THE STATUS OF TIPTON KANGAROO RATS AND THE POTENTIAL FOR THEIR RECOVERY

CURTIS E. UPTAIN, Endangered Species Recovery Program, 1900 Gateway Blvd., Suite 101, Fresno, CA 93727.

DANIEL F. WILLIAMS, Endangered Species Recovery Program, 1900 Gateway Blvd., Suite 101, Fresno, CA 93727.

PATRICK A. KELLY, Endangered Species Recovery Program, 1900 Gateway Blvd., Suite 101, Fresno, CA 93727.

LAURISSA P. HAMILTON, Endangered Species Recovery Program, 1900 Gateway Blvd., Suite 101, Fresno, CA 93727.

MARTIN C. POTTER, California Department of Fish and Game, 1234 E. Shaw Ave, Fresno, CA. 93710.

ABSTRACT: Populations of some species of kangaroo rats that are endemic to the San Joaquin Valley, California, have shown substantial declines in recent years. In this paper, we summarize 4 separate studies during which Tipton kangaroo rats (*Dipodomys nitratoides nitratoides*) have declined to near extinction. Although kangaroo rat populations typically exhibit great fluctuations in abundance, the highly fragmented and isolated condition of current populations coupled with declining numbers and naturally low fecundity threaten species survival. Many of the smaller populations may have been extirpated and many of the larger populations may not be viable. Extinction of the species may be avoided by expanding the size and suitability of existing preserves and natural areas, creating connections between those habitats that are suitable for genetic exchange, and implementing appropriate habitat management actions. We discuss some ongoing and planned actions that may contribute to achieving these goals.

Key words: endangered species, kangaroo rat, San Joaquin Valley, population decline, habitat restoration, habitat management, recovery, *Dipodomys nitratoides.*

1999 TRANSACTIONS OF THE WESTERN SECTION OF THE WILDLIFE SOCIETY 35:1-9

INTRODUCTION

Populations of kangaroo rats that are endemic to the San Joaquin Valley, California, have shown substantial declines in recent years and it has been suggested that consecutive years of above average rainfall has contributed to these declines (Single et. al. 1996). Heavy precipitation has produced tall, dense grasses and an accumulation of a dense grass-based litter cover. Increased cover of live and dead grasses may cause declines in kangaroo rat numbers by limiting their ability to forage, find mates, and potentially increase their susceptibility to predation (Culbertson 1946, Hawbecker 1951, Williams and Germano 1993). Heavier than normal precipitation may also cause direct mortality to kangaroo rats by drowning caused by sheet flooding, spoiling food sources, or increasing the prevalence of respiratory diseases (Single et. al. 1996).

Among those species exhibiting population declines within the valley are giant kangaroo rats (*Dipodomys ingens*), Tipton kangaroo rats (*Dipodomys nitratoides nitratoides*), and Tulare kangaroo rats (*Dipodomys heermanni tularensis*). Giant and Tipton kangaroo rats have been listed as endangered by the United States and California governments primarily because of loss of habitat through conversion to cultivated agriculture and urban developments (United States Fish and Wildlife Service 1998). Tulare kangaroo rats are more widely distributed and their populations tend to be less fragmented than giant and Tipton kangaroo rats; Tulare kangaroo rats are not currently listed.

Giant kangaroo rats occur in the Carrizo Plain, Cuyama Valley, and in the foothills on the western side of the San Joaquin Valley. Tipton kangaroo rats only occur on the southern San Joaquin Valley floor, a region that has been converted to an intensively developed agricultural landscape over the past 100 years. Accordingly, Tipton kangaroo rat populations have been widely affected by habitat conversion (United States Fish and Wildlife Service 1998). The resulting fragmentation and isolation increase susceptibility to variable stochastic events such as the increased rainfall experienced since 1992 (Figure 1). Herein, we report on declines in Tipton kangaroo rat numbers in 4 separate populations from within the northern and central portions of their range and discuss some strategies that may contribute to their recovery.

STUDY AREAS AND METHODS

Population studies were conducted at Pixley National Wildlife Refuge (Pixley NWR), Tulare County; Allensworth Ecological Reserve (Allensworth ER), Tulare County; North Kern State Prison, Kern County; and Naval Air Station Lemoore (NAS Lemoore), Kings County (Figure 2). These sites differed in past land use, current management practices, and habitat characteristics.

Pixley NWR is located approximately 30 km south of Tulare in Tulare County, California, at an elevation of about 65 m. It was designated a National Wildlife Refuge in 1959 and is administered and managed by the United States Fish and Wildlife Service (United States Fish and Wildlife Service 1984). It is approximately 1,814 ha in size and about 365 ha are dedicated to waterfowl management; about 122 ha are seasonally-flooded wetland. Topography on the refuge is generally flat with occasional rolling mounds. Excluding the wetland, 2 primary plant associations exist on the site. Non-native Annual Grassland (Holland 1986) is the predominant association, but some small areas of Valley Sink Scrub (Holland 1986) also are present. The entire area, except the wetlands, has been grazed by horses and cattle for the past 75 years (Tollestrup 1979), and occasional wildfires have occurred. Hesparia sandy loam and clay loam are the dominant soil types at the refuge. Surrounding lands are intensively cultivated farmland.

