EFFECTS OF LIVESTOCK GRAZING ON A COMMUNITY OF SPECIES AT RISK OF EXTINCTION IN THE SAN JOAQUIN VALLEY, CALIFORNIA

Annual Report[1]

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Summary

The fencing and water supply on the Lokern Natural Area study site were completed, and protocols for sampling plots, vegetation, and animals were developed and implemented in 1997 and 1998. The effects of the 1997 accidental wildfire and subsequent prescribed burn on the study site were considerable, but they are expected to become less important in the next year or two. As the fire effects lessen with time, and we continue to gather information on the year-to-year variation in rainfall, plot condition, and relative abundance of plants and animals, it will become possible to develop a better understanding of grazing effects. If this study is to succeed it will take time, patience, and resources. Beginning in the year 2000, the field research on the Lokern will require $65,000 per year. This assumes that in-kind support from cooperating agencies and organizations will continue at past levels.

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Background

In 1995, the Bureau of Land Management (BLM) approached the US Geological Survey – Biological Resources Division (then the National Biological Service) for assistance in developing a research project to help determine how livestock grazing on arid public lands in the southwestern San Joaquin Valley might be impacting several plant and vertebrate species that were listed by state and federal agencies as threatened or endangered. The Western Ecological Research Center (WERC) of the Biological Resources Division developed a research proposal to carry out the research in cooperation with several other agencies and organizations interested in the topic (see Cooperator's section below).

In 1997, a study site on the Lokern Natural Area in western Kern County was chosen and prepared for the research. This included fencing eight plots (Figure 1), four controls (62 acres or 29 hectares) each nested within four treatment pastures (one Section each or 640 acres or 259 hectares). Water was piped into each treatment plot for the cattle.

Midway through the construction of cattle fencing in May 1997, an accidental wildfire burned through half of the study area. In order to reduce the confounding effect of this

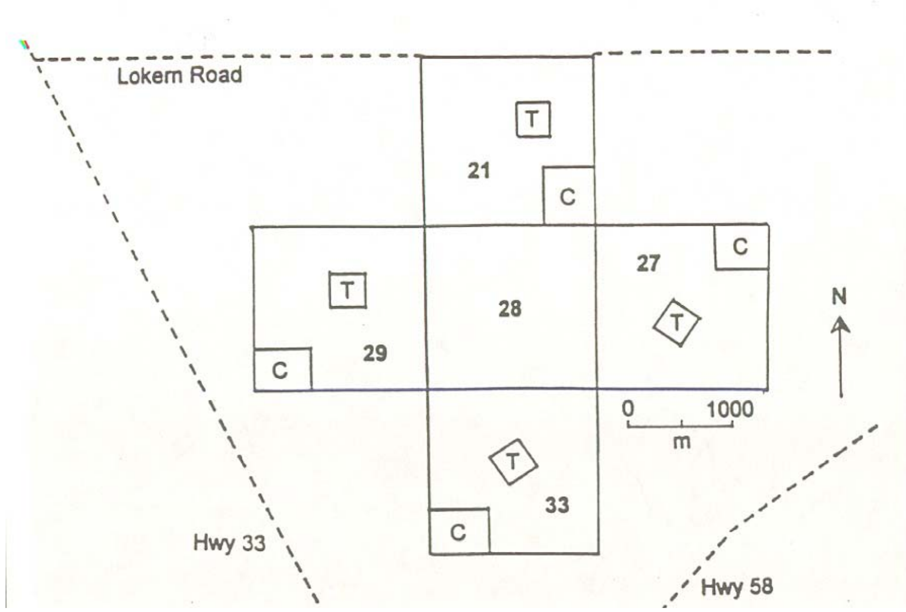

Figure 1. Lokern Study Area showing design of experimental and control plots.

fire on the study design, the other half of the study area was intentionally burned in July 1997. Initial, baseline plant sampling was completed on the four treatment and four control plots before the burns in 1997, while baseline vertebrate sampling was completed on the eight plots after the burns in July and August 1997. A summary of these results, along with a copy of the research study plan, was included in the Annual Report for 1997.

