be the primary prey item consumed by kit foxes (Table 6). Lagomorphs had the second highest frequency of occurrence (29.1%). Remains of other animals found in kit fox scats included: cricetids (4.4%), birds (4.0%), San Joaquin antelope squirrel (2.6%), gophers (2.4%), snakes (1.3%), San Joaquin pocket mice (0.7%), crickets/grasshoppers (0.7%), and beetles (0.4%). The frequency of occurrence of kangaroo rats and lagomorphs (the two primary prey species for kit foxes on NPRC) differed significantly ($X^2 = 23.8$, $df = 1$, $p < 0.001$) between NPR-1 and NPR-2 (Table 6). Kit foxes exhibited a greater use of lagomorph prey as a secondary food item on NPR-2 than NPR-1. This may be due in part to a greater availability of this prey species on NPR-2. Lagomorph densities, based on line transect surveys (Section 2.4), were 86% higher on NPR-2 than NPR-1. An analysis of 1,404 scats collected during winter trapping sessions between 1983 and 1994, has indicated that prey selection by kit foxes has changed considerably on NPRC during this period (Figure 5). Kangaroo rats continued to be the primary prey species found in scats since 1991, whereas lagomorphs were the primary prey species found in kit fox scats between 1983 and 1990.

Figure 5. Frequency of occurrence of lagomorph and kangaroo rat remains found in kit fox scat collected during winter trapping sessions (1983-1994) on the Naval Petroleum Reserves in California, Kern County, California, 1995.

Table 6. Frequency of occurrence (%) of items found in San Joaquin kit fox scat collected and analyzed during FY95, Naval Petroleum Reserves in California, Kern County, California.

Food Item	NPR-1		NPR-2		Total	
	n	%	n	%	n	%
Lagomorph	43	17.9	103	37.5	132	29.1
Kangaroo Rat	165	68.8	141	51.3	271	59.7
San Joaquin antelope squirrel	8	3.3	6	2.2	12	2.6
Fox hair	14	5.8	6	2.2	20	4.4
Cricetidae	11	4.6	14	5.1	20	4.4
Heteromyidae	1	0.4	1	0.4	1	0.2
San Joaquin pocket mouse	3	1.3	1	0.4	3	0.7
Wool	1	0.4	3	1.1	4	0.9
Gopher	7	2.9	5	1.8	11	2.4
Bird	10	4.2	11	4.0	18	4.0
Snake	6	2.5	5	1.8	6	1.3
Cricket/Grasshopper	2	0.8	2	0.7	3	0.7
Beetle	1	0.4	1	0.4	2	0.4
Grass	0	-	6	2.2	6	1.3
Empty	14	5.8	11	4.0	20	4.4
Other	15	6.3	26	9.5	36	7.9
Total	240		275		454	

2.7 GIANT KANGAROO RAT POPULATION MONITORING

I. INTRODUCTION

In 1994, a program was initiated to monitor giant kangaroo rats on NPR-1. Objectives of the program were to (1) monitor annual population trends and (2) collect demographic information that would contribute to regional conservation efforts.

II. METHODS

Monitoring was conducted by live-trapping on a grid plot and assessing the dynamics of a sample of giant kangaroo rat colonies. A 12x12 trapping grid was established in summer 1994 on a site occupied by giant kangaroo rats. Trap stations were established at 15-m intervals and one Sherman live-trap was placed at each station. Two trapping sessions were conducted, one in March and one in August. Traps were prebaited for three nights, and then traps were opened in the afternoon, baited, and checked for six consecutive mornings. Captured small mammals were identified to species, marked ventrally with a non-toxic pen, sexed, aged, weighed, and released at the capture site. All kangaroo rats were also eartagged.

To assess the dynamics of giant kangaroo rat colonies, 11 colonies were located in fall 1994. Colony size was based on the number of active precincts (burrow systems) comprising the colony. Parallel transects were walked through colonies and active precincts were marked with pin flags. Criteria used to identify active precincts included presence of clipped vegetation, haystacking of clipped vegetation, large diameter burrow entrances, vertical burrow entrances, pit caching, and large-sized scats (≥ 7 -mm). Results were compared between 1994 and 1995, and also to preliminary data collected on some colonies in 1993.

III. RESULTS

During the March trapping session, five giant kangaroo rats were captured nine times. Other species captured in the March session included 13 short-nosed kangaroo rats, four San Joaquin pocket mice, and one San Joaquin antelope squirrel.

Trapping in August resulted in one giant kangaroo rat capture. Other species captured included 33 San Joaquin pocket mice, one southern grasshopper mouse, three short nosed kangaroo rats, and six San Joaquin antelope squirrels.

In 1995, the number of precincts in giant kangaroo rat colonies ranged from three to 241. Eight of the 11 colonies that were monitored in 1994 were actively being used in 1995 (Table 7). One other colony in 2B, not surveyed previously, was determined to be active during the 1995 assessments. With the exception of the colonies in 15B and 11G, the number of active giant kangaroo rat precincts per colony decreased from 1994 to 1995. The colony in 11G has increased substantially since 1993 despite being in an area of high oil field activity. The reason for this increase is unknown.

Table 7. Number of giant kangaroo rat precincts in colonies monitored in 1993, 1994, and 1995, Naval Petroleum Reserves in California, Kern County, California.

Number of Precincts			
Colony Location	1993	1994	1995
1B	3	3	0
2B	-	N/A	6
9B	-	46	4
11B	19	16	11
13B	5	43	15
15B	-	36	44
17B	-	10	0
21B/22B	-	186	178
35B	-	93	3
20S	-	4	0
11G	1	95	241
18G	18	68	12

IV. CONCLUSIONS

Giant kangaroo rat populations on the grid plot and in most of the giant kangaroo rat colonies sampled decreased in 1995. Vegetation characteristics were measured in 1995 and will serve as a baseline for determining whether annual fluctuations in environmental conditions affect giant kangaroo rat populations trends.

2.8 BLUNT-NOSED LEOPARD LIZARD MONITORING

I. INTRODUCTION

Previous studies have been conducted on and adjacent to NPR-1 to define the distribution, abundance, and habitat use of the blunt-nosed leopard lizard. Suitable blunt-nosed leopard lizard habitat is found on NPR-1 in flat areas with sparse vegetation and in gentle to moderate sloping areas with washes. Blunt-nosed leopard lizards were found to occur in low numbers and generally

near the borders of the reserve. The objectives of this monitoring task are to: 1) assess the annual abundance of blunt-nosed leopard lizard, 2) determine whether blunt-nosed leopard lizard population trends differ between a developed area and an undeveloped area, 3) assess the effects of habitat features (e.g., roads, pipelines, washes) on blunt-nosed leopard lizard space use patterns, 4) collect demographic data to contribute to on-site and range-wide conservation and recovery efforts, and 5) determine whether annual variation in vegetation characteristics influence blunt-nosed leopard lizard abundance.

II. METHODS AND MATERIALS

Blunt-nosed leopard lizards are monitored using transect surveys conducted on two 16-ha study plots established on NPPRC. One plot is located in a section that is less than 5% developed (4B), and the other is located in a section that is more than 15% developed (18G). Each 16-ha plot is composed of 16-20 parallel transects spaced 20-m apart. Ten surveys are conducted on each plot in the spring to assess the abundance of adults, and again in late summer/early fall to assess the abundance of juveniles. Surveys are conducted when air temperature is optimal for blunt-nosed leopard lizard activity (25°-35°C). When a blunt-nosed leopard lizard is observed, attempts are made to capture it with a noose pole. After capturing a lizard, it is sexed, weighed, measured, and uniquely marked by clipping one or more toes before it is released at the capture site. The location of each lizard observed is plotted to determine the effects of disturbance and topographic features on blunt-nosed leopard lizard distribution within each plot.

Cover was estimated in April to assess differences in percent ground cover between the two monitoring plots and differences between years on the plot located in Section 4B. Six 200-m transects were randomly placed on each study plot. At 5-m intervals, five points were sampled for a total of 200 points per transect.

III. RESULTS AND CONCLUSIONS

Adult Surveys

Surveys were conducted for adult blunt-nosed leopard lizard on the two monitoring plots between May 23 and June 30, 1995. Twenty adult blunt-nosed leopard lizard (ten males, ten females) were observed on the monitoring plot located in Section 4B. The abundance of adult blunt-nosed leopard lizard appeared lower on this plot than in 1993, when 40 adult blunt-nosed leopard lizard were observed during ten transect surveys. This may in part be due to the increase in the amount of vegetative cover likely resulting from above average precipitation this year. Blunt-nosed leopard lizard also were observed along roadsides and washes in 1995 (where more open space could be utilized for foraging), whereas in 1993 the distribution of observations was more ubiquitous. No adult blunt-nosed leopard lizard were observed on the 18G monitoring plot. During adult blunt-nosed leopard lizard surveys on both monitoring plots, there were no sightings of side-blotched lizards (*Uta stansburiana*), which are usually abundant and are an important prey species for blunt-nosed leopard lizard.

Juvenile Surveys

Surveys to assess the abundance of juvenile blunt-nosed leopard lizard were conducted between August 9-31, 1995. Two hatchling and three adult blunt-nosed leopard lizard were observed on the 4B monitoring plot. Similar results were obtained on this plot during juvenile surveys conducted in 1994, when two hatchlings and one adult male blunt-nosed leopard lizard were observed. During juvenile surveys conducted on the 4B plot in 1993, seven juveniles were observed. No blunt-nosed leopard lizard were observed during juvenile surveys on the 18G monitoring plot.

2.9 HOOVER'S WOOLY-STAR POPULATION MONITORING

Hoover's wooly-star (HWS), *Eriastrum hooveri*, was listed as federally threatened in July 1990. EG&G/EM has conducted surveys specifically for Hoover's wooly-star at NPRC since 1988 and staff routinely search for Hoover's wooly-star during preactivity surveys. Currently, there are a minimum of 278 documented Hoover's wooly-star localities on or adjacent to NPRC. The listing of Hoover's wooly-star resulted in increased inventory activities for this species throughout its range. These studies showed that Hoover's wooly-star was more common and widespread than originally believed. Also, numerous Hoover's wooly-star populations occur on public lands where conservation measures are being implemented. As a result, the Bureau of Land Management recently submitted a proposal to the FWS recommending the delisting of Hoover's wooly-star, and information collected at NPRC was used to support this proposal. Research and monitoring of Hoover's wooly-star at NPRC continues, and the resulting data should facilitate decisions regarding future protection and management of Hoover's wooly-star.

