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

A study plan was prepared, which was successfully used to raise start-up funds for the research project. The general design of the study is to compare the relative abundance of species on four replicated, grazed (treatment) and ungrazed (control) study plots over a 5-10 year period. Approximately $90,000 was spent during 1997 in preparing a five-Section study site within the Lokern Natural Area, which is located in the southwestern San Joaquin Valley. Pre-treatment or base-line data were collected from the study site during 1997. Personnel from several cooperating agencies and organizations will continue to monitor the study site, but additional funding must be found for 1998 and subsequent years.

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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 US Geological Survey-Biological Resources Division (BRD) developed a research proposal to do the work on the Carrizo Plain Natural Area in San Luis Obispo County, CA.

Because of the scope of the proposed research, and the shrinking budgets in both state and federal resource and research agencies, it was realized from the outset that if the study was to be completed it would require the cooperation and support of numerous government, conservation, and private organizations. A meeting to discuss a draft research proposal, with all interested parties invited, was held at Santa Nella, CA, on 19 March 1996. However, the difficulty of getting a large number of organizations and people, all with agendas of varying degrees of similarity, to agree on how to accomplish the overall goals of the research was underestimated.

In the end, logistical and philosophical differences in how the research should be done on the Carrizo Plain Natural Area resulted in a decision to move the proposed study site to the Lokern Natural Area in Kern County, CA. The land in this area was largely owned by private industry, and there were fewer competing agendas to satisfy. The research study plan developed for the Carrizo Plain was modified and peer reviewed (Appendix A), and logistical and financial support was pursued.

Cooperators

The BLM has been the principal "client" of the proposed research, and therefore their needs have driven much of the planning and design of the study. Numerous other agencies and organizations, however, have realized that the research has broader applicability than the southwestern San Joaquin Valley, and they have participated in various aspects of the project. These other organizations include the San Joaquin Valley Endangered Species Recovery Program (SJVESRP); 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 Jim Etcheverry, Eureka Livestock Company.

Funding

The Lokern Project, unfortunately, was initiated during the chaos of federal funding reductions of the mid 1990s. However, the level of cooperation for this project has been extraordinary. Especially important has been our ability to leverage support based on those agencies and organizations that promised support early on. Over the last year we have received the following contributions in personnel from government agencies and private organizations:

- BRD, California Science Center: Two research-grade biologists ¼ time each.
- BRD, Piedras Blancas Field Station: One biologist as available and needed.
- BRD, Piedras Blancas Field Station: Administrative support, as needed.
- BLM: One wildlife biologist ½ time
- BLM: One fire aid 1/8 time, and one biotechnician as available and needed.
- BLM: Fire crew for prescribed burn.
- SJVESRP: One research-grade ecologist 1/8 time.
- University of California, Davis: One research-grade biologist for short periods.
- CNLM: One biologist for short periods as available and needed.
- FWS, Kern Nat'l. Wildlife Refuge: Biologists for short periods.
- CDFG: Biologists for short periods as available and needed.
- CDWR: Biologists for short periods as available and needed.
- Kern County: Fire crew for prescribed burn.

During the last year, we have received the following financial support (total=$189.4K):

- BRD, California Science Center: $50K.
- BRD, Western Regional Office: $35K.
- BRD, Piedras Blancas Research Station: $12.4K.
- BLM, Bakersfield Field Office: $42K.
- USFWS, Region 1 National Wildlife Refuges: $40K.
- USFWS, Sacramento Endangered Species Office: $10K.

In 1997, we received the following material and construction support:

- USFWS, Region 1 National Wildlife Refuges: Barbed wire to complete 16 miles of fencing.
- BLM, Bakersfield Field Office: Land survey, heavy equipment, and fencing crews.
- Chevron: Cooperative Agreement to use 4 Sections of land within the Lokern Natural Area, and water for the livestock.
- ARCO: Permission to use 1 Section of land within the Lokern Natural Area.
- Laidlaw: Climatic data for the Lokern area.
- Jim Etcheverry, Eureka Livestock Company, lessee for Chevron and Arco: Cooperation in supplying and removing cattle on study area, as needed.

We believe that we have sufficient personnel and financial support to continue the research on the Lokern area through 1998. However, because of the high variability in environmental conditions in the area (see Research Study Plan, Appendix A), the study must be continued for 5-10 years. We will need to secure support for 1999 and beyond.

Results

At present, we are fully prepared to begin the experimental stage of the research. We have a group of dedicated collaborators, a Research Study Plan (Appendix A), a study site that has been specifically prepared for the project, all necessary state and federal permits for trapping animals, written permission to carry out the research from the land owners, an enthusiastic and cooperative livestock operator, a Cooperative Agreement with California State University at Bakersfield to facilitate the implementation of the research, research protocols and standardized field data forms, and computer hardware and software to manage and analyze data. In 1997, we gathered pre-treatment (baseline) data on plants and animals on the study site (see Results section, below). Sufficient funding remains to gather data during 1998, the first year of the actual experiment.

Study site

The study design described and illustrated in the Research Study Plan (Appendix A) was followed in the past year. During the spring of 1997, BLM provided a cadastal survey team to locate and mark study site Section corners (Sections 21, 27-29, and 33), fence-lines, and plots within the five Sections making up the Lokern study site. All cooperators then staked the grids within the four replicated control and treatment study plots (e.g., 8 plots designated 21C, 21T, 27C, etc.) and positioned and staked the plant sampling transects.

After all of the bird and plant sampling for 1997 was completed (see below), and nearly all eight of our animal trapping grids were staked, an accidental wildfire spread through the Lokern Natural Area on 19 May 1997. The fire burned all of the standing vegetation and most of our hundreds of wooden grid stakes in Sections 21 and 27, and about ¾ of Section

28. Many newly placed wooden fence posts were also burned. In order to preserve our study design, it was necessary to burn the remainder of the study site. On 22 July 1997, the remainder of Section 28 was burned, along with all of Sections 29 and 33. This resulted in our entire study site receiving essentially the same pre-experiment burn treatment.