Endangered Species Recovery Program (ESRP) biologists studied the population of Tipton kangaroo rats at Pixley NWR from December 1992 to April 1998 to determine abundance, seasonal activity patterns, reproductive biology, and to identify interactions with Tulare kangaroo rats. We established 1 trapping grid consisting of 196 trap stations placed in a 14 x 14 grid at 15-m intervals (resulting in a 4.41 ha grid) in the northeastern corner of Pixley NWR. We trapped using Sherman™ live traps measuring 7.62 x 9.53 x 30.48 cm. We trapped at variable intervals (from 1 to several weeks) and for variable lengths of time (from 1 night to 5 nights) to maximize the information obtained while concurrently minimizing the effort expended. Additionally, we trapped quarterly (3-month intervals) for 5 consecutive nights. During these sessions, we individually numbered kangaroo rats with ear tags and passive integrated transponders (PIT) that we injected subcutaneously. In this paper, we present the February census data for 1993 to 1998.

Allensworth ER is located approximately 12.9 km west of Earlimart, Tulare County, at an elevation of about 70 m and is 1,948 ha in size. The Reserve was acquired to protect several sensitive species including Tipton kangaroo rats. Most of the Reserve is composed of lands consisting of Non-native Annual Grassland and Valley Sink Scrub vegetative communities (Holland 1986) that are seasonally grazed by cattle and sheep. This grazing is not authorized. About 400 ha of the Reserve were previously leveled for cultivated agricultural production. Some of this land was modified in winter 1996 by heavy equipment to restore hummocks and depressions. The reserve is mostly surrounded by irrigated agricultural lands.

California Department of Fish and Game biologists conducted live-trapping at Allensworth ER on 4 trap-

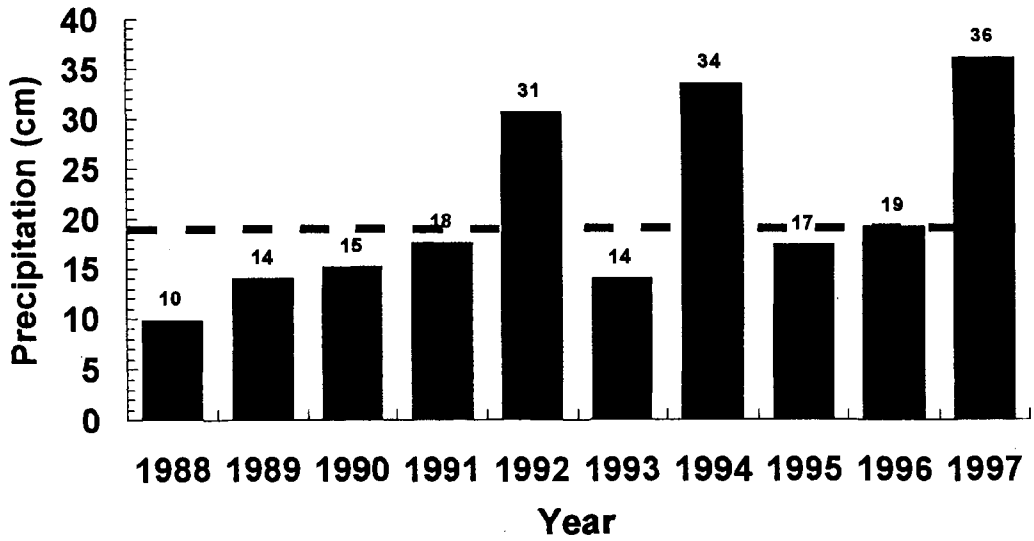

Figure 1. Annual rainfall (cm) at Naval Air Station, Lemoore for the 1988 to 1997 precipitation years (July 1 to June 30). The mean annual rainfall of 18.7 cm for the years 1961-1997 is depicted as a dashed horizontal line.

ping grids; each an 8 x 10 configuration with 15-m trap spacing. Two grids were within fenced grazing exclosures of 64 ha and 2 were outside of grazing exclosures. One outside grid and 1 inside grid were on previously cultivated and leveled land, while the 2 corresponding grids were on relatively undisturbed land. One of the authors trapped for 5 consecutive nights during June on each grid from 1994 through 1996. Because of the scarcity of kangaroo rat sign, only 1 inside grid and 1 outside grid were trapped in 1997. In 1998, traps were only set at burrow openings within the grids and surrounding areas; only 50 trap nights of effort were expended. We report animal numbers for each census as the combined number of individuals captured.