Cattle were turned out onto the newly fenced treatment plots for the first time in February 1998. The yearly plot, vegetation, and animal sampling schemes were completed as planned in 1998, and the cattle were removed in July 1998, just prior to mammal trapping.

Results

Fire Effects: The 1997 wildfire only burned part of the study area, thus introducing a confounding factor into the study design. The unequal coverage of the fire was addressed by intentionally burning the remainder of the study area. The irony about the wildfire is that it probably would not have occurred without the abundant fuel provided by the exotic annual grasses. In addition, the fire probably would not have carried through the study area if we had started our grazing a year earlier. The fires, however, have had considerable impacts on the study.

The most obvious and predictable effect of the fires has been the death of virtually all the saltbush (*Atriplex* spp.) on the study site. For example, the number of living and dead saltbush plants were counted in 10 sample areas within four of our plots before and after the prescribed burn. The average percent dead plants before the burn was 16.1% and after the burn was 99.82%. Clearly, the fires have converted the study site from saltbush scrub to grassland. It remains to be seen how the fires will have affected the habitat conversion in the long term. Will saltbush recolonize the area, or will it remain a grassland for the foreseeable future?

One consequence of the habitat shift resulting from the burns has been a change in some of the bird species using the study site. For example, the average estimated density (for methods see Annual Report for 1997) of horned larks in the eight plots went from 5.4 individuals/100 hectares in 1997 to 111.4/100 hectares in 1998. Similarly, mourning doves increased from 5.4 to 16.0/100 ha between the two years. Sage sparrows decreased from 184.5 to 126.0/100 ha, and this decline is expected to become more pronounced as the dead saltbush plants decompose through time.

Obvious, and largely predictable, fire effects on the residual dry matter (RDM) also occurred on the plots. For example, RDM estimates taken on 2 February 1998, at the beginning of the growing season after the fires and before the cattle were turned out, illustrated the virtual elimination of thatch from the plots that burned. An unburned area just outside of Section 33 had 2,690 lbs/acre, while the portion of Section 33 where the wildfire burned had only 185 lbs/acre of RDM, and the prescribed burn portion had only 450 lbs/acre. The difference between these two areas is probably related to the much hotter and more complete burn that occurred with the wildfire.

Even after the postfire growing season, the impacts of the fire are obvious. For example, the average of 30 RDM samples from each of the four control plots (ungrazed but burned) in August 1998 was 2,439 lbs/acre. This value is considerably lower than the 4,141 lbs/acre average from 30 samples taken from an ungrazed and <u>un</u>burned area immediately adjacent to and outside of the study area.

The fires have also influenced the grazing impacts. For example, on the inside back cover is an aerial photograph of Section 33 (Figure 1) taken from 11,500 feet on 28 August 1998 after the grazing treatment. The ungrazed control plot is obvious inside the lower left corner of the treatment plot. There is also a distinct difference between the two sides of the unfenced road that cuts diagonally across the treatment from the upper left to lower right corners. This road was the boundary between the wildfire (right side of road) and the prescribed fire (left side). The cattle grazed the wildfire portion of the plot more heavily than the prescribed burn portion. Presumably the composition of plants on the wildfire side (less grass and more forbs) was preferred by the cattle.

<u>Grazing Effects on Plots</u>: The El Niño winter produced a total rainfall for the year of 16.24 inches at Buttonwillow (about 11 km or 7 mi from the study site). This is more than twice the 20-year average precipitation of 6.65 inches. In addition, much of this rainfall occurred late in the season, which contributed to an abundance of forage on the plots. Although a grazing effect on the treatment plots was achieved, the target RDM level of 500 lbs/acre was not reached. Indeed, not even the average stocking rate of 0.71 AUM (Animal Units/Month) per acre on the four treatment plots could keep up with the

growth of vegetation, and unfortunately the cattle operator simply could not obtain more cattle to further reduce the forage before the beginning of our mammal trapping in late July. Even though the cattle were distributed on the four treatment plots to try and achieve similar RDM levels, this was not completely successful (Table 1). In addition to RDM, we also measured the height of vegetation, and cover (6 classes, lowest = least cover) on the plots. For all three measures, there was a significant difference between the four Sections as well as between the control and treatment plots (ANOVA, $P < 0.037$), but there were no Section/plot interactions.