During FY95, the body of knowledge regarding Hoover's wooly-star at NPR-1 was increased using four primary sources of data: (1) Hoover's wooly-star permanent reference plots, (2) Hoover's wooly-star experimental plots, (3) Hoover's wooly-star site characterization, and (4) spring surveys for the presence of special status plants. The results from the first two of these sources are described below. Results from the third will be described in a forthcoming research manuscript. Data from the final source, spring plant surveys, is discussed in Section 2.10 of this report.

2.9.1 Monitor Hoover's Wooly-Star Reference Populations

I. INTRODUCTION

The ecological status of Hoover's wooly-star is evaluated annually by monitoring known locations on NPRC. Six permanent reference monitoring plots were established on NPR-1 in 1993 for monitoring Hoover's wooly-star density and detecting habitat changes over time. Two of the plots are located on the lower slopes of the south flank of the Elk Hills formation (sections 12B and

17G), two are near the crest (sections 33R and 33S), and two are on the lower slopes of the north flank of the Elk Hills (sections 20S and 7R).

II. METHODS AND MATERIALS

Density and cover of Hoover's wooly-star and associated grass, forb, and shrub species were measured on the plots in May and June 1995. Data were gathered along three permanent linear transects located within each reference plot. All data were proofed and entered into a computer database, then data were summarized using Paradox 4.0 software. Statistical analyses were performed using SAS/STAT Version 6 software.

III. RESULTS

The density of Hoover's wooly-star in 1995 was 44.8 plants/m² at the reference plot in Section 12B, 22.5 plants/m² at the 17G reference plot, 45.6 plants/m² at the 33R reference plot, 97.5 plants/m² at the 33S reference plot, 19.9 plants/m² at the 20S reference plot, and 0.7 plants/m² at the 7R reference plot (Table 8). On all but the 7R reference plot, Hoover's wooly-star density was higher in 1995 than in 1994. However, Hoover's wooly-star density was lower in 1995 compared to 1993 on all plots except the 33S reference plot. The frequency of occurrence of Hoover's wooly-star averaged 75.5% in 1995 over all the reference plots, with a high of 97.3% at the 33S reference plot and a low of 17.0% at the 7R reference plot (Table 8). Shrub cover in 1995 over all the reference plots averaged 5.8%, grass cover averaged 32.3%, and forb cover averaged 14.1% (Table 9). Increases and decreases in Hoover's wooly-star density and frequency between 1993 and 1995 appeared to correspond with increases and decreases in total vascular plant cover.

Table 8. Density and frequency of occurrence of Hoover's wooly-star on six reference plots on Naval Petroleum Reserve No. 1, Kern County, California, 1993-1995. Standard errors are in parentheses.

Location	Hoover's Wooly-star Density (#/m ²)			Hoover's Wooly-star Frequency of Occurrence (%)		
	1993	1994	1995	1993	1994	1995
South Flank of Elk Hills						
Section 12B	56.4 (39.4)	3.1 (2.1)	44.8 (5.0)	60.0 (0)	26.7 (12.0)	80.0 (8.3)
Section 17G	32.1 (6.1)	1.2 (0.6)	22.5 (9.0)	56.7 (3.3)	13.3 (6.7)	88.7 (1.8)
Crest of Elk Hills						
Section 33R	78.4 (17.0)	3.1 (1.2)	45.6 (7.6)	56.7 (6.7)	23.3 (6.7)	79.3 (2.4)
Section 33S	86.3 (37.4)	2.7 (2.5)	97.5 (27.0)	83.3 (12.0)	30.0 (20.0)	97.3 (1.8)
North Flank of Elk Hills						
Section 20S	22.9 (1.4)	0.3 (0.3)	19.9 (1.6)	70.0 (11.6)	3.3 (3.3)	90.7 (0.7)
Section 7R	48.8 (16.1)	12.4 (1.2)	0.7 (0.3)	73.3 (14.5)	46.7 (16.7)	17.0 (11.0)
Overall Average	54.2	3.8	38.5	66.7	23.9	75.5

Table 9. Total vascular plant cover by lifeform on Hoover's wooly-star reference plots on Naval Petroleum Reserve No. 1, Kern County, California, 1993-1995. Standard errors are in parentheses.

GROWING SEASON	AVERAGE VASCULAR PLANT COVER (%)				
	Shrub	Grass	Forb	Total	PPT ¹
1993	5.3 (3.30)	35.8 (7.10)	21.9 (3.90)	63.2 (3.19)	225
1994	4.1 (1.06)	15.6 (2.20)	3.9 (1.12)	22.2 (3.38)	113
1995	7.9 (1.83)	45.6 (2.78)	16.6 (1.75)	70.1 (2.53)	227
Overall Average	5.8	32.3	14.1	51.8	143 ²

¹October 1994 through March 1995 precipitation; precipitation contributing to current year growth of annual plants.

²Eighteen-year average of October through March precipitation.

IV. CONCLUSIONS

Total vascular plant cover and the density and frequency of occurrence of Hoover's wooly-star decreased in 1994 compared to 1993 levels, and increased in 1995, in response to differences in annual precipitation. The data in Tables 8 and 9 suggest that Hoover's wooly-star in particular, and forbs in general, at the reference plots are more sensitive to changes in precipitation compared to the shrub and grass components of the community. Shrubs appear least sensitive to differences in annual precipitation, probably due to their perennial nature.

2.9.2 Assess Hoover's Wooly-Star Mitigation Strategies

I. INTRODUCTION

Habitats occupied by Hoover's wooly-star (*Eriastrum hooveri*), commonly overlies sedimentary formations containing hydrocarbon deposits; thus, oil and gas development and production activities can result in impacts to habitat suitable for this species. Such impacts primarily consist

of soil disturbance from grading and facility and infrastructure construction activities. To mitigate potential impacts to Hoover's wooly-star, it was necessary to understand the effects of oil and gas developmental activities on Hoover's wooly-star at NPRC. Primary strategies recommended by the FWS and used by DOE/NPRC to mitigate impacts to Hoover's wooly-star populations at NPRC include (1) population avoidance, or if unavoidable, (2) the salvage and replacement of topsoil laden with Hoover's wooly-star seed. Before this study, however, the effects of disturbance on Hoover's wooly-star, the effectiveness of topsoil salvage, and the effects of topsoil salvage timing were unknown. This study was conducted to answer these questions.

II. METHODS AND MATERIALS

With FWS approval, two Hoover's wooly-star study sites were established at NPR-1 in Section 18G in 1993. Prior to the study, Hoover's wooly-star was known to occur in relatively high densities at Site 1 and was believed absent at Site 2. Six replications of five treatments were randomly assigned to the study plots (Figure 6). In summary, the treatments at Sites 1 and 2 were as follows: plots disked in April (before seed maturation) with no topsoil replacement (AN); plots disked in April and covered with topsoil containing Hoover's wooly-star seed (AT); plots disked in July (after seed maturation) with no topsoil replacement (JN); plots disked in July and covered with topsoil containing Hoover's wooly-star seed (JT); and undisturbed control plots (C).

Pre-disturbance baseline data and post-disturbance experimental data were collected from both sites between 1993 and 1995. Density, frequency of occurrence, and cover of Hoover's wooly-star and associated grass, forb, and shrub species were measured. Data were gathered along a permanent linear transect located within each plot. Data were summarized using Paradox 4.0 software. Statistical analyses were performed using SAS/STAT Version 6 software. Mean Hoover's wooly-star densities among treatments were analyzed using one-way ANOVA and Tukey's studentized range test. Mean Hoover's wooly-star densities were compared using two sample *t*-tests. Mean pre-disturbance and post-disturbance Hoover's wooly-star densities were correlated with total vegetative cover, dominant shrub cover (*Atriplex polycarpa*), and dominant grass cover (*Bromus madritensis rubens*).

III. RESULTS

Pre-disturbance

Hoover's wooly-star was present on 28 of the 30 Site 1 plots prior to habitat manipulation. On a Site 2 JN plot transect, one Hoover's wooly-star plant was found in 1993. This plot was subsequently eliminated from the analysis to remove sample bias. Prior to disturbance, mean Hoover's wooly-star density was more than four times higher on the Site 1 JN plot transects compared to the other treatments (Table 10); however, when tested, this difference was found to be not significant. Hoover's wooly-star density was negatively correlated with total vegetative cover, although the relationship was weak ($r^2 = 0.0964$; $p = 0.0950$). Hoover's wooly-star density was not related to *Bromus madritensis rubens* or *Atriplex polycarpa* cover.

Post-disturbance

In 1995, Hoover's wooly-star densities were significantly lower ($F = 6.91$, $df = 4, 29$; $p = 0.0007$) on Site 1 disturbed plot (AN, AT, JN, JT) transects than control plot (C) transects (Table 10). No other statistically significant differences were observed. Hoover's wooly-star density was negatively correlated with total vegetative cover, but not related to *Bromus madritensis rubens*, or *Atriplex polycarpa* cover.

Table 10. Mean Hoover's wooly-star (*Eriastrum hooveri*) pre-disturbance and post-disturbance densities (number of individuals per 0.25 m²) at 2.5-m intervals along 25-m transects at Sites 1 and 2, Naval Petroleum Reserve No. 1, Kern County, California. Standard errors are shown in parentheses.

TREATMENT ³	SITE 1 ¹		SITE 2 ²	
	1993 ⁴	1995	1993 ⁴	1995
AN	1.82A ⁵ (0.7436)	0.85A (0.5051)	0	0A
AT	2.32A (1.5372)	0.52A (0.1956)	0	0.02A (0.0167)
JN	11.18A (7.7719)	1.75A (0.8265)	0	0A
JT	2.47A (1.2785)	0.85A (0.2377)	0	0.18A (0.1641)
C	2.30A (1.0139)	4.37B (0.8758)	0	0.02A (0.0167)

¹Experimental site located within known *E. hooveri* population area

²Experimental site located in area with near absence of *E. hooveri* (in 1993)

³AN = April, no topsoil imported; AT = April, with topsoil; JN = July, no topsoil imported; JT = July, with topsoil; C = control

⁴Pre-disturbance measurements

⁵Means within a column with difference letters are significantly different at $\alpha = 0.05$

IV. CONCLUSIONS

Topsoil salvage may not be an effective strategy for conserving Hoover's wooly-star on small disturbances in occupied habitat. In addition, the timing of topsoil did not significantly affect the density of Hoover's wooly-star emerging from treated plots. Although Hoover's wooly-star was successfully established on previously unoccupied habitat using imported topsoil, the resulting densities were very low. Hoover's wooly-star density was negatively affected by simulated oil field disturbance for the duration of the study (two growing seasons). A draft manuscript describing these results is currently undergoing review, and then will be submitted for publication in *Madroño*.