After the fires, hundreds of wooden stakes were replaced, along with dozens of wooden fence posts. Now the study site is complete, with about 19 miles of four-strand barbed-wire fencing that defines the treatment and control study plots, nearly 1,500 wooden grid-stakes in place, and dozens of steel stakes that define plant transects. In addition, a livestock watering trough in each of the four treatment and one holding pastures has been installed, with a servicing water line running about 7 miles from the Chevron Lokern Pumping Station.

Personnel from the BLM Bakersfield Field Office have coordinated the preparation of the study site for the research.

<u>Plant Monitoring</u>

Methods: Details of the vegetation monitoring are found in the Research Study Plan (Appendix A). Pre-treatment reproductive density (defined as the total number of buds, flowers, and fruits per m^2) of Kern mallow (*Eremalche kernensis*) was evaluated in belt transects 0.25 m wide by 20 m long. In each belt, the total number of buds, flowers, and fruits present were counted, and counts were divided by belt area ($5m^2$). Due to the patchy distribution of Kern mallow, reproductive densities of zero were encountered, even when belt length was increased to 50 m in trial samples. Time constraints did not permit use of longer transects. Thus, a standard belt transect length of 20 m was used for all analyses. A minimum of 10 belt transects were established and sampled in each study plot. Additional belts were sampled if necessary until the running mean reproductive density stabilized and its standard deviation changed by 5% or less.

Kern mallow belt transects were located in a stratified random fashion on and adjacent to each of the eight diurnal animal (leopard lizard and antelope squirrel) study grids. Belt transects adjacent to the grids were no more than 100 m away, and therefore were within the buffer area enclosed by fencing on the control plots (see Research Study Plan, Appendix A). Transect orientation was chosen randomly within the narrow range that would keep it from crossing the animal grid lines (except for transects outside of the grid proper) or overlapping the edge of the grid. Each end of the belt transect was marked with a steel rod and coordinates determined with a global positioning system (GPS) receiver.

Vegetation data were collected on four 50-m transects within each grid, concurrent with Kern mallow belt transects 1, 3, 7, and 9 for the first 20 m. Vegetation was sampled via the point-intercept method, by dropping a narrow rod with a sharpened tip from a point frame at 50-cm intervals along each transect. Species hits were recorded separately for the cryptogam (i.e., non-vascular plant), herb, and shrub layers. Trees were not present in the study area. Associated species were recorded within a 5-m wide belt centered over the transect.

Kern mallow data were collected 16 March through 2 April 1997. Vegetation data were collected 7-14 April 1997.

Results: Three species of *Eremalche* (*E. kernensis, E. parryi,* and *E. exilis*) were encountered in the Lokern area. Only Kern mallow was observed in Section 21, but all three *Eremalche* species were observed in Section 29. Few mallows were observed in flower in the remaining sections; all were Parry's mallow (*E. parryi*). Weather conditions in late March caused many mallow plants to cease flowering and dry out. Without flowers, individual mallow plants could not be identified to species with certainty. Thus, the reproductive densities reported may include more than one *Eremalche* species. In addition, the dried plants were very inconspicuous, and the time needed for data collection more than doubled midway through the sampling period. Personnel constraints forced a reduction in the number of belts sampled per study plot after that time.

Pre-treatment reproductive density of mallows varied considerably throughout the study area and even within a given section (Table 1). Reproductive density in the plots to be grazed exceeded that in the control plots of three sections, but the difference was statistically significant only in Section 29. Baseline differences in mallow reproductive density will be compensated for in future comparisons between grazed and control plots.

Table 1. Pre-treatment reproductive density (mean ± standard error) of Kern mallow in study plots at the Lokern Natural Area, Kern County, California. The X^2 value is an approximation based on the Mann-Whitney *U* statistic. Reproductive density is defined as the total number of buds, flowers, and fruits per m^2.

Section	**Control**	**Treatment**	***U***	**X^2 (1 df)**	**P**
21	9.2 ± 3.9 (n = 20)	12.7 ± 7.5 (n = 20)	192.0	0.06	0.81
27	0 (n = 10)	1.1 ± 1.1 (n = 10)	45.0	1.00	0.32
29	7.3 ± 4.9 (*n* = 10)	22.0 ± 6.9 (n = 21)	56.5	4.28	0.039
33	1.5 ± 1.4 (n = 10)	0 (n = 10)	60.0	2.11	0.15

A total of 41 plant taxa were encountered during vegetation sampling. The mean number of species hit per transect was 8.6 (s.d. = 3.1), with a mean of 7.3 (s.d. = 2.9) associated species present but not hit by the pointer. Total vascular plant cover on the transects averaged 97.4% (s.d. = 2.4). Cryptogamic crust was infrequently hit, at only 2% cover (s.d. = 4.2). Bare ground and litter accounted for the remaining 0.6% cover. Mean herbaceous cover was 94.6% (s.d. = 4.2), and mean shrub cover was 24.2% (s.d. = 12.0). Herbaceous and shrub values do not sum to 100% because the two layers were tallied separately.

The dominant herb species on all 32 transects was red brome (*Bromus madritensis* ssp. *rubens*), which averaged 64.4% relative cover (s.d. = 14.0). Secondary species were red-stemmed filaree (*Erodium cicutarium*) and mouse-tail fescue (*Vulpia myuros*) at 14.6% (s.d. = 7.3) and 14.5% (s.d. = 9.3) relative cover, respectively. Shrubs were present on 30 of the 32 transects; both transects lacking shrub cover were in the control area of Section 33. Only two shrub species occurred on the transects: common saltbush (*Atriplex polycarpa*) and spiny saltbush (*Atriplex spinifera*). Spiny saltbush was more common, accounting for 72.7% (s.d. = 41.3) of the relative shrub cover, and dominating the shrub layer on 23 transects.

In addition to the above plant monitoring, which is being coordinated by Dr. Ellen Cypher of the SJVESRP, Dr Truman Young of the Department of Environmental Horticulture, University of California, Davis, is independently monitoring plants on the study site using slightly different methods.