Table 1. Cattle stocking rates and vegetation characteristics of study plots.

Plots	Stocking Rate, AUM*	RDM, lbs/acre	Height, cm	Cover, 6 classes
21C	--	2094	32.8	5.7
21T	422	1380	15.4	4.6
27C	--	2282	38.0	5.3
27T	324	1267	18.0	3.5
29C	--	2634	38.7	5.5
29T	343	1237	21.8	3.7
33C	--	2746	39.0	6.0
33T	711	1902	28.0	5.9

* 1 AUM = one cow weighing 1000 lbs for one month. Stocking rate is for the entire 1998 summer season.

Vegetation Surveys: The methods used in 1998 were similar but not identical to those of the previous year (see Annual Report for 1997). Reproductive density was recorded for the combined mallow taxa (*Eremalche* spp.) and for Kern mallow only (in the broad sense, i.e., *Eremalche parryi* ssp. *kernensis*). All permanent transects were re-sampled. In addition, temporary, stratified-random transects were sampled as needed to obtain the desired precision for reproductive density of Kern mallow. Mallow reproductive data were collected 23 March to 13 April 1998 and associated vegetation data from 27 March to 6 April 1998.

Comparisons between paired data (e.g., repeated samples on permanent transects between years) were analyzed using the Wilcoxon signed ranks test (Z statistic). The Mann-Whitney test (U statistic and its approximate Chi-squared equivalent) was used for non-paired comparisons between treatments. Tests were considered significant for $P < 0.05$.

The overall mean reproductive density of *Eremalche* species was significantly greater in 1998 than in 1997 ($Z = 2.37$, $P = 0.02$) (Table 2). In 1998, reproductive density for the combined mallow species differed significantly between control and treatment grids only in Section 21 ($U = 959.5$, $X^2 = 4.97$, 1 df, $P = 0.03$). For Kern mallow alone, conclusions regarding differences between treatments were the same as for the combined species. In 1997, reproductive density differed only in Section 29.

Table 2. Reproductive density of *Eremalche* species (mean ± SE) on study plots.

	1997		1998	
21C	9.2 ± 3.9	*n* = 20	215.7 ± 47.0	*n* = 55
21T	12.7 ± 7.5	*n* = 20	46.5 ± 19.4	*n* = 27
27C	0	*n* = 10	22.2 ± 21.7	*n* = 10
27T	1.1 ± 1.1	*n* = 10	31.6 ± 21.2	*n* = 10
29C	7.3 ± 4.9	*n* = 10	50.2 ± 26.5	*n* = 10
29T	22.0 ± 6.9	*n* = 21	93.1 ± 27.5	*n* = 11
33C	1.5 ± 1.4	*n* = 10	19.2 ± 19.0	*n* = 10
33T	0	*n* = 10	0	*n* = 10
Overall	6.7 ± 2.8	*n* = 8	59.8 ± 24.3	*n* = 8

Forty-three plant taxa were encountered on transects during 1998, including nine not found during 1997. New plant taxa were *Amsinckia tessellata* var. *tessellata*, *Astragalus didymocarpus, Conyza* sp. (not in flower), *Eriogonum gracillimum*, *Filago californica, Guillenia lasiophylla, Marrubium vulgare, Sisymbrium irio,* and *Tropidocarpum gracile.* In addition, identifications of two species were revised based on samples collected in 1998: *Lasthenia californica* had been reported previously as *L. minor* and *Plagiobothrys canescens as P. arizonicus*.