2.10 ASSESSMENT OF SPECIAL STATUS PLANT SPECIES

I. INTRODUCTION

Surveys for listed plant species were completed in March and April 1995. The primary target species included San Joaquin wooly-threads (*Lembertia congdonii*) which is listed as federally endangered and oil nest-straw (*Stylocline citroleum*) which is a federal Category 2 candidate species. Currently, NPR-1 is the only known location with oil nest-straw in the world. Other species searched for included Hoover's wooly-star (*Eriastrum hooveri*), a federally threatened plant, the federally endangered Kern mallow (*Eremalche parryi* spp. *kernensis*), and recurved larkspur (*Delphinium recurvatum*), a federal Category 2 candidate species.

II. METHODS AND MATERIALS

Comprehensive surveys for the above species were completed on NPRC in Sections 7R, 10R, 12R, 17S, 18S, and 21S (Figure 7). Portions of Sections 23S and 18H were also surveyed. Plants belonging to the *Stylocline* and/or *Filago* genera were collected from each quarter-quarter section where they were observed. Specimens belonging to these genera were collected from 31 localities at NPR-1 and were later sent to a species expert, Dr. James Morefield in Carson City, Nevada, for identification verification. Occurrences of the species listed above were recorded and mapped. Forms documenting new occurrences were sent to the California Department of Fish and Game (CDFG) for inclusion in the California Natural Diversity Data Base.

III. RESULTS

No San Joaquin wooly-threads or white-flowered Kern mallow plants were observed in the areas surveyed. Five populations of recurved larkspur were discovered along the north flank of NPR-1 (Figure 7). This species had not previously been recorded on NPR-1. In addition, undocumented locations with Hoover's wooly-star were discovered. Dr. Morefield determined that specimens from four localities (SE/NW Section 10R; SW/SW Section 10R; SE/SE Section 12R; and NW/NW Section 17S) were oil nest-straw (*Stylocline citroleum*) (Figure 7). Currently, these are the only documented occurrences of oil nest-straw in the world.

IV. CONCLUSIONS

In gathering data about the occurrence and distribution of these special status species, DOE/NPRC has compiled baseline information necessary for the species' conservation and recovery. It is recommended that the ongoing effort to completely inventory special status plants at NPRC continue.

Figure 7. Results of 1995 surveys for special status plants at Naval Petroleum Reserves in California, Kern County, California, 1995.

3. CONDUCT PREACTIVITY SURVEYS FOR NPRC PROJECTS

3.1 CONDUCT ENDANGERED SPECIES AND CULTURAL RESOURCE PREACTIVITY SURVEYS

I. INTRODUCTION

As a result of the formal consultation between DOE/NPRC and FWS, the preactivity survey program was developed on NPR-1 to minimize or eliminate impacts of petroleum-related activities to endangered species and their habitats. The preactivity survey program has been expanded to cover projects on NPR-2 as well.

II. METHODS AND MATERIALS

Preactivity survey request forms are completed and transmitted to EG&G/EM by the requestor, and in cases of emergency, the request may initially be made verbally. Upon receipt, the request forms are logged in and an EG&G/EM biologist is assigned the survey. Once all pre-survey arrangements have been made, the designated biologist conducts the survey. During preactivity surveys the biologist examines the anticipated impact area and an adjacent buffer zone for evidence of threatened and endangered species. Specifically, the biologist looks for known San Joaquin kit fox dens, potential San Joaquin kit fox dens, giant kangaroo rat burrows, blunt-nosed leopard lizards, washes representing potential blunt-nosed leopard lizard habitat, and Hoover's woolly-star. Observed kit fox dens, giant kangaroo rat burrows, blunt-nosed leopard lizard habitat, and some populations of Hoover's woolly-star are then identified with wooden stakes and flagging to create avoidance zones. Once the preactivity survey has been completed, the biologist contacts the requestor to verbally report any findings and make recommendations to refrain from disturbing the area marked. The biologist also completes the survey request form which lists any findings and recommendations. A copy of this form is sent to the requestor and Environmental Services.

Follow-up surveys are conducted by an EG&G/EM biologist, usually within three months of the original survey to document whether endangered species or their habitat were impacted, recommendations were followed, and activities were confined to the surveyed project area. Recommendations that are not followed are reported in a monthly summary letter and the requestors are informed of the survey results.

III. RESULTS AND CONCLUSIONS

During FY95, 674 preactivity surveys were conducted on 521 acres (211 hectares) on or adjacent to NPRC. Of these, 107 surveys were classified as emergencies (projects requiring a preactivity survey within three working days). Most emergency surveys were conducted for cleanups, pipelines, new well pads, and other miscellaneous construction projects. Compared with FY94,

274 more surveys were conducted in FY95 (a 68% increase). There was a 65% increase in the number of acres surveyed, from 315 in FY94 to 521 in FY95.

Recommendations to prevent potential impacts to endangered species, their habitats, or revegetated areas were made on a total of 171 (25%) projects in FY95. New well pads, pipelines, and other miscellaneous construction or maintenance projects were most often affected. Alterations usually included the establishment of avoidance zones around dens and burrows, restriction of driving on revegetated sites and in washes, and establishment of avoidance zones around populations of Hoover's woolly-star. Most cleanup sites were restricted to the use of hand tools only.

A total of four known kit fox dens and 130 potential kit fox dens were identified during surveys in FY95. Six washes representing potential blunt-nosed leopard lizard habitat were identified. At 83 survey sites populations of Hoover's woolly-star were identified. Evidence of giant kangaroo rats was found at 24 survey sites. On a firebreak survey evidence of a possible cultural resource site was found, but this site was avoided during the work activities.

All resources were avoided except for the excavation of six potential kit fox dens and several giant kangaroo rat burrows, located at two new well pad sites. The entrances to all dens were dusted for three consecutive nights prior to excavation to assess if the dens were being used by kit foxes. No wildlife was found in any of the excavated dens.

Follow-up surveys were conducted on all of the projects where evidence of endangered or threatened species, their habitats, or revegetated areas were encountered during the initial preactivity survey. In addition, follow-up surveys were conducted for most cleanups and some survey areas where no endangered species were found, but where there were causes for concern. Recommendations were not followed on eight projects completed in FY95 for which recommendations were made. These incidents did not result in any take of listed species, and operators and their supervisors were contacted to correct the problems.

In FY95, the evaluation of the efficacy of the preactivity survey program was completed and submitted to DOE/NPRC.

Table 11. Summary of endangered species and cultural resource preactivity surveys conducted during FY95 on the Naval Petroleum Reserves in California, Kern County, California.

	Project Type							FY95 Totals
	Clean-ups	Corrosion Protection	Pipelines	Powerlines	New Well Pad	Well Pad Upgrade	Other	
Surveys Conducted	119	16	108	37	55	6	333	674
Acres Surveyed	51	3	121	63	96	3	184	521
Known Kit Fox Dens	0	0	1	0	0	0	3	4
Potential Kit Fox Dens	5	0	34	11	54	0	26	130
Giant Kangaroo Rat Burrows	0	0	3	14	4	0	3	24
Blunt-nosed Leopard Lizards Observed	0	0	0	0	0	0	0	0
Washes Observed	4	0	0	0	2	0	0	6
Hoover's wooly-star Populations	8	3	16	8	13	0	35	83
Possible Cultural Resource Site	0	0	0	0	0	0	1	1

3.2. GIANT KANGAROO RAT RELOCATIONS FROM NEW WELL SITES

I. INTRODUCTION

As part of the FY95 NPR-1 drilling program, a number of Shallow Oil Zone wells were proposed for the southeastern flank of NPR-1, particularly in 10G and 11G. Above average precipitation

in recent years has resulted in a noticeable increase in the giant kangaroo rat population, especially in this area (see Table 7). Giant kangaroo rats were present on four sites proposed for well pads in these sections. On two of the sites, the positions of the well pads were altered to avoid impacts to the giant kangaroo rat precincts. However, two sites (wells 56-11G and 27H-11G) could not be altered to avoid precincts. Permission was received from FWS to relocate giant kangaroo rats from these sites.

II. METHODS AND MATERIALS

Giant kangaroo rat precincts were pin flagged, and small mammal traps were placed and baited near each precinct for a total of five nights. The traps were checked each morning and the giant kangaroo rats that were caught were eartagged, weighed, sexed, aged, and returned to the traps to be transported to the EG&G/EM office.

Each giant kangaroo rat was placed in a separate 10-gallon tank which contained sand and a housing container. The giant kangaroo rats were provided with bird seed and lettuce for moisture. After the trapping session was completed, EG&G/EM employees excavated each of the precinct sites where traps had been placed to ensure that no giant kangaroo rats were present. Upon completion of the well pads, EG&G/EM biologists constructed artificial burrows near the well pads for each captured giant kangaroo rat. Artificial burrows consisted of a 30-cm square chamber approximately 50 cm below ground, and two 8-cm diameter cardboard tubes connecting the chamber with the surface. The giant kangaroo rats were then released into the artificial burrows. Following release, trapping was conducted at artificial burrows to assess the success of the relocation.

III. RESULTS AND CONCLUSIONS

At well pad 56-11G, 15 giant kangaroo rats were captured during the trapping session. Two additional giant kangaroo rats were captured during the excavation of the precincts. The captured individuals were successfully maintained in captivity for two weeks. Approximately five weeks after the giant kangaroo rats were released into the artificial burrows, EG&G/EM biologists conducted a trapping session for four nights. During this session five relocated individuals and twelve other giant kangaroo rats were captured. Two of the relocated animals and seven of the other giant kangaroo rats were observed entering the artificial burrows upon release. At well pad 27H-11G, five giant kangaroo rats were captured and retained in captivity. The captured animals were returned to the well pad area within two weeks and released into artificial burrows. Future trapping will be conducted at 27H-11G to assess success.