<u>Blunt-nosed Leopard Lizard Monitoring</u>

Methods: Detailed descriptions of the monitoring methods are found in the Research Study Plan (Appendix A). The eight survey grids in the control and treatment study plots were censused for blunt-nosed leopard lizards (*Gambelia sila*) from early May until the first week in July. The surveys extended over a longer period of time than was expected because of difficulties in getting students from CSUB to participate. Each plot was censused 10 times. Besides recording the number and location of blunt-nosed leopard lizards seen, other lizards and grasshoppers spotted during the censusing were noted. Vegetation on plots located in sections 21 and 27 burned 19 May 1997 when a wildfire burned through the area. Almost all surveys for lizards were done on these plots after the area burned. Although we burned the vegetation in sections 29 and 33 at the end of July to match what had happened in the other sections, surveys for lizards on plots 29 and 33 were done before the fire.

Results: No blunt-nosed leopard lizards were found on plots 29T and 33C, and only one sighting was made on plots 27C and 33T (Table 1). The highest number of sightings (4) was made on plot 21C, and 3 sightings were made on plots 27T and 29C (Table 1). The most side-blotched lizards (*Uta stansburiana*) were seen on plots 21T and 33T, whereas the highest number of western whiptails (*Cnemidophorus tigris*) was found on plot 27T (Table 1). In general, numbers of lizards were low on all plots. Mean number of grasshoppers counted during a census was higher in the unburned plots than the burned plots (Table 1).

Besides the blunt-nosed leopard lizards found on the plots during the surveys, several were spotted opportunistically on the dirt roads in the study area. Two leopard lizards were captured on 19 May 1997. One adult male (119 mm snout-vent length, 55 g mass; PIT #1F71772851) was caught on the road directly west of plot 27T. Another, smaller adult male (96 mm SVL, 24 g mass; PIT #1F684F5E4C) was caught 10 minutes later on the road that bisects plot 27C. Interestingly, these lizards were captured in the morning, only a few hours before this part of the study site burned. An adult female leopard lizard (109 mm SVL, 29 g mass) was also captured on 22 June 1997 on the dirt road about 50 m north of the grid at 29C. She was not gravid. Additional blunt-nosed leopard lizards were seen on the roads in the study area during the spring and early summer, but were not captured. Blunt-nosed leopard lizards exist in low abundance on the study site, and occur mainly on the roads.

Table 1. Total number of lizards spotted on different study plots on the Lokern study site during visual surveys in late spring and early summer of 1997. Grasshoppers sightings are means +/- Standard Deviation during each survey. C = control, T = treatment.

Section/Treatment	21C	21T	27C	27T	29C	29T	33C	33T
Leopard Lizard	4	2	1	3	3	0	0	1
Side-blotched Liz	3	5	3	3	2	3	1	5
Whiptail Lizard	1	1	1	5	2	2	0	1
Total Lizards	8	8	5	11	7	5	1	7
Grasshoppers, Mean +/- SD	5.2 4.85	6.4 6.62	4.3 3.40	3.9 3.89	10.6 5.15	11.9 7.84	11.2 12.79	12.7 11.17

Dr. David Germano is coordinating lizard monitoring on the Lokern Project. He is associated with the Department of Biology, California State University, Bakersfield.

Small Mammal Monitoring

Methods: The methods used are outlined in the Research Study Plan (Appendix A). Because of the limited number of traps available and personnel to service them, we carried out the 6-day trapping of the diurnal and nocturnal small mammal grids during two sessions. The nocturnal mammal grid was 12 x 12 with 10 m spacing. This grid was nested in the middle of a larger diurnal mammal grid of 8 x 8 with 40 m spacing. We first concurrently trapped the diurnal and nocturnal grids on Sections 21 and 27 from 12-17

August 1997, followed by the grids on Sections 29 and 33 from 24-29 August 1997. In total, we had 3,072 trap-mornings (dawn to ca. 1200 hrs) for the diurnal mammals, and 6,912 trap nights (dusk to dawn) for the nocturnal mammals. All mammals captured were implanted subcutaneously with passive integrated transponder (PIT) tags for long-term individual identification.

Results: Thirty-seven individual antelope squirrels (*Ammospermophilus nelsoni*) were captured, with 65 recaptures (Tables 1 and 2). One pocket mouse (*Perognathus inornatus*) and two kangaroo rats (*Dipodomys nitratoides*) were also captured; one of the kangaroo rats was recaptured twice. No other mammals were captured or sighted. We heard coyotes vocalizing at dusk and dawn, and found some burrowing activity attributable to coyotes or kit foxes. The entire study area was riddled with rodent burrows, but few if any showed signs of being used recently.

The sex ratio of the antelope squirrels was 22/15 (M/F), with a young-of-the-year/adult ratio of 6/31 (120 grams body weight or greater being considered adults).

Table 1. Number of antelope squirrels captured on each trapping grid on the Lokern study site in August 1997. C = control plots, T = treatment plots.

Section/Treatment	21C	21T	27C	27T	29C	29T	33C	33T	Total
First Captures	4	9	3	4	5	1	6	5	37
Recaptures	3	19	4	7	10	0	11	11	65
Total	7	28	7	11	15	1	17	16	102

Table 2. Cumulative total first captures of antelope squirrels during six consecutive days on all eight trapping grids on the Lokern study site in August 1997.

Trap Day	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Total Captured	12	19	26	30	36	37
Percent	32	51	70	81	97	100

The small mammal monitoring effort is being coordinated by Dr. Galen Rathbun of the Piedras Blancas Research Station of BRD, and Dr. David Germano, Department of Biology, California State University, Bakersfield.

Pitfall Trapping

Methods: Monitoring of terrestrial invertebrates and vertebrates using pitfall arrays was implemented after the study plan was written. The overall objective of using the pitfalls is to compare the relative abundance of lizards and their invertebrate prey on the control and treatment study plots. Invertebrates are also important prey of leopard lizards and antelope squirrels.

An array of ten pitfall traps per study plot (5-gallon plastic pails with steel lids and 14 x 14 inch plywood cover boards) were spaced at 40-m intervals. The linear arrays were located about 10 m outside of each of the eight animal trapping grids and were installed in late July 1997. The pitfalls were opened and serviced daily at about sunrise during the same 6-day periods in August 1997 when the mammal grids were trapped. A total of 480 pitfall-days (24-hours) were completed during the trapping sessions.