In 1998, red-stemmed filaree (*Erodium cicutarium*) dominated or co-dominated on all 32 vegetation transects and had a significantly higher percent cover than in 1997 ($Z = 4.94$, $P < 0.001$) (Table 3). Red brome (*Bromus madritensis* ssp. *rubens*) co-dominated on 7 control and 6 treatment transects but was significantly reduced in cover compared to the previous year ($Z = 4.94$, $P < 0.001$). Other co-dominants on 1 to 3 transects were Arabian grass (*Schismus arabicus*) and mouse-tail fescue (*Vulpia myuros*). Among the dominant and co-dominant species in 1998, only mouse-tail fescue differed in percent cover between controls (16.8 ± 4.1) and treatments (21.4 ± 2.9) ($U = 75.0$, $X^2 = 3.99$, 1 df, $P = 0.046$).

Table 3. Absolute cover of dominant species* by year (mean ± SE, $n_i = 4$) on study plots.

	BRMA		ERCI		SCAR		VUMY	
	1997	1998	1997	1998	1997	1998	1997	1998
21C	76.3±2.5	16.5±4.7	27.0±2.5	83.8±2.0	0.5±0.5	3.3±1.1	13.0±3.4	5.3±1.5
21T	69.8±1.7	14.5±5.0	30.3±4.9	82.5±5.4	1.0±0.4	6.0±2.1	32.5±3.1	14.5±2.5
27C	67.3±2.1	10.5±1.8	30.3±4.6	81.5±3.7	0	6.5±2.1	35.5±1.9	16.0±2.3
27T	81.0±4.6	18.5±2.6	21.0±8.5	60.3±9.6	1.5±0.9	17.5±4.3	21.5±5.3	22.5±2.2
29C	90.0±1.1	61.8±3.9	9.5±4.7	67.8±12.1	0.5±0.5	8.0±2.2	3.8±3.1	7.0±2.1
29T	91.0±1.2	37.3±5.0	16.8±5.1	63.8±9.1	1.3±0.8	5.0±1.8	10.5±3.4	11.5±2.9
33C	84.5±6.2	55.0±11.5	13.0±3.7	81.3±1.5	0.3±0.3	4.0±1.1	27.0±11.1	39.0±9.1
33T	86.3±2.3	47.8±2.0	14.5±3.3	66.0±2.3	0.3±0.3	7.0±2.3	16.5±2.4	37.3±3.2
Overall	80.8±1.8	32.7±3.8	20.3±2.1	73.3±2.7	0.7±0.2	7.2±1.0	20.0±2.4	19.1±2.5

* BRMA = *Bromus madritensis* ssp. *rubens,* red brome
ERCI = *Erodium cicutarium,* red-stemmed filaree
SCAR = *Schismus arabicus,* Arabian grass
VUMY = *Vulpia myuros*, mouse-tail fescue

Total plant cover ($Z = 3.98$, $P < 0.001$) and cryptogamic crust cover ($Z = 2.21$, $P = 0.03$) were reduced significantly in 1998 compared to 1997 (Table 4), but herbaceous plant cover did not differ ($Z = 1.45$, $P = 0.15$). The number of species per belt transect was greater in 1998 than in 1997 ($Z = 2.53$, $P = 0.01$) and was the only vegetation variable that differed between controls (19.3 ± 0.8) and treatments (16.5 ± 0.9) in 1998 ($U = 192.5$, $X^2 = 6.00$, 1 df, $P = 0.014$). Shrub cover was absent on all transects in 1998 due to fire mortality.

Table 4. Vegetation characteristics by year (mean ± SE, n_i = 4) on study plots.