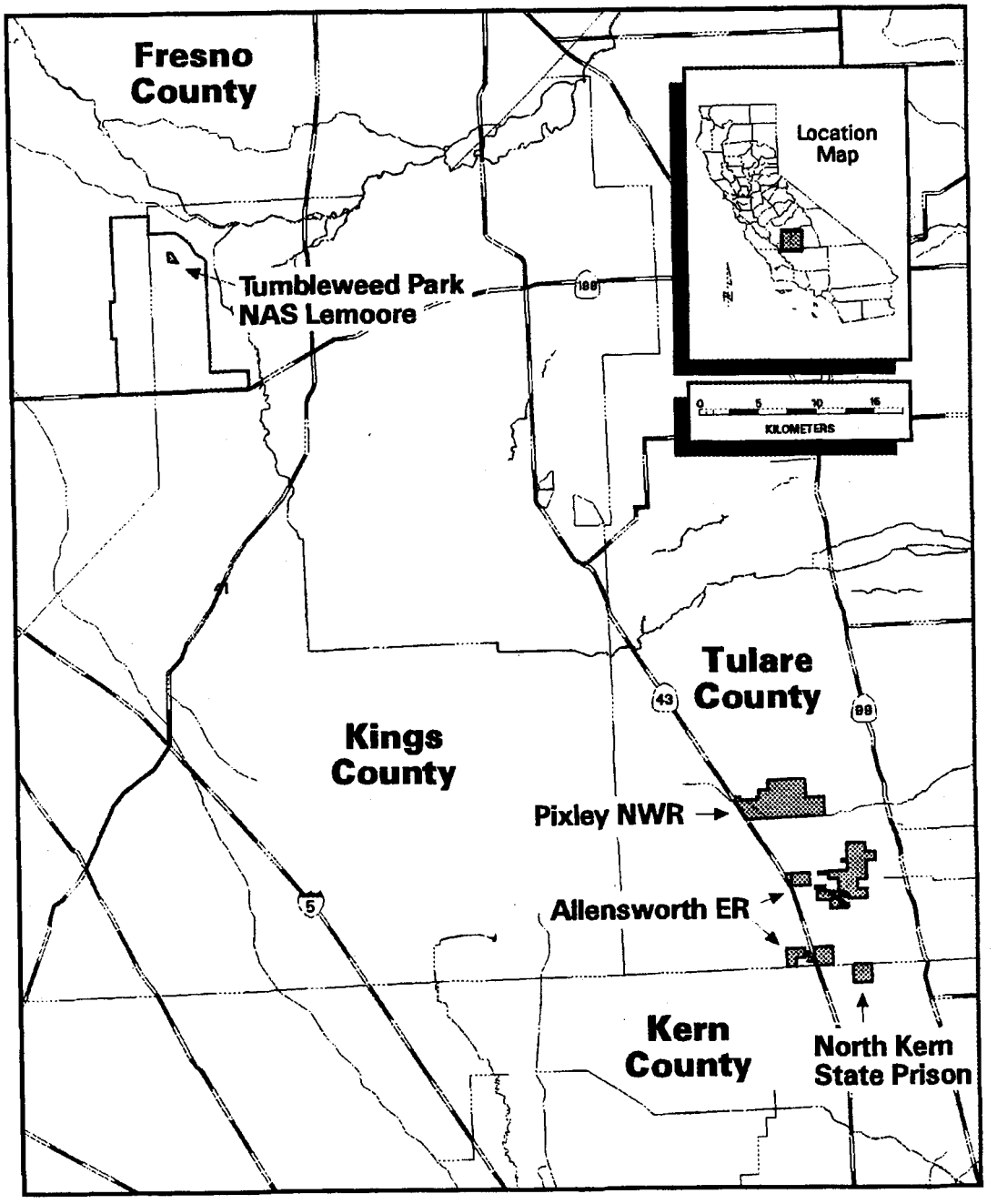

Figure 2. Map depicting locations of the four study sites (shaded areas). Pixley NWR = Pixley National Wildlife Refuge, Allensworth ER = Allensworth Ecological Reserve, NAS Lemoore = Naval Air Station, Lemoore.

North Kern State Prison is located approximately 4.8 km west of Delano, Kern County, California. The prison is located on a 259 ha site; 116 ha are developed and the remaining lands are used as a security buffer area. The prison was constructed between 1990 and 1992 and put into operation in 1993 (Uptain 1995). Previously, the site was an intensively cultivated cotton field that was fallowed in 1982 (Uptain 1995). By 1989, the site was still barren alkali soil with prominent furrows and little vegetative cover. Small patches of grasses and forbs occurred along the fencelines, dirt roads, and in some small, isolated areas within the interior of the site. Vegetation was mostly peppergrass (*Lepidium dictyotum*), seep weed (*Suaeda fruiticosa*), annual saltbushes (*Atriplex* spp.), alkali barley (*Hordeum depressum*), spikeweed (*Hemizonia pungens*), fescue (*Vulpia myuros* and *V. microstechys*), and red brome (*Bromus madritensis rubens*). These and other plants were common in uncultivated and relatively undisturbed areas surrounding the site on all sides. Also by 1989, there was substantial evidence of site use by burrowing owls (*Athene cunicularia*), San Joaquin kit foxes (*Vulpes macrotis mutica*), and Tipton kangaroo rats (Uptain 1989).