3.3 THIRD PARTY PROJECTS

I. INTRODUCTION

Other companies occasionally conduct projects that cross a portion of NPR-1 or on NPR-2 lands leased from the government. These projects are classified as third party projects. EG&G/EM provides assistance on these projects to meet federal regulations pertaining to endangered species and cultural resources.

II. METHODS AND MATERIALS

When requested by NPRC, EG&G/EM reviews biological archeological assessments prepared by third party proponents or their consultants to ensure that these documents are consistent with NPRC policies and requirements regarding protection of listed species and cultural resources. EG&G/EM then prepares these documents for submission by DOE to FWS or the State Historic Preservation Officer (SHPO) on behalf of the third party. The cultural resource activity results are described in Section 3.4.

III. RESULTS AND CONCLUSIONS

In FY95, EG&G/EM drafted and reviewed biological assessments, conducted consultations with federal agencies, and provided other necessary technical support for the following projects: Chevron sump abandonments in Sections 22B and 2D; a Chevron 12kV powerline project; the ARCO Pipe Line Company's proposed pipeline project; and the West Kern Water District's proposed pipeline 101.

For a proposed Chevron CO₂ flood project, EG&G/EM also conducted a biological survey for endangered species and completed a biological report in addition to the above mentioned support. EG&G/EM also provided on-site biological support for the City of Taft when a sewer line crossing the Sandy Creek Wash threatened to rupture. In July 1995, EG&G/EM reviewed and submitted a final compliance report for the 5M/6M 12kV powerline.

3.4 CULTURAL RESOURCES SUPPORT

I. INTRODUCTION

Prehistoric and historic cultural resources found on NPRC are protected under the National Historic Preservation Act of 1966 (as amended) and the Archeological Resources Protection Act of 1979 (Public Law 96-95). Section 106 of the National Historic Preservation Act requires federal agencies to take into account the effects of agency actions on historic properties. Section 110 requires all federal agencies to carry out programs in accordance with the National Historic Preservation Policy. EG&G/EM coordinates cultural resource protection efforts at NPRC.

II. METHODS AND MATERIALS

In order to comply with the above federal regulations, qualified archaeologists are contracted to conduct surveys for all third party projects. DOE/NPRC projects conducted on NPR-1 are surveyed by EG&G/EM personnel who have received training from a qualified archeologist.

Cultural resource surveys on NPR-1 are conducted in conjunction with the preactivity survey program. If a potential cultural resource site is found, the Cultural Resource Management Administrator examines the site to see if the artifacts or site appear to be fifty years old or more. If the site appears to be fifty years old or more, a qualified archaeologist is contacted to conduct a survey. The results of these surveys are sent to SHPO for their comments regarding potential impacts and mitigation measures.

III. RESULTS AND CONCLUSIONS

FY95 cultural resource projects are summarized in Table 12.

Surveys were conducted for two proposed Chevron sump abandonments in sections 22B and 2D, and the surveys for these projects were completed in August 1991. No cultural resources were found during the surveys, and concurrence of no effect were received from the SHPO. A survey for the Chevron 12kV powerline project was completed in November 1994. No cultural resources were found during the survey, and a concurrence of no effect was received from the SHPO. A survey for Chevron's CO₂ flood project was conducted in April 1995. No cultural resources were found during the survey. A request to the SHPO for a concurrence of no effects was sent on August 9, 1995. The 30-day waiting period expired without receipt of any comments from the SHPO.

A survey was conducted for the West Kern Water District's pipeline 101 replacement project in May 1994. Several artifacts were found; however, none were judged to fit the criteria for eligibility for listing in the National Register of Historic Places (NRHP). A concurrence from the SHPO was received.

A survey was conducted in June 1993 for a proposed powerline project in sections 5M and 6M. The project route that was used had the potential to effect a prehistoric site. Testing of that site was conducted and the contract consultant judged the site to be ineligible for listing in the NRHP. A determination of no adverse effect was received from the SHPO.

A survey for the proposed ARCO Pipe Line Company pipeline was conducted in May 1994. The project was for a crude oil pipeline replacement. The field survey found no evidence of cultural resources along the pipeline, and a concurrence from the SHPO was received.

A survey for the proposed 26S East landfill cleanup was completed on August 8, 1994. Several artifacts were found, however, none were considered significant. This assessment was sent to SHPO, and a concurrence of no effect was received.

EG&G/EM provided a final draft to DOE/NPRC of the NPR-1 Programmatic Agreement (PA) and the Cultural Resource Management Plan (CRMP). Once the PA and the CRMP are approved by DOE/NPRC and CPDN, they will be sent to the SHPO and the Advisory Council on Historic Preservation for their review and approval.

Table 12. Summary of cultural resource compliance issues completed during FY95 on the Naval Petroleum Reserves in California, Kern County, California, 1995.

Survey Date	Project Description	Section	# Arch. Sites	# Isolates	SHPO ¹ Review
August 1991	Chevron Sump Abandonment ²	22B	0	0	Received a "no effect" concurrence from SHPO on 07/10/95
August 1991	Chevron Sump Abandonment ²	2D	0	0	Received a "no effect" concurrence from SHPO on 08/09/95
June 1993	5M/6M 12kV Powerline Project	6M	1	0	Received a "no adverse effect" concurrence from SHPO on 09/08/95
May 1994	ARCO Pipe Line's Proposed Pipeline Replacement ²	18H	0	0	Received a "no effect" concurrence from SHPO on 11/9/94
May 1994	West Kern Water District Proposed Pipeline 101 ²	32G	2	2	Received a "no adverse effect" concurrence from SHPO on 12/8/94
August 1994	26S East Landfill Closure ³	26S	1	0	Received a "no adverse effect" concurrence from SHPO on 03/09/95
November 1994	Chevron 12kV Powerline Project ²	26Z	0	0	Received a "no effect" concurrence from SHPO on 05/04/95
April 1995	Chevron CO ² Flood Project ²	26B, 25B, 36B, 1C	0	0	Letter for concurrence sent to SHPO on 08/09/95. 30 day period expired, concurrence implied

¹State Historic Preservation Officer

²Third-Party Projects

³This project located in 25S, but the location is historically referred to as 26S E. Landfill

3.5 NPR-1 3D SEISMIC SURVEY

I. INTRODUCTION

DOE/NPRC conducted a 3D noise source test (Test) on June 16, 1995, between Sections 8R and 19R in the western part of NPR-1, Kern County, California (Figure 8). The purpose of the Test was to determine the efficacy of a full-fold coverage seismic survey of the western portion of NPR-1. EG&G/EM staff provided endangered species and cultural resources compliance support services for the Test. The Test consisted of drilling nine shotholes at two locations, stringing two lines of geophone arrays, placing and backfilling explosive charges in the holes, detonating the charges, and recording the results.

Based on the Test results, DOE/NPRC is now preparing to conduct a pilot 3D seismic survey (Pilot Survey) of the western part of NPR-1 (Figure 8). The Pilot Survey area consists of approximately 36 km² including DOE/NPRC administered lands, Bureau of Land Management administered lands, Chevron U.S.A lands, and other private lands. The Pilot Survey will require: land surveying of geophone and shothole locations; hydraulic drilling of approximately 700 11-cm diameter shotholes; loading the holes with dynamite; backfilling the holes; hand placement of geophone lines; detonating the charges; and recording the energy releases. As with the Test, EG&G/EM provided endangered species and cultural resources compliance support services for the Pilot Survey program during FY95.

II. METHODS AND MATERIALS

EG&G/EM staff attended Test and Pilot Survey project meetings during FY95. Guidance and background information was provided to DOE/NPRC, Chevron U.S.A, and project personnel with regard to compliance with the state and federal endangered species acts and relevant cultural resources legislation and regulations. During the meetings, resource avoidance and impact scenarios were discussed and plans for consultation with FWS and SHPO were made. Prior to the Test, an EG&G/EM staff member attended group field visits to the proposed study area and conducted endangered species and cultural resource preactivity surveys of the proposed shothole locations. Following detonation and project cleanup, the EG&G/EM staff member conducted follow-up surveys of the shothole locations and assessed impacts to natural habitat resulting from the hand placement and removal of geophone lines. Maps were provided to the seismic project manager delineating known Hoover's woolly-star (a federally-threatened plant species) population locations and previously recorded archaeological sites in and near the project area. A map was provided which showed areas previously surveyed and not surveyed for archaeological resources. EG&G/EM staff also directed the completion of a cultural resource records search of the Pilot Survey area.

III. RESULTS

No impacts to endangered species or their habitat or to cultural resources were observed during the endangered species preactivity surveys or the follow-up surveys. Impacts to vegetation resulting from hand placement and removal of geophone lines were barely discernable and were considered insignificant. No Hoover's woolly-star localities are reported to occur in the Pilot Survey area; however, the species is likely to occur there based on habitat characteristics of the area.

Two archaeological sites, a historic railroad grade (P-15-0002190), and a historic well with associated kilns (CA-KER-3171H), were identified during the records search as occurring within the Pilot Survey area. Approximately 8,550 acres (3,460 hectares) of the total area have not been surveyed for cultural resources and will require comprehensive (100%) survey coverage prior to drilling of shotholes. The Center for Archaeological Research (CAR) determined that the segment of the railroad grade on NPR-1 is not eligible for the NRHP. CAR's report will be reviewed by DOE/NPRC, then forwarded to SHPO for comments. Further consultation with SHPO for this project is not anticipated because DOE/NPRC intends to avoid CA-KER-3171H and any additional resources found during the comprehensive survey.

IV. CONCLUSIONS

No impacts to endangered species or cultural resources were observed during the endangered species preactivity surveys and follow-up surveys for the 3D noise source test. Potential impacts to endangered species will be mitigated during the Pilot Survey by adhering to mitigation measures stipulated in a forthcoming FWS Biological Opinion.

The segment of site P-15-0002190 which crosses NPR-1 has been determined ineligible to the NRHP and is not considered significant. DOE/NPRC intends to avoid site CA-KER-3171H and all sites found during the comprehensive survey in order to avoid impacts to any potentially significant cultural resources during the Pilot Survey. To identify potentially significant resources in the Pilot Survey area, CAR has been requested to perform a comprehensive (100%) cultural resources survey of the area plus a 100-m buffer. The survey is scheduled to begin in early FY96, and the results will be submitted to SHPO for consultation.