	Percent total cover		Percent herbaceous cover		Percent cryptogamic crust cover		Number of species on belt	
	1997	1998	1997	1998	1997	1998	1997	1998
21C	92.8±1.1	91.8±1.8	86.8±1.4	91.8±1.8	1.3±0.5	0	21.0±0.6	22.5±1.2
21T	97.3±1.1	93.3±1.7	95.0±1.7	93.3±1.7	0.5±0.3	0	18.8±1.4	19.0±1.5
27C	98.0±0.4	93.3±2.7	92.0±1.5	93.3±2.7	1.3±0.9	2.5±2.2	17.0±1.1	20.3±0.5
27T	97.8±0.5	86.3±3.3	96.0±1.1	86.3±3.3	3.8±1.9	1.0±0.4	19.5±1.4	18.0±0.7
29C	97.5±1.0	91.0±4.3	93.5±0.5	91.0±4.3	5.3±4.0	1.8±1.2	13.3±0.5	18.5±0.5
29T	98.5±1.2	87.3±2.7	97.0±0.9	87.3±2.7	4.0±4.0	0.3±0.3	17.5±0.9	14.3±2.2
33C	99.8±0.3	99.0±0.4	99.5±0.3	99.0±0.4	0	0	8.5±1.5	16.0±1.4
33T	97.8±0.5	97.3±1.4	96.8±0.9	97.3±1.4	0	0	12.3±0.8	14.8±1.3
Over all	97.4±0.4	92.4±1.1	94.6±0.7	92.4±1.1	2.0±0.7	0.7±0.3	16.0±0.8	17.9±0.6

Precipitation and fire are the two factors most likely to be responsible for observed differences in mallow reproductive density and vegetation characteristics between 1997 and 1998. Rainfall during the 1998 growing season was at a record high, totaling over twice as much as the 20-year average. The wildfire and subsequent prescribed burn in summer 1997 may have affected plant responses by releasing nutrients and by destroying plants and seeds of some species while stimulating others. The lack of shrub cover in 1998 would account for the lower total cover on vegetation transects compared to 1997. The fires also could have destroyed or obscured much of the cryptogamic crust layer, accounting for its decrease. Similarly, the wildfires apparently were detrimental to red brome seed; the only transects where it co-dominated in 1998 were in the two sections that had been prescribed-burned. Conversely, the fires most likely stimulated growth of red-stemmed filaree, accounting for its increase in cover. The combination of fire and high rainfall also would explain the appearance of nine new plant species and the higher number of species on vegetation transects overall.

The patterns in mallow reproductive density were similar to those found in 1997, except for Section 21. Although reproductive densities in the control and treatment areas of Section 21 had been similar in 1997, reproductive density in the control area far exceeded that in the treatment area during 1998. Kern mallow was still actively growing when data collection was terminated on 13 April. However, differences in reproductive density between the two grids are not likely to be related to differences in timing because data were collected on the same dates in both the control and treatment areas. Furthermore, differences between the treatments are not necessarily attributable to cattle grazing, particularly because they were largely observed before significant grazing had occurred. One possible explanation for the change in Section 21 is that the control area may have had a larger seedbank that responded to the high rainfall with massive germination.

The higher Kern mallow reproductive density in the control area of Section 21 and the greater number of plant species present in control areas overall may or may not be related to cattle grazing. All comparisons between controls and treatments herein are preliminary, and many more years of data collection are necessary to establish trends related to cattle.

<u>Mammal Surveys</u>: During the July/August 1997 nocturnal small mammal trapping we captured one pocket mouse (*Perognathus inornatus*) and two kangaroo rats (*Dipodomys nitratoides*) in 6,912 trap-nights (see Annual Report for 1997). This year, with the same number of trap-nights in late July and early August, our success was better (Table 5).

Table 5. Numbers of nocturnal mammals captured on study plots in 1998.

	Species*					
Plot	DH	DI	DN	OT	PI	Total
Sect 21C	0	0	1	0	11	12
Sect 21T	0	0	1	0	2	3
Sect 27C	0	0	8	1	11	20
Sect 27T	0	0	3	0	0	3
Sect 29C	0	0	0	0	1	1
Sect 29T	1	0	0	0	0	1
Sect 33C	0	0	0	0	2	2
Sect 33T	0	1	0	0	0	1
Total	1	1	13	1	27	43

*DH = *Dipodomys heermanni*, Heermann's kangaroo rat
DI = *Dipodomys ingens*, Giant kangaroo rat
DN = *Dipodomys nitratoides*, San Joaquin kangaroo rat
OT = *Onychomys torridus*, Southern grasshopper mouse
PI = *Perognathus inornatus*, San Joaquin pocket mouse

However, the number of nocturnal rodents captured is still too small to carry out any meaningful statistical tests or draw any conclusions. Small mammal numbers have been low throughout the region over the last few years (D. Germano, B. Cypher, and P. Kelley, personal communication). We expect numbers of nocturnal rodents on the Lokern to continue to increase.