Results: The only vertebrates captured in the pitfalls were six lizards (one *Uta stansburiana*, and five *Cnemidophorus tigris*). The *Uta* was captured on Section 21C, while two *Cnemedophorus* were caught on 21C, two on 33T, and one on 29C. One *Cnemidophorus* was recaptured once. No mammals or leopard lizards (*Gambelia sila*) were caught in the pitfalls. Invertebrates (identified to major group only) constituted the vast majority of animals caught in the pitfalls. We collected voucher specimens representing the more common taxa encountered, which included (in no specific order) spiders, centipedes, scorpions, pseudoscorpions, solpugids, isopods, silverfish, beetles, ants, winged hymenopterans, hemipterans, cockroaches, and crickets. The overall abundance of invertebrates captured in each major taxon varied (Table 1). The total number of invertebrates captured in each pasture is presented in Table 2.

Table 1. Summary of selected invertebrates captured on the Lokern study site during 480 pitfall-days in August 1997.

Taxon	Number of Pitfalls-days	Total Individuals	Mean/Pitfall-day	Std. Deviation
Ants	220	952	4.33	7.62

Silverfish	231	492	2.13	1.59
Eliodid Beetles	143	212	1.48	1.17
All Beetles	233	330	1.42	1.01
Scorpions	214	258	1.21	0.43
Cockroaches	131	160	1.22	0.57

Table 2. Total number of invertebrates captured during 60 pitfall-days on each study plot during trapping on the Lokern study site in August 1997.

Section/Treatment	21C	21T	27C	27T	29C	29T	33C	33T
Total Inverts Captured	234	254	253	232	297	776	268	264

Dr. Galen Rathbun, BRD, Piedras Blancas Research Station, and Dr. David Germano, Department of Biology, California State University, Bakersfield, are coordinating the pitfall trapping.

Bird Monitoring

Introduction: Because birds respond quickly to changes in vegetation, it is desirable to include this group in the study, even though none are listed species. After the Research Study Plan was finalized (Appendix A), a modest bird-monitoring scheme was initiated in cooperation with Sam Fitton, a wildlife biologist working out of the Hollister office of BLM.

Methods: A baseline was established by completing five-minute point-counts of birds on two 100-m radius areas in each pasture on two days, which resulted in 32 censuses. Sixteen of these censuses were completed on 25 April 1997, and these were replicated on 7 May 1997. During the five-minute counts, birds were tallied by distance from the center of the area (0-50 and 50-100 meters); time (0-3 and 3-5 minutes); and whether the birds were sedentary within the point-count area, or were flying overhead across the area.

Results: A summary of the bird species detected during the 32 point-counts is presented in Table 1, and the number of birds detected during the censuses are presented in Table 2. An estimate of the density of the more common bird species on the eight study plots is presented in Table 3.

Table 1. Number of Point-count censuses (32 total) where birds (by species) were detected on four treatment and four control plots (4 censuses per plot) on the Lokern study site during April and May 1997.

Species	Treatment	Control
Common Raven	3	1
European Starling	1	0
Horned Lark	4	7
Loggerhead Shrike	1	0
Mourning Dove	3	2
Northern Mockingbird	0	1
Red-winged Blackbird	0	1
Sage Sparrow	13	13
Western Meadowlark	12	9

Table 2. Total number of birds sighted during 32 point-counts on four treatment and four control plots (4 censuses per plot) on the Lokern Study site during April and May 1997. Distances are from the center of the 100-m radius point-count areas. Minutes are from the beginning of each five-minute count.

	50 meters		100 meters		Fly over		
Treatment	0-3 min	3-5 min	0-3 min	3-5 min	0-3 min	3-5 min	Total
Treatment	12	4	31	6	14	8	73
Control	17	3	30	3	2	12	67
Total	29	7	61	9	16	20	140

Table 3. Estimate of the density (number/100 hectares) of 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. Estimates are based on the 4 point-counts done per study plot (averaged) and the area of the 100-m radius point-counts.

Section/Treatment	21C	21T	27C	27T	29C	29T	33C	33T
Horned Lark	0	0	0	31.8	0	0	63.7	31.8
Mourning Dove	0	31.8	0	0	31.8	0	0	0
Sage Sparrow	382	350.1	318.3	477.5	413.8	382	31.8	63.7
Western Meadowlark	127.3	191.0	127.3	95.5	31.8	159.2	95.5	31.8

Issues for 1998: This level of survey, which is minimal, should be repeated in 1998. It would be highly desirable to also carry out more detailed monitoring by spot-mapping bird territories on the 500 m square sites within the treatment and control study plots. This effort, however, will require more personnel and financial support than is currently available.

With the fire that occurred after the bird surveys were completed, tremendous changes in the diversity and number of birds detected are expected from this year to next year. This will be interesting to track. Similar to the other monitoring programs, it will take several years for the vegetation to have an impact on the bird numbers and diversity between the control and treatment study plots.

Expenditures

By the end of 1997, all monies received for the Lokern Project (see Funding section above) will have been spent, except for about $16K remaining from funds that were transferred into the Bakersfield Cooperative Agreement, the $40K contributed from FWS refuges, and about $6K remaining from money received from FWS, Sacramento Endangered Species

Program (total=$62K). The preparation of the study site cost us about $5K more than the $85K that was budgeted. This cost overrun was due to the repairs to trapping grids and fences required after the wildfire, and the cost of conducting the prescribed burn to "equalize" the study area after the wildfire. We estimate that we need about $55K to cover costs related to gathering data during the upcoming 1998 field season. If we use our unspent balance of $62K to cover our expenses in 1998 related to gathering data, we have a balance of $7K to apply towards our $5K cost over-run.. This means that we essentially will balance our accounts through 1998. We have no funds committed to the project after 1998.

Future Support

If the collaborating agencies continue to provide personnel and administrative support to the Lokern Project at the level we had for 1997, and we believe they will, then our future costs are minimal. We estimate that our recurrent, yearly funding requirement for the Lokern Project as follows:

Salary for ¼ time research-grade biologist . . .	$20K
Salary for one half-time field technician . . .	$15K
Salary for 5 intermittent field technicians . . .	$8K
Travel for salaried personnel and volunteers . . .	$2K
Government rental pick-up	$5K
Equipment replacement and repairs, misc. . . .	$5K
TOTAL .	$55K

The recurrent, year-to-year costs of supporting the research on the Lokern are relatively small now that we have the study site prepared and most of the equipment needed. If all the agencies and organizations interested in the results would commit a modest $10-20K per year to the project, the needs of the project will be covered with little burden to any one agency, but to the great benefit of all.