Figure 8 Map depicting Western Naval Petroleum Reserves No. 1 3D Seismic Survey Program features, Kern County, California, 1995.

4. HABITAT RECLAMATION AND MANAGEMENT

4.1 MONITORING RECLAMATION SUCCESS

I. INTRODUCTION

The success of the habitat reclamation program at NPRC has been monitored since 1987. Monitoring includes qualitatively evaluating the vegetative recovery on reclaimed sites compared to adjacent undisturbed sites.

II. METHODS AND MATERIALS

In FY95, 50 sites which had been reclaimed in 1985 were qualitatively evaluated. These sites were randomly selected and were representative of different types of disturbance (cut and fill slopes, well pads, roads, pipelines, and borrow areas). Qualitative estimations were calibrated by quantitatively sampling percent vascular plant cover, litter, and bare ground at ten Blowout Study plots. Qualitative estimations were adjusted by comparing the results of previous qualitative estimations for a plot with the actual quantitative results. Percent vascular plant cover, cover by lifeform, litter, and bare ground were estimated at the 50 sites and evidence of use by wildlife was recorded. In addition, total vascular plant cover was estimated on an undisturbed site adjacent to each reclamation site. Data were entered into a Paradox 4.0 computer database, then summarized.

III. RESULTS

Total vascular plant cover averaged 63.1% for the sample of 1985 reclamation sites. Litter cover averaged 8.0% and bare ground cover averaged 29.1%. Vascular plant cover was nearly twice as high on the sites in 1995 (63.1%) than in 1994 (35.4%), probably due to a corresponding increase in precipitation. To be considered successfully revegetated, sites at NPRC must equal or exceed 70% of the vascular plant cover on adjacent undisturbed sites. Forty-nine of the 50 sites sampled met this criterion. In FY95, total vascular plant cover on 1985 reclamation sites had an average of 82.1% of the average cover observed on adjacent undisturbed sites (76.9%). Of the total vascular plant cover, shrubs, grasses and forbs comprised an average of 26.4%, 45.6%, and 27.8% of the total, respectively. Small mammal burrows were observed on all of the sites sampled, but no predator dens were observed. Evidence of herbivory was found on 94% of the sites. Lagomorph, rodent, kit fox, and coyote scat were observed at 92%, 92%, 0%, and 18% of the sites, respectively.

IV. CONCLUSIONS

All except one of the 1985 reclamation sites sampled during FY95 had 70% or more of the total vascular plant cover found on adjacent undisturbed sites and are now considered successfully revegetated. These sites exhibited use by wildlife, especially rodents, lagomorphs, and coyotes.

5. RESEARCH AND DEVELOPMENT

5.1 FACTORS INFLUENCING THE DISTRIBUTION AND ABUNDANCE OF KIT FOXES ON NPRC

I. INTRODUCTION

Information collected from live-trapping foxes is useful not only for determining population size (Section 2.1), but it also provides an opportunity for investigating the spatial distribution of these animals. Fox captures have not been evenly distributed over NPRC and there probably are biological, physiographic, or land use factors underlying the distributional patterns. Therefore, this study was initiated to investigate the effects of variables such as oil field development, topographic ruggedness, and coyote and lagomorph abundance on kit fox distribution. Investigating the distribution and abundance of kit foxes in relation to these variables may yield insight into which habitat features are important for the long term persistence of kit foxes and help determine what constitutes high quality habitat for foxes. Determining the habitat requirements and preferences of foxes may help identify new strategies to enhance habitat for kit foxes and assess the effects of oil field development and other land uses on this species.

II. METHODS

Multivariate models will be used to determine whether the selected factors have influenced fox distribution. Many of the dependent and independent variables were calculated using data from long-term monitoring tasks that are described in other sections of this report.

Dependent Variables

Information on fox abundance was gathered during previous live-trapping sessions (see Section 2.1 for capture methodology). The number of adult foxes captured per trap site and the number of years that adult foxes were captured at each trap site will be used as dependent variables.

Independent Variables

Several independent variables will be investigated during this project. As analyses progress, some of the variables that do not prove useful in explaining fox distribution may be dropped from the analyses.

The percentage of land in each trap site area affected by oil field development was calculated by overlaying transparent dot grids on 1:10,000 scale aerial photographs taken in 1988. Disturbance levels were determined for each quarter section on or adjacent to NPRC. The percentage of each quarter section burned was determined by reviewing EG&G/EM and Kern County Fire

Department records and aerial photographs. A dot grid was used to determine the percentage of each quarter section burned.

Within the boundaries of NPR-1 and the DOE/NPRC sections of NPR-2, it is not lawful to graze sheep. However, because NPR-2 and some areas of NPR-1 are not fenced, there is little deterrent to trespass grazing. Therefore, the proportion of each quarter section grazed by sheep was estimated by determining what proportion of each quarter section was within the boundaries of the NPR-1 fence.

Coyote abundance and lagomorph abundance was indexed for quarter sections that contain scent stations and lagomorph transects, respectively. Methods for determining coyote abundance are found in section 2.3 and methods for determining lagomorph abundance are found in section 2.4.

Distance to urban development, permanent watering basins, and the California Aqueduct were determined by estimating the distance from the center of each quarter section to each of these types of developments.

III. RESULTS

No significant progress was made on this project in FY95 due to staff time being redirected to other tasks. Planned FY96 activities include completion of data analyses and preparation of a manuscript for publication.

5.2 BLOWOUT ASSESSMENT

I. INTRODUCTION

Well 313H-26R, located near the center of Naval Petroleum Reserve No. 1, blew-out on June 21, 1994 resulting in deposition of oil downwind (south) of the well site. The well was capped on June 26, 1994, and site evaluations of injury to natural resources were initiated on June 27, 1994. Some light oil spray was found as far as 13 km south of the well, but the most heavily affected area was within 0.8 km of the well. Even within the most heavily affected area, there were no pools of oil and the oil that was present on the ground quickly formed a dry crust not more than 0.3 cm thick on the soil surface. A plan to further assess damages to biota and restore or remediate habitat affected by oil spray was completed and implemented in August 1994.

II. METHODS

Kangaroo rats were collected from a heavily oiled area, a lightly oiled area, and a control area to determine if they had ingested crude oil hydrocarbons. The heavily oiled and lightly oiled sites were 0.5 km and 1.9 km, respectively, south of the well. The control site was located

approximately 0.3 km northeast of the well in an area that was not sprayed with oil during the blowout.

Three male Heermann's kangaroo rats were collected from each of the three sites. The collected kangaroo rats were sacrificed and their livers were removed, placed in glass vials, and frozen. To assure an adequate quantity of tissue for the analyses, the three liver samples for a given site were combined into one composite sample. Liver samples were sent to a laboratory to characterize any crude oil hydrocarbons found in the tissues. To determine if hydrocarbons found in kangaroo rat livers matched hydrocarbons in the oil released during the blowout, crude oil and soil samples were also collected for analysis. One soil sample was collected at the surface (upper 0.6 cm of soil) at each of the three trapping sites. After a surface sample was collected, a sub-surface sample was collected at the same location but at a depth of 0.6 to 5 cm below the surface. A crude oil sample was collected from a nearby well (312A-26R) that was extracting oil from the same geologic formation as well 313H-26R. The crude oil and soil samples were placed in glass jars and frozen until they were transported to a laboratory for analyses.

The most heavily oiled area was divided into three sites, which ranged in size from five to nine hectares. In October 1995, the restoration techniques of surface modification and bioremediation were implemented on two of the sites. Surface modification consisted of lightly scarifying the soil surface by dragging chain-link fence material behind a light weight tractor. Bioremediation included scarifying the soil surface and applying a slow-release fertilizer designed to stimulate the action of soil microbes, which break down the oil. No treatment occurred on the third site so that natural recovery of the plant and animal communities could be monitored. In addition, a fourth site was established 0.5 km northwest of well 313H-26R in an unaffected (control) area. Two 7 x 7 trapping grids (10-m spacing) were placed within each of the four sites to monitor small mammal and invertebrate abundance. One grid was placed in a drainage and one grid was placed on a hillside with a northeastern aspect. Each of the 49 stations per grid contained one Sherman non-folding live trap placed under a metal "tent." Traps were baited and operated for three consecutive nights. Each captured rodent was eartagged, weighed, and sexed before release at its capture site. Population size of Heermann's kangaroo rats at each grid was determined using the jackknife estimator of program CAPTURE.

Ground dwelling invertebrates were monitored during small mammal trapping. Darkling beetles and ants are common invertebrate species at NPR-1 and they are attracted to bait used for trapping rodents. Therefore, the trapping sessions also provided an opportunity to assess the abundance of these species. A count of the number of darkling beetles and the presence or absence of ants within a 1-m radius of each trap was recorded each time a trap was checked. The average number of trapsites with ants observed per grid each day and the average number of beetles per grid each day were used to compare abundance of these invertebrate species between the study sites.

Six 70-m transects were established between the rows of each trapping grid. Herbaceous production was estimated by harvesting, drying, and weighing all grass and forb plants within six 0.25-m² plots spaced at 10-m intervals along each transect. Vascular plant cover was estimated

by determining the intercept of 100 points along each transect using an ocular point projection device. Points were recorded as intercepting either vegetation (by species), litter, or bare ground.

Saltbush survival was determined by randomly selecting and marking 50 living desert saltbush plants within or near each of the grids in September 1994 and revisiting these plants in June 1995. Saltbush vigor was determined by photographing the shrubs from above and later projecting the images onto a grid. The number of grid intersections that intercepted green foliage was divided by the total number of grid intersections that intercepted the shrub to obtain an index of vigor. A z-test was used to test for differences in population estimates of kangaroo rats. A Kruskal-Wallis test and Tukey-type multiple comparison test was used to test for differences between grids in the number of beetles seen per day, average number of trapsites with ants per day, and average herbaceous production and cover. Differences in shrub vigor were determined using analysis of variance and a Tukey multiple comparison test.

II. RESULTS

Ingestion of Hydrocarbons by Small Mammals

Three male Heermann's kangaroo rats were collected from a heavily oiled site, a lightly oiled site, and a control site during a trapping session on July 8, 1994. The stomach contents of the kangaroo rats ranged in color from pale yellow to light brown. There were small black or brown flecks in the stomach contents from one kangaroo rat from the heavily oiled area and in two stomachs from the control area. Based on visual inspections, there were no clear differences in stomach contents between kangaroo rats from oiled and control sites.