As partial mitigation for construction of the prison, the security buffer area was used as compensation lands. Portions of the buffer were enhanced in 1990 by creating topographic relief, and were vegetated by hand-sowing saltbush seeds. Tipton kangaroo rats that inhabited the construction area were captured and relocated to artificial burrows that were created in an area that was previously devoid of kangaroo rats. One of us (Uptain 1995) conducted a 5-year study to monitor various aspects of habitat recovery on the site including the degree of natural and artificial vegetative recovery, site-wide use by sensitive species, and success of the Tipton kangaroo rat relocation effort. In that study, 4 trapping grids were established; 1 in the area where kangaroo rats were released, 1 in an area where topographic relief was created and hand-sowing of saltbush occurred, 1 in an area where there was no treatment, and 1 on adjacent property that had not been previously cultivated. The grid configuration used was that of 2 parallel basic lines and 2 parallel assessment lines as developed and described by OÕFarrell et. al (1977). These grids were trapped for 5 consecutive nights in September 1990, April 1991, September 1991; and in April of 1993, 1994, and 1995. April census data are reported here for 1991, 1993, 1994 and 1995 as the combined number of kangaroo rats captured on all grids.

NAS, Lemoore is located in the heart of the San Joaquin Valley, approximately 56 km south of Fresno in the northeast corner of Kings County, California. It is built on approximately 12,069 ha of land that is either owned by the Navy (7,245 ha) or is within an overflight lease. Most of this land was previously in agricultural production, primarily cotton. Tumbleweed Park, the site of the ESRP habitat management study, is in northwest portion of the Naval Air Station. The park is 39.3 ha in size and is 67 m in elevation. It is entirely surrounded by intensively cultivated fields. The park was previously used as an off-road-vehicle racetrack, but that activity was halted in 1989 because of fears that it was detrimental to the resident Tipton kangaroo rat population (Morrison and Mills 1993). It remained fenced and unmanaged between 1989 and 1995, when the first management treatments (burning and grazing) were initiated. There is no flowing or year-round standing water and most of the site has good drainage, although water does sometimes pool in areas of compacted soil on the abandoned ORV track and in a low area on the southern side of the site. The topography is mostly flat, with a few man-made contours. The plant community is classified as Non-native Annual Grassland (Holland 1986). A few saltbush shrubs are located along the south and west fencelines.

Two experimental treatments were used to manipulate habitat conditions at Tumbleweed Park: burning and grazing. Five sampling grids were exposed to each treatment and 5 additional grids were not treated and used as controls. We conducted vegetation sampling on the grids to ascertain vegetative responses to the treatments and we conducted small mammal trapping to determine affects on small mammal populations. Each grid was 90 m on a side resulting in an area of 1.1 ha and contained 49 traps equally spaced at 15 -m intervals. We established grids in April 1995 and trapped quarterly through April 1998. January census data are reported here for 1996 to 1998 as the combined number of kangaroo rats captured on all grids.

RESULTS

Trapping periods, grid size, grid configuration, experimental treatments, and other protocols varied among the 4 sites. Accordingly, results are not comparable across sites. However, there is a consistent trend of declining populations at these sites. At 3 of the 4 sites, Tipton kangaroo rats have declined to near extinction. At the fourth site (NAS, Lemoore) the decline has not been so dramatic, but the population may not be viable. Captures at Pixley NWR declined by 68% (from 161 to 51 animals captured) between February 1993 and February 1994 (Figure 3). From 1994 through 1998 the population continued to decline to the extent that only a single individual has been captured on the grid since November 1996. That lone individual, which subsequently disappeared, was captured in November 1997 and may have come from a very small population that persists about 1 km away from the grid.

Tipton kangaroo rat captures at Allensworth ER declined by 63% (242 to 90) between June 1993 and June 1994 (Figure 4). By June 1995, kangaroo rats were virtually absent from the grids.

At the North Kern Prison site, there was an initial increase in Tipton kangaroo rat numbers on the grids from April 1991 to April 1993 (Figure 5). However, between April 1993 and April 1995 there was a decrease

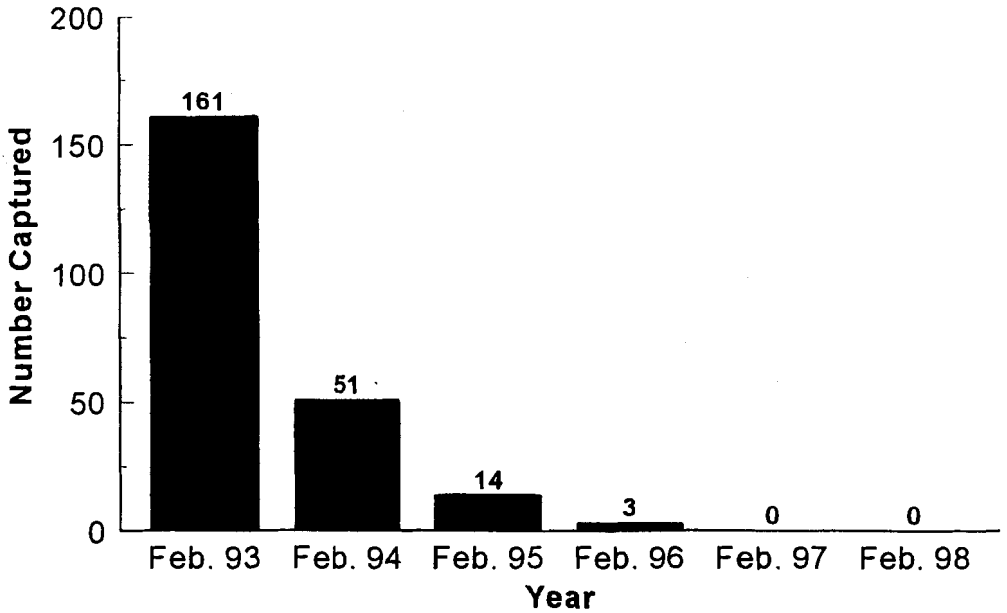

Figure 3. Number of Tipton kangaroo rats captured at Pixley National Wildlife Refuge, 1993 - 1998.