This report was prepared by the following personnel involved with the Lokern Project:

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APPENDIX A

7 March 1997

U.S. Department of the Interior
U.S. Geological Survey
Biological Resources Division
CALIFORNIA SCIENCE CENTER

RESEARCH STUDY PLAN

TITLE: Effects of Livestock Grazing on a Community of Species at Risk of Extinction in the San Joaquin Valley, California

BACKGROUND AND JUSTIFICATION:

Most of the hundreds of studies about livestock grazing and browsing are related to range and livestock condition and optimal production. There are also numerous studies of the influences cattle and sheep have on wildlife (Peek and Dalke 1982, Severson 1990, Rosenstock 1996), but few of these have addressed conditions in the arid west. Only recently has the topic of grazing become the concern of conservation biologists (Noss 1994) who have focused largely on documenting the widespread detrimental ecological effects that livestock grazing has had on western lands (Fleischner 1994). There also has been attention given to some of the beneficial effects of livestock (Bicak et al. 1982, Neal 1982, Severson 1990), especially in Europe (Bokdam and Wallis de Vries 1992, Wallis de Vries 1995). Over the last two years, a lively debate has developed on advocacy and objectivity in grazing research (Noss 1994, Brussard et al. 1994, Brown and McDonald 1995, Curtin 1995, Joslyn 1995, Heinz 1995, Noss 1996, etc.). To help clarify the debate we propose an objective, non-advocacy study to help determine if livestock can be used to manage exotic annual grasslands for the benefit of a community of declining species in the San Joaquin Valley ecosystem of California.

The most important factor in the declining distribution and abundance of several plant and animal species endemic to the San Joaquin Valley (Bradford 1992) has been loss of habitat (Griggs 1992, Williams and Kilburn 1992). The southwestern portion of the valley supports ten species listed as threatened or endangered (Table 1), which is among the most concentrated densities of such species in the United States (Flather et al. 1994). Kangaroo rats represent nearly a fifth of these taxa.

Kangaroo rats are often an important component of arid habitats in the west, and have been shown to significantly influence communities, and thereby function as keystone species (Brown and Heske 1990, Heske et al. 1993). In the western San Joaquin Valley, the giant kangaroo rat is probably such a species. Because it reaches high densities, it is perhaps one of the most important prey items for mammalian carnivores (including the endangered San Joaquin kit fox) and numerous raptors. Kangaroo rat burrows provide shelter for several vertebrates, including antelope squirrels, tiger salamanders, and leopard lizards (Williams 1992b). In some areas, it is thought that the burrowing activity of giant kangaroo rats results in mounds that not only modify the topography of the land (Williams 1992b), but also influence the distribution and abundance of several plants, including some of those that are threatened or endangered (Schiffman 1994, Cypher 1994a and 1994b). The kangaroo rat's habit of harvesting and caching grass seed-heads is a significant factor in reducing the standing biomass of grasses after the growing season, and perhaps in reseeding these plants (Shaw 1934, Schiffman 1994). Because the giant kangaroo rat is probably a keystone species, the influence of livestock grazing may be especially important at the community level through its effect on kangaroo rats.

Prior to European settlement, elk, deer, and pronghorn grazed and browsed throughout the San Joaquin Valley (Williams 1992a); it is likely that the community of plants and animals associated with these ungulates evolved under this feeding pressure (Barbour et al. 1993). Indeed, it has been suggested that many of California's habitats evolved under heavy grazing and browsing pressures from a wide array of large herbivores, most of which became extinct in the Pleistocene (Edwards 1992). However, current domestic livestock impacts probably differ from those of native ungulates. In addition, the composition of plant species throughout much of the west, and especially the San Joaquin Valley, has changed remarkably since European settlement. Mediterranean and European annual grasses and forbs, introduced accidentally and for the benefit of cattle and sheep, now dominate the landscape (Biswell 1956, Blumler 1992, Baker 1978, D'Antonio and Vitousek 1992). Some biologists believe that much of the San Joaquin Valley was a grassland dominated by perennial bunchgrasses (Barbour et al. 1993). However, there is convincing evidence that both annual grasses and perennial bunch grasses were relatively uncommon over much of the arid zones of the San Joaquin Valley before European and American settlement. Instead, the arid areas were apparently characterized by lush displays of annual forbs (wildflowers) and some native grasses during the winter. During the long, dry summer these annuals largely died back, leaving vast areas of what appeared to early explorers to be nearly barren soil (Wester 1981, Blumler 1992). Some biologists have suggested that the conversion of San Joaquin Valley native habitats to introduced annual grasses has contributed to the decline of some of the species at risk by creating dense stands of virtually impenetrable vegetative cover (see Williams and Germano 1992 for a brief discussion). For species adapted to habitats characterized by vast open areas this dramatic alteration of vegetative structure probably affects activity times, foraging behavior, predation risk, space partitioning, and visual obstruction (Price, et al. 1994, Schooley et al. 1996). The decline may be further exacerbated in some areas as public pressure is put on land managers to reduce livestock grazing, resulting in even denser stands of annual grasses. However, overgrazing by livestock has been implicated in habitat degradation in some areas of the San Joaquin Valley (Williams and Germano 1992). It has been suggested that livestock grazing might be used to manipulate the exotic, annual grasses for the benefit of species that require more open habitats (Holechek et al. 1982, Kie and Loft 1990, Williams and Germano 1992). One group of biologists and wildland managers has strongly recommended research into the effects of livestock grazing on threatened and endangered species (San Joaquin Valley Biological Technical Committee 1993).

Preliminary field studies on California jewelflower (*Caulanthus californicus*), Kern mallow (*Eremalche parryi* ssp. *kernensis*), San Joaquin woolly-threads (*Lembertia congdonii*), and Hoover's woolly star (*Eriastrum hooveri*) were initiated by the San Joaquin Valley Endangered Species Recovery Planning Program (SJVESRPP) in 1993 at several sites in Fresno, Kern, Kings, and San Luis Obispo counties. The SJVESRPP received funding from the Bureau of Land Management (BLM), Bureau of Reclamation, California Department of Fish and Game (CDFG) and US Fish and Wildlife Service (FWS) to conduct these studies. The primary focus has been to obtain demographic data pertaining to ungrazed populations of the plants.