Liver tissues were also collected from the rats on July 8, 1994. Sterane, terpane, monoaromatic steranes, and triaromatic steranes were identified in livers from kangaroo rats inhabiting the oiled areas (Table 13). The composite liver sample from the heavily oiled site had approximately two to ten times the concentration of these hydrocarbons as the sample from the lightly oiled area. These hydrocarbons were either found in trace amounts or not detected in the composite liver sample from the control site. C_{25} - C_{35} alkane levels were also significantly higher in tissues collected at the heavily oiled site than at the lightly oiled and control sites. However, these alkanes were not very useful in estimating crude oil uptake because they were dominated by hydrocarbons typical of epicuticular plant waxes. There was no evidence of incorporation of polycyclic aromatic hydrocarbons or low molecular weight n-alkanes in the liver tissues from any of the sites.

Table 13. Levels of hydrocarbons (ppm) found in liver samples from kangaroo rats collected from a control site and two sites oiled during the blowout of well 313H-26R, Naval Petroleum Reserve No. 1, Kern County, California.

Sample	C ₂₅ -C ₃₅ Alkanes	Steranes	Terpanes	*MAS	*TAS
Liver (control)	0.26	Trace	Trace	Trace	Not Detected
Liver (lightly oiled area)	0.70	0.39	0.35	0.79	0.11
Liver (heavily oiled area)	1.30	0.86	0.73	0.99	1.01

* MAS = monoaromatic steranes; TAS = triaromatic steranes

Hydrocarbons were extracted from all soil samples but the highest levels were found in surface soil from the heavily oiled site. Surface soil from the heavily oiled area had approximately 50 times the concentration of hydrocarbons as the lightly oiled area and 1,000 times the concentration of the control site (Table 14). Subsurface samples at both oiled sites only showed slight evidence of contamination with crude oil hydrocarbons. Hydrocarbons found in control samples were primarily from plant waxes but there were some very low level petroleum hydrocarbons at this site also.

Table 14. Weight and concentration of extracted hydrocarbons* from soil samples taken at a control site and two sites oiled during the blowout of well 313H-26R, Naval Petroleum Reserve No. 1, Kern County, California.

Site	Sample Depth	Sample Weight (g)	Weight of Extract (mg)	Concentration of Extract (ppm)
Control	Surface	50.0	0.35	7.0
Control	Sub-surface	50.1	0.24	4.8
Lightly Oiled	Surface	50.3	6.93	138.6
Lightly Oiled	Sub-surface	50.0	0.54	10.8
Heavily Oiled	Surface	50.1	365.80	7,300.0
Heavily Oiled	Sub-surface	50.3	0.54	10.7

* Extract may contain some lipid material in addition to hydrocarbons.

Results indicated that oil from well 312A-26R (same geologic formation as 313H-26R) matched hydrocarbons extracted from soil samples and kangaroo rat livers. Soils at the heavily and lightly oiled sites were contaminated with crude oil identical to that from well 312A-26R and the distribution of hydrocarbons in the crude oil and soils were also very similar to the distribution in the kangaroo rat livers. A manuscript reporting the results of the small mammal liver analysis has been submitted and accepted for publication.

Small Mammal and Invertebrate Abundance

Six trapping sessions were conducted during the study. One pre-treatment trapping session was conducted in October 1994. Post-treatment sessions were conducted in November 1994, December 1994, and then quarterly until September 1995.

During the study, 905 small mammals were captured and trapping success was 52.5% (3,698 captures/7,042 trapnights). Heermann's kangaroo rats were the most frequently captured rodent (91.5% of individuals), followed by San Joaquin pocket mice (4.0%), deer mice (2.1%), southern grasshopper mice (1.3%), Nelson's antelope squirrels (0.6%), and short-nosed kangaroo rats (0.3%).

Population estimates of Heermann's kangaroo rats at drainage grids were significantly higher on the control grid than on the other grids during the October, November, and December sessions (Figure 9(a)). Population estimates declined on all grids in March and the only difference was that the natural recovery grid had a higher population than the bioremediation grid. In June, the population on the control grid was significantly higher than the bioremediation grid. By September 1995 there were no differences in population estimates.

In October 1994, population estimates of Heermann's kangaroo rats at the hillside grids were higher on the grid scheduled to receive the bioremediation treatment than on the grid that was to receive the surface modification treatment (Figure 9(b)). In November 1994, the population estimate on the control grid was significantly higher than the estimate on the surface modification grid and the bioremediation grid. In December 1994, the control grid was significantly higher than the surface modification grid. In March, June, and September 1995, estimates on the surface modification grid were significantly smaller than all other grids. The only other significant difference occurred in September, when the population estimate from the control grid was higher than that for the natural recovery grid.

On drainage grids, darkling beetle abundance (average number seen per day) was significantly higher on the control grid than on the natural recovery grid in October 1994 (Table 15). On the hillside grids, the abundance of darkling beetles was significantly higher on the control grid than the surface modification grid in November 1994 (Table 16). There were no other significant differences in beetle abundance. There were no significant differences in ant abundance between the grids in any session.

Figure 9. Estimates of population size (with 95% confidence intervals) of Heerman's kangaroo rats at three oiled and one control trapping grids established in drainages (a) and hillsides (b) at Naval Petroleum Reserve No. 1, 1994-1995.

Table 15. Average (SE) number of darkling beetles seen per day at three trapping grids oiled during the blowout of well 313H-26R, and one control grid established within drainages at Naval Petroleum Reserve No. 1, Kern County, California.

BEETLE ABUNDANCE: DRAINAGE GRIDS						
Grid/Treatment	Trapping Session					
	10/94	11/94	12/94	3/94	6/95	9/95
Surface Modification	29.7AB ^a (3.2)	20.7 (0.9)	0.3 (0.3)	6.0 (0.6)	2.3 (1.2)	3.7 (2.0)
Natural Recovery	12.7A (3.3)	24.7 (4.2)	0.3 (0.3)	2.7 (1.2)	4.7 (2.3)	13.0 (9.6)
Bioremediation	14.3AB (1.3)	16.7 (3.8)	0.3 (0.3)	3.0 (0.6)	2.7 (1.3)	20.0 (1.0)
Control	62.3B (14.4)	27.3 (9.5)	0.7 (0.3)	6.0 (0.6)	2.7 (0.7)	23.0 (1.0)

^a Averages with the same letter within a column are not significantly different at $p=0.05$

Table 16. Average (SE) number of darkling beetles seen per day at three trapping grids oiled during the blowout of well 313H-26R, and one control grid established on hillsides at Naval Petroleum Reserve No. 1, Kern County, California.

BEETLE ABUNDANCE: HILLSIDE GRIDS						
Grid/Treatment	Trapping Session					
	10/94	11/94	12/94	3/94	6/95	9/95
Surface Modification	15.7 (4.2)	3.3A ^a (3.3)	0.0 (0.0)	3.3 (1.9)	1.7 (1.2)	5.7 (3.2)
Natural Recovery	21.3 (5.4)	9.7AB (2.0)	0.0 (0.0)	2.3 (0.9)	2.0 (1.2)	22.0 (2.9)
Bioremediation	21.7 (9.8)	8.7AB (2.9)	0.0 (0.0)	0.3 (0.3)	2.0 (1.2)	18.7 (9.4)
Control	32.7 (5.2)	16.3B (1.5)	0.7 (0.7)	3.7 (1.7)	4.7 (2.0)	13.3 (6.7)

^a Averages with the same letter within a column are not significantly different at $p=0.05$

Vegetation

Herbaceous cover and production did not differ significantly between any of the drainage grids (Table 17). On the hillside grids, percent cover was significantly higher on the bioremediation grid (96.8%) than the natural recovery (86.7%) and control grid (87.2%) (Table 18). Herbaceous production was also significantly higher on the bioremediation grid (3,569 pounds/acre) than on the surface modification grid (2,280 pounds/acre).

Table 17. Average percent herbaceous cover and average herbaceous production per transect (n=6) at three grids oiled during the blowout of well 313H-26R, and one control grid established within drainages at Naval Petroleum Reserve No. 1, Kern County, California.

HERBACEOUS COVER AND PRODUCTION: DRAINAGE GRIDS						
Grid/ Treatment	Percent Cover			Production (pounds/acre)		
	Average	SE	Range	Average	SE	Range
Scarification	88.7	2.9	75-95	2,020	258	1,066-2,928
Natural Recovery	83.3	4.4	63-94	2,484	195	1,955-3,177
Scarification + Fertilizer	80.3	4.2	64-94	2,911	345	2,027-4,107
Control	79.5	4.5	59-89	1,905	232	1,156-2,535

Table 18. Average percent herbaceous cover and average herbaceous production per transect (n=6) at three grids oiled during the blowout of well 313H-26R, and one control grid established on hillsides at Naval Petroleum Reserve No. 1, Kern County, California.

HERBACEOUS COVER AND PRODUCTION: HILLSIDE GRIDS						
Grid/ Treatment	Percent Cover			Production (pounds/acre)		
	Average	SE	Range	Average	SE	Range
Scarification	92.3AB ^a	1.2	88-97	2,280B	326	1,309-3,095
Natural Recovery	86.7B	2.5	78-93	2,392AB	154	1,872-2,987
Scarification + Fertilizer	96.8A	1.8	88-100	3,569A	312	2,632-4,552
Control	87.2B	1.1	84-92	2,491AB	268	1,685-3,541

^a Averages with the same letter within a column are not significantly different at $p=0.05$.

Shrub survival from September 1994 to June 1995 was 100% for all grids. Stakes used to mark the locations of four shrubs were not found in June and these were not included in the sample. Shrub vigor within the drainage grids was higher on the control grid and the grid to be treated with surface modification, than on the grid to be treated with bioremediation in September 1994 (Table 17). Shrub vigor at least doubled on all of the oiled grids by June 1995 and the only significant difference in June was that shrub vigor was significantly higher on the surface modification grid than the bioremediation grid. Shrub vigor within the hillside grids was significantly higher on the control grid than the natural recovery and bioremediation grids, and the scarification grid was significantly higher than the natural recovery grid in September 1994 (Table 18). In June 1995, average shrub vigor on the bioremediation grid was significantly less than the other three grids.