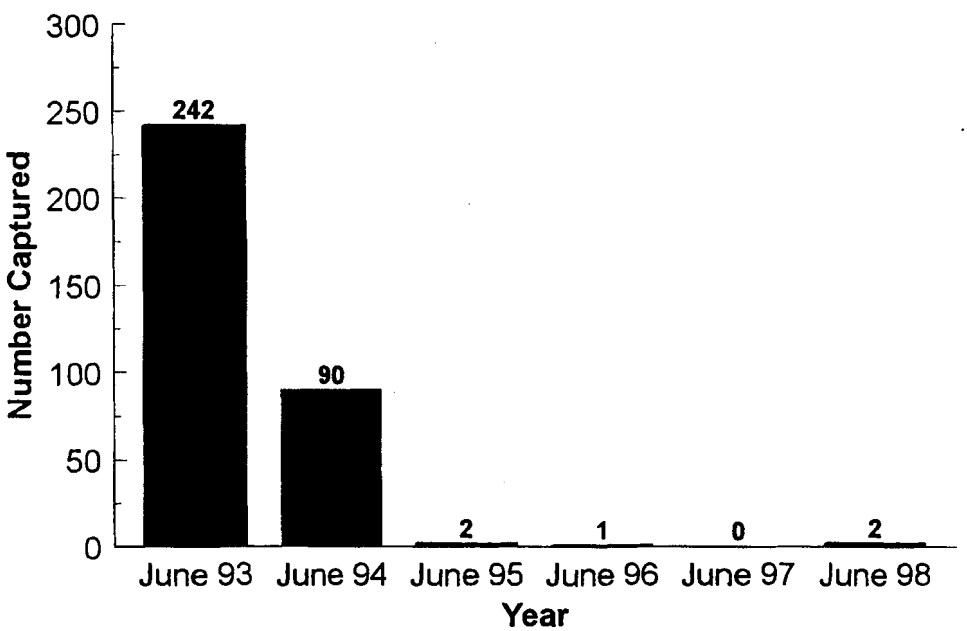

Figure 4. Number of Tipton kangaroo rats captured at Allensworth Ecological Reserve, 1993 - 1998. Note that trapping efforts were not equal across years.

in abundance similar to that observed at Pixley NWR and Allensworth ER. Captures declined by 43% (112 to 64) between April 1993 and April 1994, and no animals were captured in April 1995. Some sign (burrows and scat), however, still existed at the site off of the grids. Results of a walkover survey conducted in winter 1997 showed that Tipton kangaroo rats were still present at the North Kern Prison site, but suggested that the population was at a very low level.

The NAS Lemoore study began 2 to 4 years after the other 3 studies. Nevertheless, the Tipton kangaroo rat population at NAS Lemoore exhibited similar population dynamics (Figure 6). In January 1996, at a time when populations were decreasing at the other 3 sites, kangaroo rat numbers were relatively high (71 individuals captured). Captures declined by 76% (71 to 17) between January 1996 and January 1997. As of June 1998, the population seemed to have stabilized at this lower density level (i.e., 23 individuals were captured in January 1998).

DISCUSSION

The results of the studies presented here show that there has been declines in Tipton kangaroo rat abundance at the 4 study sites during the 1990's. The exception to this is at North Kern State Prison where there was an increase in abundance from 1991 to 1993. This can probably be attributed to habitat recovery that occurred on that site. Further, while populations of kangaroo rats were declining at other sites in 1996, those at NAS Lemoore were increasing. This may be attributed to habitat manipulations that were initiated on the site in 1995 to improve conditions; Tipton kangaroo rats persisted in areas where the exotic grasses were absent or had been removed by controlled burns.

Extreme population declines have also been noted at other remaining occupied sites throughout the San Joaquin Valley (Endangered Species Recovery Program unpublished data). While no studies have clearly demonstrated a cause-and-effect relationship between Tipton kangaroo rat abundance and amount of precipitation, it has been inferred by Single et. al. (1996) and such a relationship was shown for giant kangaroo rats by Williams et al. (1993). The declines in Tipton kangaroo rat abundance shown here correspond to a period of average and above average rainfall (Figure 1). Although these studies were conducted over a relatively short period, they do suggest a relationship between precipitation and abundance.