The number of San Joaquin antelope squirrels (*Ammospermophilus nelsoni*) caught during 3,072 trap-mornings in the two years was similar (Table 6).

Table 6. Number of antelope squirrels captured on study plots.

	Year	
Plot	1997	1998
Sect 21C	4	5
Sect 21T	9	2
Sect 27C	3	8
Sect 27T	4	2
Sect 29C	5	0
Sect 29T	1	2
Sect 33C	6	5
Sect 33T	5	9
Total	37	33

Three individual squirrels were recaptured from 1997 - two on the same plot, while one moved from the control to the treatment plot in Section 21.

If all the small mammal data for 1998 are pooled, the average number of individuals captured on the control plots (13.3) was not significantly greater than the average (5.7) on the treatment plots (t-test, P=0.3).

<u>Bird Studies</u>: The methods used in 1997 and 1998 were the same. Sixteen species of birds were detected within the point-count plots in 1998 (11 species in the treatment plots and 14 species in the control plots) compared to only nine species in 1997 (seven species each encountered within treatment and control point-count plots). The total number of birds detected was also higher in 1998 than in 1997 -- 174 and 106, respectively. Migration and nesting season appeared to be later than normal. This is indicated by four species of birds being detected in the plots that would usually be nesting either out of the immediate area or outside of California. These lingering migrants are not the sole reason for the increase in the total number of birds observed, rather the most common nesting birds were also much increased this year with the exception of the Sage Sparrow (Table 7).

Table 7 presents estimates of the density (number/100 hectares) for selected bird species on each of the control (C) and treatment (T) study plots (identified by Section number - e.g., 21C, 21T, etc.) on the Lokern study site during April and May 1997 and 1998. Estimates are based on the 4 point-counts done per study plot (averaged) and the area of the 100-m radius point-counts. Individual birds seen flying over during the point-count are not included in this density estimate.

Table 7. Bird densities (number/100 hectares) on study plots.

	Species* and year							
	HOLA		MODO		SAGSP		WEME	
Plots	1997	1998	1997	1998	1997	1998	1997	1998
21C	0	11	0	32	233	233	42	127
21T	0	42	11	0	160	96	85	0
27C	11	11	0	0	212	149	32	42
27T	0	212	0	0	329	371	53	53
29C	0	0	32	96	212	53	11	74
29T	0	212	0	0	255	74	53	42
33C	21	148	0	0	32	11	32	21
33T	11	255	0	0	43	21	11	74
Total	43	891	43	128	1476	1008	319	433

* HOLA = horned lark, MODO = mourning dove, SAGSP = sage sparrow, WEME = western meadowlark

The effects of the wildfire and prescribed burn are the most conspicuous change between the two years. Last year five Le Conte's thrashers, a species dependent on shrubs for nesting, were observed, while none were found this year. Likewise, eight loggerhead shrikes were seen in 1997, compared to only two in 1998. Both of these species build fairly large nests in the protective cover of larger shrubs. A similar drop in numbers is expected in the future for the sage sparrow. Fewer of this species was detected in 1998 compared to 1997, even though the number of birds overall was much higher. Observations on Carrizo Plain suggest that sage sparrows may nest in shrub skeletons for a year or two before abandoning the area. Observations this year on the Lokern study area are consistent with those on Carrizo Plain. Differences between control and treatment plots would be expected for each of these shrub-nesting species.