Preliminary evidence suggests that competition from exotic annual grasses, particularly red brome (*Bromus madritensis* ssp. *rubens*), is reducing survival rates and reproductive output of Kern mallow. In fact, in certain portions of its range that are densely occupied by exotic grasses, no Kern mallow individuals have survived to the flowering stage in recent years (E. Cypher unpublished data). Continued declines in seed set could lead to the extinction of Kern mallow, which is an endangered species restricted to a very small area of Kern County, California. Seeds of many exotic annuals apparently germinate earlier in the growing season than Kern mallow and begin flowering earlier. Exotic bromes (*Bromus* spp.) can germinate under a wide range of temperatures (Martens et al. 1994), and their rapid root growth allows them to out compete native plants for moisture in arid areas. If grazing is restricted to the period when Kern mallow is still in the seedling or rosette stage, but the exotics are close to flowering, exotic plant biomass and seed production may be reduced while avoiding detrimental effects on Kern mallow. With decreased competition from exotics, survival rates of Kern mallow may improve, and the plants that reach flowering also may produce a greater number of flowers. Appropriately-timed grazing potentially could reduce biomass and seed set in annual bromes without a concomitant decrease in native plants (Vallentine and Stevens 1994). Management strategies that can improve survival and reproduction of Kern mallow are needed and livestock grazing may be a useful tool to reduce competition from exotic plants.

Survival and reproduction of Hoover's woolly-star and San Joaquin woolly-threads were compared between grazed and ungrazed portions of three populations that were divided by existing fences (Cypher 1994a). In 1994, small grazing exclosures were built to evaluate grazing effects on San Joaquin woolly-threads and Kern mallow, and this study is still in progress (E. Cypher pers. comm.). Clipping studies on these two species were conducted in 1995 to determine the effects of competition on survival and reproduction (E. Cypher, pers. comm.) In addition, Dr. Susan Mazer and associates from the University of California, Santa Barbara, conducted studies on the demography and reproductive biology of California jewelflower, Kern mallow, and San Joaquin woolly-threads during 1992 and 1993. They also studied effects of competitors on California jewelflower (Mazer and Hendrickson 1993). Funding for Mazer's studies was provided by Section 6 of the federal Endangered Species Act through CDFG, with matching funds from the National Science Foundation.

The potential importance of grazing to terrestrial vertebrates in the San Joaquin Valley ecosystem has been the subject of several studies. Williams et al. (1993) initiated a study of grazing effects on giant kangaroo rats and blunt-nosed leopard lizards on the Elkhorn Plain Ecological Reserve, which is within the Carrizo Plain Natural Area. The Elkhorn Plain study was initiated in 1987 and is on-going, with funding from various federal, state, and private sources. Williams and Germano (1991) also completed a grazing study on Pixley National Wildlife Refuge (NWR). Unfortunately, the results from nearly all of the grazing studies have been largely inconclusive (Williams and Germano 1991, Williams et al. 1993, E. Cypher pers. comm.). These indecisive studies are the result of several factors; primary among these are inadequate funding and lack of control over grazing intensity. Thus, at no fault of the biologists, constraints external to the study caused inadequate experimental designs. Funding, study design, and logistics should no longer be allowed to continue to influence the quality of future grazing research in the region.

BLM authorizes livestock grazing on approximately 162,000 ha (400,000 acres) in the San Joaquin Valley and adjacent interior Coast Range valleys of California, and much of this land has been identified as key to the recovery of species at risk (D. Williams pers. comm.). Recovery of these species depends on the proper management of the extant habitats by public agencies, conservation organizations, preserve managers, and private landowners. Lands acquired by state, federal and private organizations should be evaluated for the effects of grazing on the species at risk; very few data are available on which to base important decisions on the use of livestock to manage these lands. Recent Endangered Species Act Section 7 consultations have highlighted the need for this information, and future grazing authorizations on public lands may be subject to these data being available.

OBJECTIVES:

Only with the results of broadly-conceived, long-term research can the multitude of potential grazing effects (e.g. food/cover reduction, burrow and vegetation trampling, erosion, behavioral interference, predation) be understood. This type of research, however, requires political support, and substantial, stable funding -- both are traditionally fickle with governmental agencies. This research plan is a compromise -- with medium-term, modest research objectives that are appropriate to current funding limitations. However, if additional resources (money and people) become available, it would be relatively easy to include additional sites, making the results more broadly applicable. The scope of the work could also be expanded to include demographic and behavioral factors, leading to a fuller understanding of grazing effects on these at-risk species.

Our overall objective is to determine whether annual grasslands in the San Joaquin Valley can be managed with livestock grazing for the <u>benefit</u> of several species at risk (Table 1). Our current, pragmatic approach, however, restricts us to measuring "benefit" in terms of relative abundances and densities, and thus the following specific questions:

1. Are the relative abundances of small mammals and the blunt-nosed leopard lizard the same on grazed and ungrazed experimental plots?

2. Is the reproductive output of Kern mallow the same on grazed and ungrazed experimental plots?

3. Do percent cover and composition of dominant plants change on grazed and ungrazed experimental plots?

STUDY AREA:

We have chosen two study sites within the Southern San Joaquin Valley: the Lokern Natural Area (LNA) in Kern County and the Pixley National Wildlife Refuge/Allensworth Ecological Preserve (PIX) located in Tulare County, California (Figure 1). The LNA contains approximately 18,000 ha of lands owned and managed by Chevron, BLM, The Center for Natural Lands Management (CNLM), California Department of Fish and Game (CDFG), ARCO, and other private interests. Pixley National Wildlife Refuge (NWR) (approx. 2500 ha) is owned and managed by the U.S. Fish and Wildlife Service, while Allensworth Ecological Preserve is owned and managed by the CDFG. The LNA study site will accommodate our study design and supports 10 of the species at risk (Table 1; San Joaquin kit fox, giant kangaroo rat, short-nosed kangaroo rat, San Joaquin antelope squirrel, blunt-nosed leopard lizard, California tiger salamander, Mountain plover, Loggerhead shrike, Swainson's hawk, and Kern mallow). PIX also supports a number of the species at risk and research there could provide corroborating information, but the species and habitats present are not considered to be as vulnerable as those on LNA. Thus, LNA is considered to be the primary study site.