Typically, declines in abundance would not be of great concern because many species of kangaroo rats and other small mammals periodically undergo large fluctuations in abundance (Briese and Smith 1974, M'Closkey 1972). However, the range of the Tipton kangaroo rat today is fragmented into small, isolated, and often degraded parcels on the valley floor (United States Fish and Wildlife Service 1998). The combination of range fragmentation, recent population declines, and naturally low fe-

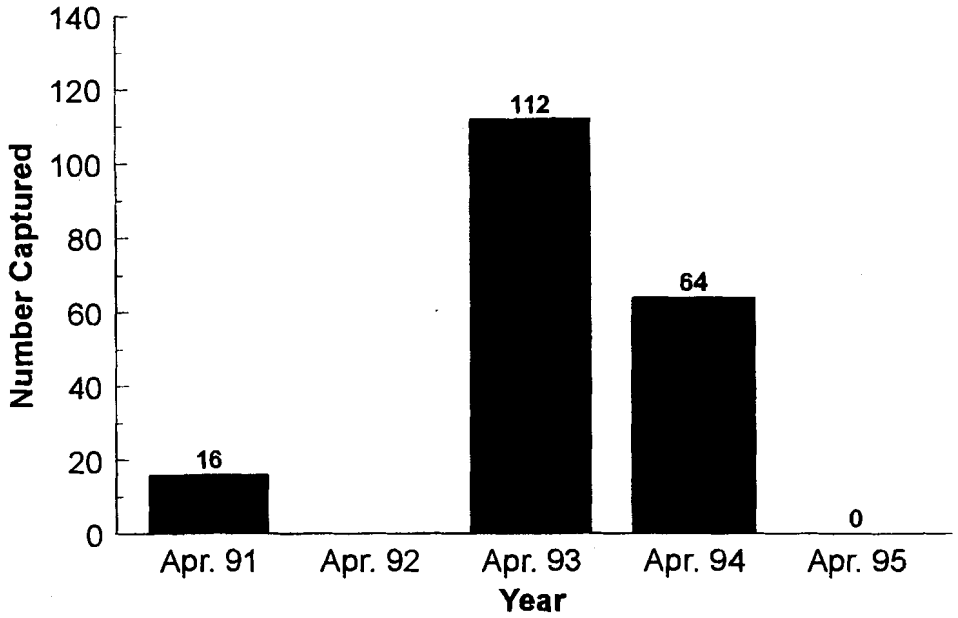

Figure 5. Number of Tipton kangaroo rats captured at the North Kern Prison site, 1991 - 1995. Note that no sampling occurred in April 1992.

cundity magnify concerns about the recovery of Tipton kangaroo rats. Many of the smallest populations already may have been extirpated and many of the larger populations may not be viable.

PROGRAMS THAT MAY CONTRIBUTE TO RECOVERY

Recovery of Tipton kangaroo rats can and must be approached in a number of different ways. Some important recovery actions include but are not limited to: expanding the size and enhancing the suitability of existing preserves; creating connections between preserves and habitat blocks to facilitate dispersal and genetic exchange; and determining and implementing appropriate habitat management actions. There are several programs in progress, or being initiated, that should aid in the recovery of Tipton kangaroo rats. Among these are the Central Valley Project Improvement Act (CVPIA) Land Retirement Program that was instituted in 1992, and the federal Wetlands Restoration Project's Central Valley Habitat Joint Venture that was instituted in 1988. Both could serve to enlarge existing upland preserves and create connections between upland habitats. There are also a number of field studies currently being conducted, or that are being developed, that address kangaroo rat population dynamics and appropriate habitat enhancement and management concerns. The results of these studies may provide appropriate strategies to enhance Tipton kangaroo rat survival, especially during periods of low abundances.

The CVPIA Land Retirement Program is focused in an area of approximately 30,374 ha in the trough of the valley where there are problems with agricultural drainage, high groundwater, accumulation of selenium and other metals, or increasing salinity (Figure 7). Lands will be purchased from willing sellers and retired from irrigated agricultural production in an attempt to alleviate those problems. Land selection criteria includes aspects associated with the recovery of sensitive species such as proximity to existing preserves or other native lands, ability to be enhanced for wildlife habitat, and potential for use as a wildlife corridor. Some previously cultivated lands in western Fresno County have already been acquired and a demonstration project is underway. Habitat restoration will soon take place and a study to determine effective and efficient means of restoration is being instituted. Ultimately, we would hope that large blocks of land, strategically located, would provide a mosaic of habitat types and an abundance of upland wildlife habitat.

The Wetlands Restoration Program's Central Valley Habitat Joint Venture focuses on acquiring fee title or easements in the Tulare Basin to restore or enhance wetland habitat. At least 50% of the land acquired must be returned to wetlands, which would leave up to 50% of the land available for upland areas. It is expected that much of the upland areas would need restoration or enhancement to be suitable for sensitive plants and wildlife.