Table 19. Average shrub vigor (% green foliage) at three grids oiled during the blowout of well 313H-26R, and one control grid established within drainages at Naval Petroleum Reserve No. 1, Kern County, California.

SHRUB VIGOR: DRAINAGE GRIDS								
Grid/ Treatment	September 1994				June 1995			
	Average	n	SE	Range	Average	n	SE	Range
Surface Modification	32.7A ^a	25	4.9	0-71.6	80.1A	24	2.5	54.5-95.9
Natural Recovery	24.5AB	25	4.9	0-76.4	67.9AB	25	3.4	32.3-95.9
Bioremediation	11.8B	25	2.7	0-49.0	60.9B	23	5.5	4.2-100
Control	36.6A	25	3.8	4.7-75.4	70.3AB	25	3.6	23.0-96.9

^a Averages with the same letter within a column are not significantly different at $p=0.05$.

Table 20. Average shrub vigor (% green foliage) at three grids oiled during the blowout of well 313H-26R, and one control grid established on hillsides at Naval Petroleum Reserve No. 1, Kern County, California.

SHRUB VIGOR: HILLSIDE GRIDS								
Grid/ Treatment	September 1994				June 1995			
	Average	n	SE	Range	Average	n	SE	Range
Surface Modification	30.0A ^a	25	5.1	0-86.5	79.1A	25	2.7	48.7-99.3
Natural Recovery	6.6C	25	2.7	0-44.4	79.0A	24	2.6	45.8-100
Bioremediation	25.0B	25	3.0	1.3-53.8	56.3B	25	5.2	0-94.7
Control	39.8A	25	4.4	6.9-78.1	75.1A	25	3.0	39.9-96.7

^a Averages with the same letter within a column are not significantly different at $p=0.05$.

III. CONCLUSIONS

Crude oil deposited from the blowout seemed to have few if any long term effects on animals or plants inhabiting the affected area. Heermann's kangaroo rats ingested hydrocarbons deposited during the blowout, but the more toxic components of oil such as polycyclic aromatic hydrocarbons were not found in their livers. Populations of Heermann's kangaroo rats were usually higher on the control grids in 1994, but by March 1995 and thereafter, estimates from the control grids were usually not significantly different than the grids affected by the blowout. Abundance of darkling beetles tended to be higher on the control grids in 1994, but by 1995 there were no significant differences in abundance between grids. No significant differences in ant abundance occurred during any of the trapping sessions. Vegetative cover and production was as high or higher on the oiled grids than the control grids by the spring of 1995. Shrub survival was 100% on all the grids. Shrub vigor tended to be higher on the control grids in September 1994, but by June 1995 vigor on the oiled grids was similar to that on the control grids.

There were few consistent differences between treatments in plant or animal abundance. Vegetative cover and production were higher on the bioremediation grids but there were no other consistent differences between treatments, but shrub vigor in June 1995 tended to be lowest on the bioremediation plots. Preliminary results suggest that the effects of the oil released during the blowout were minimal and short-term, and that natural recovery may be the most appropriate strategy for such spills.

5.3 KIT FOX LIFE TABLE ANALYSIS

I. INTRODUCTION

During preparation of the preliminary draft NPR-1 Supplemental Environmental Impact Statement (SEIS), Argonne National Laboratory performed a life table analysis of the NPR-1 San Joaquin kit fox population. This analysis was performed to gain insight into an observed decline in kit fox captures on NPR-1 between 1981 and 1988. Argonne National Laboratory found that the intrinsic rate of change (r) for the population was -0.3001 , indicating a declining population. Argonne National Laboratory concluded that although reproduction by vixens was fairly high, survival of pups was low, resulting in the observed population decline. Examination of the trend in kit fox captures between 1981 and 1988 indicated that the period of greatest decline was between 1981 and 1984, followed by a period where the population was relatively stable from 1985 and 1988. Consequently, additional life table analyses were performed to reveal differences in kit fox demographic parameters between the period of rapid decline (1981-1984) and relative stability (1985-1988).

II. METHODS AND MATERIALS

Life table parameters were estimated using data collected on juvenile and adult vixens radiocollared between 1981 and 1988. Only foxes whose year of birth and date of death were known were included in the data sets analyzed. Foxes whose radiocollar had expired or was removed, or whose ultimate fate was unknown were included in data sets only for years in which they wore operable radiocollars and were actively monitored. Estimates of fecundity (reproductive success) were calculated from data collected during kit fox pup trapping and observations of natal dens occupied by at least one radiocollared fox (male or female). Litter sizes were recorded as the total number of pups known to be offspring of an identifiable vixen or mated pair. Total fecundity was estimated separately for yearling and adult vixens as the total number of pups born divided by the total number of vixens known to be alive at time of breeding. The fecundity value used for life table analyses was calculated by halving total fecundity to estimate the total number of female pups born.

Conventional life table analysis methods were used to estimate kit fox survival, mortality, and related parameters in each age class (x) for both time periods (1981-1984 and 1985-1988). The parameters calculated for each analysis are listed and defined below.

l_x = Survival:

The probability that an individual in age class 0 will survive to enter age class x .

d_x = Mortality:

The probability that an individual in age class 0 will die during age class x .

p_x	=	Age-specific survival: The probability that an individual in age class x will survive to enter the next age class (age class $x + 1$).
q_x	=	Age-specific mortality: The probability that an individual in age class x will die before entering the next age class (age class $x + 1$).
m_x	=	Age-specific fecundity: The average number of female offspring born to a female in age class x .
$l_x m_x$	=	Age-specific expected reproduction: The average number of female offspring expected to be born in age class x to females who are currently in age class 0.
$\Sigma l_x m_x$	= R_0	Net reproductive rate: The average number of female offspring born to an average female in the population.
$\frac{\Sigma(x)l_x m_x}{R_0}$	= T	Generation time: The average time interval between the birth of parents and the birth of their offspring.
$\frac{\ln(R_0)}{T}$	= r	Intrinsic rate of change: The annual rate of population change in the absence of crowding and limited resources.

III. RESULTS

The survival and mortality rates and life table developed from San Joaquin kit foxes radiocollared between 1981 and 1984 are presented in Table 21 and Table 22. A total of 122 vixens radiocollared during the period were used in the analysis. Fecundity values were estimated from a total of 37 litters. Kit fox survival into age class 1 was 27.63%. Age-specific survival was lowest in age class 4 (20.19%) and highest in age class 1 (48.82%). The net reproductive rate was 0.5588 and the intrinsic rate of change was -0.2735.

The survival and mortality rates and life table developed from San Joaquin kit foxes radiocollared between 1985 and 1988 are presented in Table 23 and Table 24. A total of 39 vixens radiocollared during the period were used in the analysis. Fecundity values were estimated from a total of 36 litters. Kit fox survival into age class 1 was 22.88%. Age-specific survival was

lowest in age class 1 (21.88%) and highest in age class 2 (66.64%). The net reproductive rate was 0.8795 and the intrinsic rate of change was -0.0662.

Table 21. Rates of survival and mortality for San Joaquin kit fox on Naval Petroleum Reserve No. 1, Kern County, California, 1981-1984.

x	l_x	d_x	p_x	q_x
0	1.0000	0.7237	0.2763	0.7237
1	0.2763	0.1414	0.4882	0.5118
2	0.1349	0.0862	0.3610	0.6390
3	0.0487	0.0274	0.4374	0.5626
4	0.0213	0.0170	0.2019	0.7981
5	0.0043	0.0043	0.0000	1.0000
6	0.0000			

Table 22. Life table analysis for San Joaquin kit fox on Naval Petroleum Reserve No. 1, Kern County, California, 1981-1984.

x	l_x	q_x	m_x	$l_x m_x$	$(x)l_x m_x$
0	1.0000	0.7237	0.0000	0.0000	0.0000
1	0.2763	0.5118	0.5000	0.1382	0.1382
2	0.1349	0.6390	2.0109	0.2713	0.5425
3	0.0487	0.5626	2.0109	0.0979	0.2938
4	0.0213	0.7981	2.0109	0.0428	0.1713
5	0.0043	1.0000	2.0109	0.0086	0.0432
6	0.0000				
Sums (Σ)			8.5436	0.5588	1.1890

$$\text{Net Reproductive Rate (NRR)} = R_0 = \Sigma l_x m_x = 0.5588$$

$$\text{Generation Time (T)} = \frac{\Sigma (x) l_x m_x}{R_0} = \frac{1.1890}{0.5588} = 2.1278 \text{ years}$$

$$\text{Intrinsic Rate of Change (r)} = \frac{\ln(R_0)}{T} = \frac{\ln(0.5588)}{2.1278} = -0.2735$$

Table 23. Rates of survival and mortality for San Joaquin kit fox on Naval Petroleum Reserve No. 1, Kern County, California, 1985-1988.

x	l_x	d_x	p_x	q_x
0	1.0000	0.7812	0.2188	0.7812
1	0.2188	0.1094	0.5000	0.5000
2	0.1094	0.0365	0.6664	0.3336
3	0.0729	0.0364	0.5007	0.4993
4	0.0365	0.0243	0.3342	0.6658
5	0.0122	0.0061	0.5000	0.5000
6	0.0061	0.0061	0.0000	1.0000
7	0.0000			

Table 24. Life table analysis for San Joaquin kit fox on Naval Petroleum Reserve No. 1, Kern County, California, 1985-1988.

x	l_x	q_x	m_x	$l_x m_x$	$(x)l_x m_x$
0	1.0000	0.7812	0.0000	0.0000	0.0000
1	0.2188	0.5000	2.0000	0.4376	0.4376
2	0.1094	0.3336	1.8636	0.2039	0.4078
3	0.0729	0.4993	1.8636	0.1359	0.4076
4	0.0365	0.6668	1.8636	0.0680	0.2721
5	0.0122	0.5000	1.8636	0.0227	0.1137
6	0.0061	1.0000	1.8636	0.0114	0.0682
7	0.0000				
Sums (Σ)			11.3180	0.8795	1.7070

$$\text{Net Reproductive Rate (NRR)} = R_0 = \Sigma l_x m_x = 0.8795$$

$$\text{Generation Time (T)} = \frac{\Sigma (x) l_x m_x}{R_0} = \frac{1.7070}{0.8795} = 1.9409 \text{ years}$$

$$\text{Intrinsic Rate of Change (r)} = \frac{\ln(R_0)}{T} = \frac{\ln(0.8795)}{1.9409} = -0.0662$$

IV. CONCLUSIONS

The survival and mortality rates calculated for both time periods were fairly similar. Kit fox survival to age class 5 was less than 2% for both time periods. No individuals survived into age class 7, which is probably near the maximum age for San Joaquin kit foxes in the wild. The patterns of age-specific mortality are typical of many mammalian species where mortality is high in young animals, decreases as animals reach prime-age, and increases as animals approach maximum longevity. Estimates of intrinsic rates of change calculated for the 1981-1984 and 1985-1988 time periods indicate that the San Joaquin kit fox population declined at annual rates of 27% and 6%, respectively. These estimates support live-trapping data that indicated a rapid decline in fox abundance between 1981 and 1984 and a period of relative population stability between 1985 and 1988. These analyses indicate that the period of kit fox decline prior to 1984 was not due to low pup survival, as suggested by Argonne National Laboratory. Instead, the decline was likely due to relatively high age-specific mortality in age classes 2 (63.90%) and 3 (56.26%), when vixens are adults and producing larger litters. High adult mortality probably resulted in fewer pups entering the population, causing it to decline. During the 1985-1988 period, however, age-specific mortality in age class 2 and 3 were considerably lower (33.36% and 49.93%), resulting in more adult vixens producing litters.