The PIX complex is considered the secondary site, which could be used if funds and personnel should become available. If studies are conducted at this secondary site, our procedures will be as similar as possible to those described for the LNA site.

PROCEDURES:

<u>Study Design</u>: Our basic design is to compare the abundance of animals and plants on grazed treatment plots and ungrazed control plots. We will have four replicated pairs of treatments and controls. Each treatment plot will be a one-mile square Section (640 acres, ca. 260 hectares). The four Sections will be arranged in a four-leaf clover pattern, with a fifth Section enclosed in the middle of the clover-leaf. The middle Section will serve as a pasture to place livestock while moving them into or out of the four surrounding treatment pastures. The four control pastures will be 25 ha (ca. 62 acres) each and located inside each treatment pastures, in a corner to save fencing costs (Figure 2).

Grazing on the LNA is normally accomplished with sheep, whereas cattle are the preferred class of livestock at other potential study sites. Because it is likely that sheep cannot achieve the desired treatment results, and because cattle are grazed on more lands in the San Joaquin Valley than other forms of livestock, we will use cattle in this study. Arrangements with current livestock operators and the LNA managers will be made to ensure that the enclosures and livestock are adequately maintained, and that stocking rates result in desired grazing effects (weather and growing season allowing). Grazing will not start until 1 December and new grass growth must be at least 6 cm (2 inches) high. If grass growth does not attain the minimum standard in any given year, then pastures will not be grazed during that year. This standing crop height represents the minimum dry mulch rate of 560 kg/ha (500 pounds/acre). Our objective is to obtain the minimum dry mulch rate by at least 1 April each year, when the livestock will be removed.

The treatment pastures are a Section each in order to satisfy the livestock operator's pasture requirements. The control pastures are as large as possible, given the restraints of land ownership and costs of fencing. The number of replicate pairs (four) are also limited by logistical and funding considerations. Because of the importance of placing the animal and plant sampling plots in habitats that support as many species as possible, random placement will not be used. The large size of the treatment pastures relative to the size of the sampling grids for animals and plants should ensures independence and minimal boundary effects. All the pastures will be fenced with four strands of barbed wire. This will keep the cattle inside the treatment pastures and outside the control pastures, and prevent the free-ranging (but tended) sheep from entering either of the fenced pastures. The study will last at least five-years. However, given the interyear variation in weather conditions in California, and especially in the Southern San Joaquin Valley, it may be necessary to extend the study period up to 10 years (Williams and Germano 1992).

<u>Blunt-nosed leopard lizard sampling</u>: Relative abundance will be estimated using a set of 16 parallel transect lines, 300 meters long and spaced 20 meters apart. The sample plots will be placed about in the middle of each control pasture and at least 100 meters from treatment plot fences. Censusing of lizards will consist of walking the transects, and for each sighting the approximate location, sex and age-class will be recorded (Degenhardt 1966, Germano et al. 1994). Each set of transects will be walked ten times within four weeks; the maximum count will be used as the abundance estimate for that plot. Each plot will be censused during May or early June, and a second time during August. One of the treatment/control pairs will be used to gather demographic data. The more intensive effort required on these two plots will include capturing all leopard lizards by noosing or pitfalls (under good habitat conditions up to 650 per year). Standard morphometrics will be taken from all individuals, including reproductive condition. All lizards will be toe clipped, and juveniles and adults implanted with a PIT tag (using protocol described in Germano and Williams 1993), before release at their capture sites.

Antelope squirrel sampling: Abundance will be obtained by establishing an 8 X 8 live-trapping grid with 64 traps at 40-meter intervals. The grid will be superimposed on the transect grid set up for sampling leopard lizards. The grid of traps will be run for six consecutive days once a year, during August. Because we only have about 300 traps, we will run four grids at once; the entire sampling procedure will take about two weeks each year. Trapping protocols will be those developed by Rathbun (pers. comm.), which have been approved by state permitting authorities. Tomahawk live traps covered with burlap will be opened at dawn and closed at noon or when ambient temperature exceeds 95°F, or which ever occurs first. Traps will be checked about every two hours while open. Each squirrel captured (under good habitat condition up to 250 per year) will be located on the grid, sexed, weighed, and injected subcutaneously with a PIT tag between the shoulder blades (protocol as in Schooley et al. 1993), and released. Mark-recapture models will be used to derive and compare population estimates for the treatment and control pastures. Depending on the number of squirrels we find in the study area, up to 20 may be radio-collared for up to three months each year. This will allow us to assess home range sizes as habitats change in the control and treatment areas, and gather information on the ecological relationship between the squirrels and other rodents.

Kangaroo rats sampling: Relative abundance of all small, nocturnal mammals (mostly giant kangaroo rats) will be obtained by live-trapping. Square trapping grids (12x12 grid pattern) with 144 traps at 10-meter intervals will be positioned within and in line with the antelope squirrel grid. The traps will be run for six consecutive nights once in August each year, during the same time the squirrel traps are run. Trapping methods will be those used by Williams et al. (1993), which have been approved by federal and state permitting agencies. Extra-long folding aluminum Sherman traps will be used. Traps will be set in late afternoon and checked the next morning. Given the warm weather during August, there should no danger of low temperature exposure to the trapped rodents. Each animal trapped (under good habitat condition up to 950 per year) will be located on the grid, sexed, weighed, temporarily marked on the fur with a felt-tipped pen, and released. This will give us the total number of individuals trapped for each plot (relative abundance). Identical procedures will be used concurrently on both the treatment and control plots, which will allow us to make valid comparisons of relative abundance for each species between the control and experimental pastures. If funding allows, each rodent will be permanently marked with a PIT tag injected subcutaneously between the shoulder blades (protocol following that of Schooley et al. 1993). A monel size #1 ear tag also will be attached to each pinna. These permanent tags will enable us to collect demographic information and estimate and compare abundance with mark-recapture models. Up to 60 giant kangaroo rats also may be radio-collared each year. Radio tracking protocols for giant kangaroo rats have been developed by Rathbun (pers. comm.) under past state and federal permits. Each individual will be collared for about two weeks before being recaptured and the neck region checked for wear. If any sign of wear is detected, the collars will be removed and placed on a different individual. Radio-tracking will provide information on home range sizes between the treatment and control areas, as well as information on the ecological relationship between antelope squirrels and kangaroo rats.