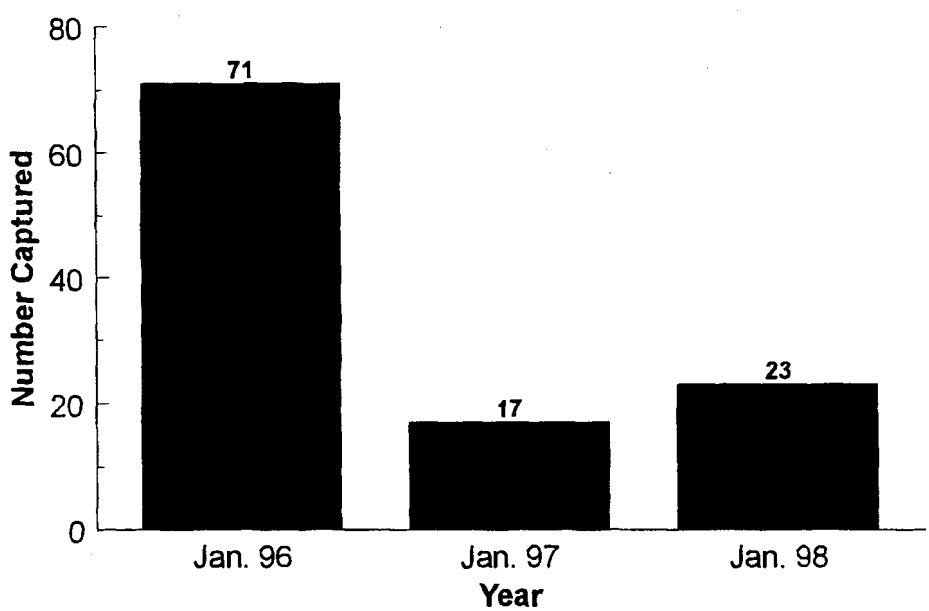

Figure 6. Number of Tipton kangaroo rats captured at Naval Air Station Lemoore, 1996 - 1998.

There are several studies currently underway, or in the process of being developed, which will provide valuable information concerning appropriate habitat restoration and habitat management techniques for Tipton kangaroo rats. A study in the Lokern area of Kern County is quantifying the effects of grazing and assessing its potential use as a technique for habitat enhancement. The study is supported by the Biological Resources Division (BRD) of the U.S. Geological Survey and the U.S. Bureau of Land Management (BLM). A similar, but more widely applicable grazing study is being developed by the BRD, BLM, ESRP, and CDFG that would occur on Pixley NWR, Allensworth ER, and on the Carrizo Plain. Results from a study on burning as a habitat management tool at NAS Lemoore will soon be released by ESRP. Finally, the CVPIA Land Retirement Program's demonstration project will provide essential information on the most efficient and economical meth-