<u>Lizard Surveys</u>: Survey methods for lizards in 1997 and 1998 were the same (see Annual Report for 1997). Cool and rainy weather persisted into the first week of June 1998, with only a few days in April and May warm enough to census lizards. Plots were surveyed for blunt-nosed leopard lizards (*Gambelia sila*) on Section 27 from April until the end of June and on the other Sections from early June until mid July. Each plot was censused 10 times. Dave Germano completed all censuses on the control and treatment plots in section 27, and three assistants censused for lizards in Sections 21, 29, and 33. Besides recording blunt-nosed leopard lizards seen, sightings of other lizards and grasshoppers were also noted.

Activity (and probably numbers) of blunt-nosed leopard lizards was very low in 1998. No leopard lizards were found on plots 21T, 27C, 27T, 29C, 33C, and 33T (Table 8). Only three sightings of leopard lizards were made during 1998: one on 21C and two on 29T. Few side-blotched lizards (*Uta stansburiana*) were found during censusing, and numbers also were less than in 1997. However, western whiptail lizards (*Cnemidophorus tigris*) were found in greater numbers in 1998 than in 1997, especially on plots in

Sections 21 and 27. Mean number of grasshoppers counted during censuses were much greater in 1998 than in 1997, and were consistently greater on the grazed (treatment) plots than on the ungrazed control plots.

Table 8. Number of lizards and mean number of grasshoppers on the study plots.

	Species* and Year							
	BNLL		SBL		WWL		Average GH	
Plot	1997	1998	1997	1998	1997	1998	1997	1998
21C	4	1	3	2	1	7	5.2	611.2
21T	2	0	5	2	1	10	6.4	654.4
27C	1	0	3	0	1	4	4.3	139.6
27T	3	0	3	3	5	16	3.9	192.0
29C	3	0	2	0	2	1	10.6	136.7
29T	0	2	3	2	2	2	11.9	473.8
33C	0	0	1	0	0	1	11.2	55.3
33T	1	0	5	0	1	0	12.7	131.0
Total	14	3	25	9	13	41	--	--

* BNLL = Blunt-nosed leopard lizard, *Gambelia sila*
SBL = Side-blotched lizard, *Uta stansburiana*
WWL = Western whiptail lizard, *Cnemidophorus tigris*
GH = grasshoppers

In addition, only two leopard lizards were opportunistically sighted on roads in the study site during three months of driving from plot to plot. Also, no leopard lizards were seen during rodent trapping in July/August. Abundance of leopard lizards seems to be even lower this year than previous years.

<u>Invertebrate studies</u>: Terrestrial invertebrates were sampled with arrays of ten pitfalls on each of the eight plots, as in 1997 (see Annual Report for 1997). These traps were monitored during the same six days that mammals were trapped in July/August of both years. Table 9 compares the average number of invertebrates captured per pitfall per day for each plot in 1997 and 1998:

Table 9. Average number of invertebrates/pitfall/day on study plots.

Plots	1997	1998
21C	3.9	11.1
21T	4.2	15.0
27C	4.2	24.7
27T	3.9	9.4
29C	5.0	5.8
29T	12.9	7.4
33C	4.5	5.8
33T	4.4	21.8
Average	5.4	12.6

In 1998, the average invertebrates/pitfall/day for control plots was 11.8 and for treatment plots was 13.4. These results are not significantly different (ANOVA, P=0.56). However, there was a significant difference between the four Sections (ANOVA, P=0.04). In both years we also captured terrestrial vertebrates in the pitfalls. In 1997, one side-blotched lizard and five whiptail lizards were caught, while in 1998 the pitfalls yielded one San Joaquin pocket mouse, 10 side-blotched lizards, and 13 whiptails.

There are several reasons why the capture results for terrestrial vertebrates should be examined with caution, and conclusions drawn sparingly this early in the study. First, it will take another year or two for the major effects of the fires on RDM to disappear on the control plots. Secondly, because of relatively low reproductive rates there is an inevitable lag time for these populations to respond to environmental changes – including grazing. Thirdly, the populations certainly respond to more environmental variables than just grazing, and it will require several years of monitoring relative numbers in the different plots to begin to understand these factors.