6. PROGRAM ASSISTANCE

6.1 PROGRAM SUPPORT

A primary objective of EG&G/EM's participation in the Endangered Species and Cultural Resource Program at NPRC is to provide the expert advice, guidance, and assistance necessary for DOE/NPRC compliance with the ESA of 1973 (as amended), the National Environmental Policy Act (NEPA), the National Historic Preservation Act (NHPA), and other laws protecting cultural and historic resources. Other objectives include providing technical and management progress reports, presenting and publishing scientific findings, and engaging in information transfer and educational outreach activities.

Support of specific compliance procedures pursuant to the ESA, the NHPA and other cultural resource laws, and NEPA was accomplished through preparing the necessary documentation and supporting consultations as required by these laws. A significant activity in FY95 was supporting the formal Section 7 consultation between DOE/NPRC and the FWS for continuing oil and gas operations at NPR-1. This activity included providing an analysis of alternative responses, and producing a thorough written response and supporting information to FWS' draft biological opinion. In addition to supporting this programmatic consultation, 13 additional consultations were conducted for specific projects on NPRC. Two formal consultations were conducted which resulted in amendments to 1987 Biological Opinion for continuing oil and gas operations on NPR-1. Five informal consultations were conducted for NPRC projects, and six other informal consultations were conducted for projects proposed by third parties on NPRC lands. For historic and cultural resources compliance activities, please see section 3.4 of this report.

Throughout FY95, the Endangered Species and Cultural Resource Program provided programmatic management support through a number of activities. These included the preparation of weekly coordination summaries, quarterly progress reports, monthly financial reports, annual scope of work, and detailed project plans. Written input was provided to NPRC's annual Environmental Site Report, Annual Report of Operations, Long Range Plan, and Quarterly Report. Procedure self-assessments were conducted on two field activities, lagomorph transects and preactivity surveys.

Numerous articles for the *Elk Hills Weekly* were drafted and provided to DOE/NPRC. EG&G/EM staff members prepared a poster presentation and attended the NEPA 25th Anniversary celebration, participated in the Second Annual Environmental Trade Show and Oil and Gas Conference, and attended weekly environmental coordination meetings, DOE/NPRC Technical Assurance Branch staff meetings, and NPR-1 3-D Seismic Program meetings. Briefings were provided to NPRC management on the annual scope of work, project progress, and related compliance issues. EG&G/EM staff participated in a briefing to reporters from the Bakersfield Californian (a local newspaper) regarding implications of the proposed sale of Elk Hills. A briefing was also provided to the California Department of Food and Agriculture staff on the

location of sensitive endangered species habitat prior to malathion spraying for beet-leafhoppers. EG&G/EM staff hosted a visit by Kirsten Tarp, a FWS botanist from the Sacramento Field Office, who visited NPRC to learn more about NPRC oil field operations, local habitat conditions, and issues regarding conservation of listed plants at NPRC, especially Kern mallow.

Scientific findings based on work performed by the Endangered Species and Cultural Resource Program at NPRC were presented at various forums, including Endangered Species Advisory Committee meetings, professional society meetings, and at an Annual Program Review attended by approximately 75 people from various federal and state agencies, oil and gas companies, and other interested organizations. EG&G/EM also attended meetings sponsored by the San Joaquin Valley Endangered Species Recovery Planning Program, the Bureau of Land Management, the San Joaquin Valley Biotechnical Committee, and the Lokern Natural Area Management Program to provide these groups with the information and experience gained through the Endangered Species and Cultural Resource Program at Elk Hills.

Numerous educational outreach activities were conducted throughout the year. The graduate student research agreement with the University of California, Berkeley, continued this year with the support of a graduate student at Elk Hills conducting a study of bobcat home range. EG&G/EM provided training in handling kit foxes to staff from the San Joaquin Valley Endangered Species Recovery Planning Program (SJVESRPP) and provided assistance to SJVESRPP biologists with live-trapping and radiocollaring kit foxes in the Panoche Hills located in the northwestern portion of the San Joaquin Valley.

On-site tours and briefings also were given to a variety of persons and groups, including a biology professor from the University of California, Berkeley, and five of his students who observed kit fox dens and giant kangaroo rat precincts. EG&G/EM also hosted a visit to NPRC by members of the SJVESRPP and the American Farmland Trust, who are sponsoring an effort to conserve endangered species on private lands. Sanjay Pyare, a graduate student with the University of Nevada, Reno, spent a week with EG&G/EM biologists observing San Joaquin kit fox trapping sessions. Bakersfield Californian staff observed trapping of giant kangaroo rats and interviewed EG&G/EM staff for an article on the NPRC Endangered Species Program.

EG&G/EM made significant contributions to NPRC's annual Earth Day activities held both on-site and at the California State University, Bakersfield campus by providing educational booths, displays, activities for visiting school children, and coordinating booths and displays from off-site organizations. EG&G/EM staff members participated in the Derricks to Desks program, sponsored by local industry to inform teachers about oil field operations. Staff also participated in several presentations at the Coles Levee Ecosystem Preserve in cooperation with staff from ARCO Western Energy, California Department of Fish and Game, and private environmental and cultural resources consultants. One of the presentations was filmed for a television program aired on the Discovery Channel. Staff also collaborated with a local science mentor teacher in planning activities for elementary school teachers, focusing on information for classroom use on endangered species, local area species, and cultural resources. EG&G/EM staff participated in

several classroom visits to local schools to present information about endangered species, and an EG&G/EM staff member gave presentations to seven Wasco High School classes on various aspects of cultural resources. In addition to judging science fairs at local schools and for the Kern County Science Fair, several EG&G/EM staff participated in DOE's Science Bowl by volunteering their time as coaches to high school teams.

6.2 PROJECT DOCUMENTATION

The work on endangered species sponsored by NPRC has resulted in the generation of numerous data of value to regional as well as on-site conservation efforts. In FY94, an effort was initiated to examine existing data collected at NPRC and identify data sets that would constitute valuable contributions to the scientific literature. Significant progress was made in FY95 on the preparation of five technical manuscripts for submission to scientific journals.

During 1982 to 1984, data were collected on movements and home range patterns of radiocollared blunt-nosed leopard lizards. Some of these data were presented in a topical report published in 1987. In FY95, these data were reanalyzed to more thoroughly examine home range, movement, and habitat use patterns of blunt-nosed leopard lizards relative to habitat conditions, particularly vegetative cover. A manuscript has been completed and is being reviewed internally.

During 1984 to 1985, data were collected on movements and home range patterns of radiocollared San Joaquin kit foxes. These data were summarized and presented in a topical report published in 1987. The information in this report has been revised and updated, and a manuscript has been completed and is being reviewed internally.

Information on kit fox demographics and the effects of oil field activities has been collected since 1980. Some of this information has been presented in various published topical reports. This information is being summarized in a manuscript that is in preparation. Also, data were collected on the occurrence of oil field contaminants in soil, water, and kit fox fur samples. These data were presented in a topical report published in 1992. A scientific manuscript reporting this information is in preparation.

Finally, data on coyote and kit fox food habits collected from 1985 to 1990 were analyzed to assess dietary overlap and potential competition between the two species. A manuscript will be completed in FY96. Also, work will continue on two additional manuscripts in FY96. One manuscript will report data collected from 1980 to 1984 on small mammal community composition and dynamics. The other manuscript will report data collected from 1980 to 1990 on den use patterns of radiocollared kit foxes. Additional manuscripts will be identified and prepared as time and funding permit.

7. PUBLICATIONS

Several technical reports and scientific manuscripts were drafted, and some published during the year.

Published documents include:

Anderson, D. C., B. L. Cypher, G. L. Holmstead, K. L. Hammer, and N. Frost. 1994. Occurrence and distribution of special status plant species on the Naval Petroleum Reserves in California. U. S. Department of Energy Topical Report. EG&G/EM Report No. EGG 11265-2052. 37 pp.

EG&G Energy Measurements, Inc. 1995. Endangered Species Program Naval Petroleum Reserves in California Annual Report FY93. U. S. Department of Energy Topical Report. EG&G/EM Report No. EGG 11265-2047. 51 pp.

Documents in press include:

Anderson, D. C. Habitat reclamation plan, Naval Petroleum Reserve No. 1, Kern County, California. U. S. Department of Energy Topical Report.

Cypher, B. L. Influence of physiography and vegetation on small mammals at the Naval Petroleum Reserves, California. Transactions of the Western Section of the Wildlife Society.

Cypher, B. L. Coyote morphometric characteristics and mass dynamics in the San Joaquin Valley, California. The Southwestern Naturalist.

Cypher, B. L., and J. H. Scrivner. Summary of coyote data collected at the Naval Petroleum Reserves in California. U. S. Department of Energy Topical Report.

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Holmstead, G. L., and D. C. Anderson. Reestablishment of Hoover's woolly-star (*Eriastrum hooveri*) following disturbance. Madroño.

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Otten, M. R., and G. L. Holmstead. Effects of seeding burned lands on the abundance of rodents and leporids on Naval Petroleum Reserve No. 1, Kern County, California. *The Southwestern Naturalist*.

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