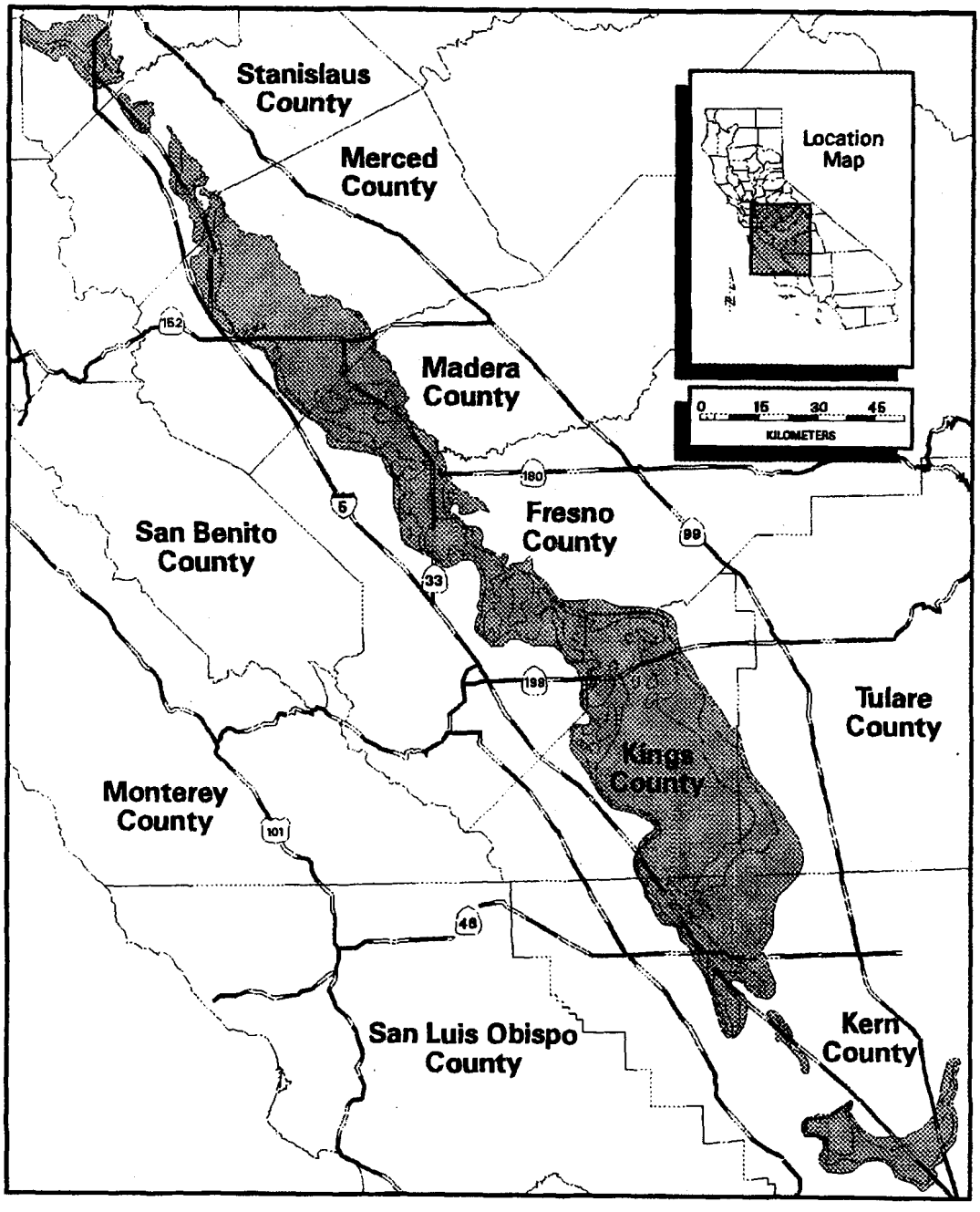

Figure 7. Central Valley Project Improvement Act Land Retirement Project area of focus (shaded area).

ods to restore previously cultivated lands to wildlife habitat.

While Tipton kangaroo rats and many other sensitive species in the southern San Joaquin Valley are still declining, it is hoped that these and other similarly focused and collaborative programs will play major roles in ecosystem recovery. After many years of habitat loss, fragmentation and degradation, continuing population declines, and pessimism about endangered species and ecosystems in the San Joaquin Valley, it is somewhat reassuring to see collaborative efforts focused on recovery. However, if above-average precipitation and further population declines are continuing features in the San Joaquin Valley, immediate habitat management actions to conserve Tipton kangaroo rats, based upon an adaptive management strategy (Holling 1978), are likely to be required.

ACKNOWLEDGMENTS

Many people have dedicated their efforts to gather the information presented here and it would be virtually impossible to name them all. Suffice it to say that the work of the field biologists from ESRP, Consultants in Wildlife and Environmental Services Agency, and CDFG has been monumental; reams of data have been collected, sometimes under very unpleasant conditions. T. Charmley of the United States Fish and Wildlife Service, kindly allowed access and support for the studies conducted at Pixley NWR. The Department of the Navy granted access and funding for the studies conducted on NAS Lemoore; we are particularly grateful for the ongoing assistance of J. Crane at NAS Lemoore. D. Johnson of the California Department of Corrections provided funding for studies and access to the North Kern Prison Site. To these people and many others, we give our sincere thanks.

LITERATURE CITED

Briese, L.A. and M.H. Smith. 1974. Seasonal abundance and movement of nine species of small mammals. Journal of Mammalogy 55:615-629.

Culbertson, A.E. 1946. Observations on the natural history of the Fresno kangaroo rat. Journal of Mammalogy 27:189-203.

Hawbecker, A.C. 1951. Small mammal relationships in an ephedra community. Journal of Mammalogy 32:50-60.

Holland, R.F. 1986. Preliminary descriptions of the terrestrial natural communities of California. The Resources Agency, California Department of Fish and Game, Nongame Heritage Program, Sacramento, California. 156 pp.

Holling, C.S. (ed). 1978. Adaptive environmental assessment and management. Wiley, New York. 377pp.

M'Closkey, R.t. 1972. Temporal changes in populations and species diversity in a California rodent community. Journal of Mammalogy 53:657-676.

Morrison, M.L. and L.S. Mills, 1993. Ecology of the Fresno kangaroo rat and associated small mammals at NAS Lemoore. Unpubished. report to Western Division, Naval Engineering Command, San Bruno, California. 31pp.

O'Farrell, M.J., D.W. Kaufman, and D.W. Lundahl. 1977. The use of live-trapping with the assessment line method for density estimation. Journal of Mammalogy 58:575-582.

Single, J. R., D.J. Germano, and M.H. Wolfe. 1996. Decline of kangaroo rats during a wet winter in the southern San Joaquin Valley, California. 1996 Transactions of the Western Section of the Wildlife Society 32:24-41.

Tollestrup, K. 1979. The ecology, social structure, and foraging behavior of two closely related species of leopard lizards, *Gambelia silus* and *Gambelia wislizenii*. Ph.D. dissertation., University of California at Berkeley, 146 pp.

United States Fish and Wildlife Service. 1984. Pixley National Wildlife Refuge Master Plan.

____. 1998. Recovery Plan for Upland Species of the San Joaquin Valley, California. Region 1, US Fish and Wildlife Service, Portland OR. 391 pp.

Uptain, C.E. 1989. Survey for Tipton kangaroo rats (*Dipodomys nitratoides nitratoides*) on the proposed Delano Prison site, Kern County, California. Unpublished report to the California Department of Corrections. 11 pp.

____. 1995. Habitat recovery on the North Kern Prison Site: a summary of six seasons of monitoring. Unpublished Report to the California Department of Corrections, Sacramento, California. 49 pp.

Williams, D.F., and D.J. Germano. 1993. Recovery of endangered kangaroo rats in the San Joaquin Valley, California. Transactions of the Western Section of the Wildlife Society 28:93-106.

____, ____, and W. Tordoff III. 1993. Population studies of endangered kangaroo rats and blunt-nosed leopard lizards in the Carrizo Plain Natural Area, California. California Dep. Fish and Game, Nongame Bird and Mammal Section. Report No. 93-01, 114 pp.