Funding

We have successfully raised nearly $150,000 in cash to prepare the study site for the research, and to implement plant and animal sampling in 1997, 1998, and 1999. This figure does not include nearly an equal amount of in-kind contributions from cooperators. It costs about $65,000 in cash per year (see below) to maintain the study site and carry out the sampling, which does not include on-going commitments for in-kind support. At present, we have funds to cover costs through 1999. We have no funds for 2000 and beyond. As in the past, we will be relying on contributions from all of the participants to meet future funding needs.

Yearly Budget (Does not include in-kind contributions):

Item	Cash Amount	
CA State Univ. Bakersfield Foundation	$35,000	
End. Sp. Recov. Prog. Plant Studies	$15,000	
WERC, Piedras Blancas Field Stn	$3,500	
WERC, Kern Field Stn	$3,500	
Vehicle	$3,000	
Travel	$3,000	
Field Supplies/Repairs		$2,000
Total	$65,000	

Cooperators

The Bureau of Land Management (BLM) has been the principal "client" of the Lokern Project, and their needs have driven much of the planning and design of the study. Numerous other agencies and organizations have realized that the research has broad applicability to their lands and interests, and they have participated in various aspects of the project.

In addition to WERC and BLM, the main supporters and participants in the Lokern Project include the Endangered Species Recovery Program (ESRP); the US Fish and Wildlife Service (USFWS); the California Department of Fish and Game (CDFG); the California State University, Bakersfield (CSUB); the Center for Natural Lands Management (CNLM); the California Department of Water Resources (CDWR); Chevron Oil Company; ARCO Oil Company; Laidlaw Environmental Services; and Eureka Livestock Company.

The following investigators have been responsible for implementing the different aspects of the Lokern research. These scientists have also contributed summaries of data for this annual report:

Dr. Doug Barnum, Research Biologist, Kern Field Station, Western Ecological Research Center, US Geological Survey, Delano, CA 93216-0670. Phone 805/725-1958. Doug_Barnum@usgs.gov. ***Plot studies.***

Dr. Ellen Cypher, Research Ecologist, Endangered Species Recovery Program, PO Box 9622, Bakersfield, CA 93389-9622. Phone 805/398-2201. Cypher@lightspeed.net. ***Vegetation studies.***

Mr. Sam Fitton, Widlife Biologist, Bureau of Land Management, 20 Hamilton Court, Hollister, CA 95023. Phone 831/830-5000. Sfitton@ca.blm.gov. ***Bird studies.***

Dr. David Germano, Research Biologist, Department of Biology, California State University, Bakersfield, CA 93311. Phone 805/589-7846. Dgermano@csubak.edu. ***Lizard, mammal, and invertebrate studies.***

Dr. Galen Rathbun, Research Biologist, Piedras Blancas Field Station, Western Ecological Research Center, US Geological Survey, San Simeon, CA 93452-

0070. Phone 805/927-3893. Galen_Rathbun@usgs.gov. ***Mammal and invertebrate studies. Project and report coordination.***

Mr. Larry Saslaw, Wildlife Biologist, Bureau of Land Management, 3801 Pegasus Drive, Bakersfield, CA 93308. Phone 805/391-6086. Lsaslaw@ca.blm.gov. ***Plot and cattle studies.***

In addition, the following people and agencies assisted with field work: Tom Murphey, WERC Piedras Blancas Field Station; Marc Kalbaugh, April Sandoval, and Dave Arms, WERC Kern Field Station; Graciela Hinshaw, Center for Natural Lands Managment; Kathy Sharum, BLM, Carrizo Plain Natural Area; Joe Hoscheidt, Will Kohn, and Martin Potter, CDFG; Tamra Sandoval, Jason Storlie, and Rachel Zwerdling-Morales, ESRP; Vida Germano, Matt Kohr, Maria Lum, and Gayle Faber, CSU Bakersfield Foundation; Margie Graham, California Department of Water Resources. We greatly appreciated the assistance from the following volunteers that participated in field work: Brady Barnum, Anita Reich, Joel Saslaw.