San Joaquin kit fox sampling: Relative abundance of active kit fox dens inside the pastures will be determined by visual searches during the August small mammal surveys.

Kern mallow sampling: Reproductive density (i.e., the number of flowers produced per square meter) will be determined for Kern mallow to incorporate plant density, survival, and reproduction into a single index of abundance. The total number of flowers will be estimated in March of each year on quadrats located through stratified random sampling. Quadrats will be oriented with their long axes parallel to any obvious gradient in Kern mallow densities due to environmental factors or grazing intensity. Sampling will begin with 10 quadrats of 20 m by 0.25 m per study plot. If any quadrats have a tally of zero flowers, the length will be increased in 5-m increments until positive counts are obtained. The longest quadrat identified in this manner then will be applied to all study plots to maintain consistency. A single estimate of reproductive density will be obtained for each study plot by pooling tallies from the 10 quadrats. Additional quadrats will be sampled as necessary until the running mean density for each study plot stabilizes (Mueller-Dombois and Ellenberg 1974).

The goal of this sampling is to detect a difference in Kern mallow flower density between grazed and ungrazed plots of twice the overall mean (in any given year) with alpha = 0.05 and beta = 0.05. Annual plant densities and reproduction are affected greatly by weather conditions, and thus actual figures for differences in reproductive density cannot be proposed in advance, nor can different years be compared. Similarly, the amount of seed produced per plant is related to the long-term survival of a plant population (Hickman 1993). However, the baseline (i.e., pre-treatment) reproductive density for each study plot will be used as a covariate in the statistical analysis to account for inherent differences in Kern mallow abundance among study plots. The first year will constitute a pilot study to determine appropriate quadrat length and to assess the adequacy of the study design to obtain the desired statistical precision.

Vegetation cover and composition sampling: Vegetation cover and composition will be assessed annually in early April on four 50-m transects per study plot located in stratified-random fashion. Vegetation will be sampled via the point-intercept method (Mueller-Dombois and Ellenberg 1974, Bonham 1989). A narrow rod with a sharpened tip will be lowered from a point frame (Bonham 1989) at 50-cm intervals along each transect, in a modified version of the method used by the California Native Plant Society (1995). Cover estimates will be averaged over all transects within a given study plot, resulting in a single value per pasture.

Detecting changes in vegetation cover and composition due to the treatment is secondary to determining the effects of grazing on listed species abundance. Thus, the vegetation sampling is proposed simply to obtain estimates of overall cover, cover of exotic plants versus natives, and to identify the dominant plants in each study plot. The sampling is not designed to detect differences in individual species. The statistical goal will be to detect differences of 25% overall cover or exotic cover between paired grazed and ungrazed study plots in a given year, with alpha = 0.10 and beta = 0.10.

Pasture assessment: The treatment Sections will be evaluated using a comparative estimation of vegetative yield technique modified from Haydock and Shaw (1975), which BLM currently uses to assess range readiness. The evaluation will be done beginning immediately prior to livestock placement in enclosures (November) and at one week intervals thereafter until the minimum residual dry mater (560 kg/ha) is attained, when the cattle will be removed. We expect the date of cattle removal will vary from year to year, but should be no later than 1 April each year.

Weather data: Data currently being collected at weather stations near the study area will be used to assess temporal patterns in air temperature, humidity, and rainfall.

Statistical analyses: The null hypothesis in this study is Ho: relative abundances (or densities) of animals and plants are the same in grazed and ungrazed plots. Rejection of the null hypothesis will occur at the p=0.05 level. Analysis of variance will be used to test for differences in the relative abundances of each animal species between plots and across years. Data for Kern mallow will be analyzed using two-factor analysis of variance to account for both grazing and giant kangaroo rat effects. Analysis of covariance will be used to test for differences in the reproductive density of Kern mallow between the grazed and ungrazed plots in the same year, using the pre-study flower density as a covariate to account for inherent differences in abundance. A paired T-test will be used to compare overall cover of vegetation and cover of exotics between grazed and ungrazed plots.

DATA ARCHIVING:

All data will be collected on standardized field forms, and entered into personal computer data base files.

WORK SCHEDULE:

During spring 1997, plots and grids will be laid out, fencing constructed, watering system installed, and livestock operators coordinated in preparation for data collection. Data will be collected for a minimum of five years, and analyses and write-up will take one year. If funding permits, it may be advisable to carry out the monitoring for up to ten years to assess interyear variation, especially if particularly wet or dry years occur during the first five years. The animals and plants will be monitored as follows:

ANNUAL SCHEDULE FOR SAMPLING ANIMALS AND PLANTS

	Months											
Sampling	J	F	M	A	M	J	J	A	S	O	N	D
Leopard Lizard					X	X	X					
Antelope Squirrels							X	X				
Kangaroo Rats							X	X				
Kit Fox							X	X				
Kern Mallow		X	X	X								
Vegetation Transects		X	X	X								
Residual Dry Matter	X	X	X	X	X	X	X	X	X	X	X	X

HAZARD ASSESSMENT/SAFETY CERTIFICATION:

We will closely monitor and assess the various precautions and protocols that are being recommended by authorities on reducing exposure and risk to plague and hantavirus by field workers. In addition, all personnel will be briefed on the potential hazard of being bitten by rattlesnakes, and emergency procedures to be followed in case of being bitten. All project personnel will be trained in the hazards and prevention of dehydration and heat prostration.

ANIMAL CARE AND USE CERTIFICATION:

Appropriate research permits from state and federal authorities will be obtained for all personnel involved. In addition to the protocols already in place for all the species at risk (see citations in Methods section), state and federal permits often stipulate recent modifications to acceptable capture and handling procedures.

EXPECTED PRODUCTS:

The research outlined in this plan is designed to evaluate the effects of livestock grazing on several species at risk on the annual grasslands that occur in the San Joaquin Valley. However, this research also will be directly applicable to the management of species at risk and annual grasslands within the greater San Joaquin Valley ecosystem, including the entire Carrizo Plain Natural Area and Cuyama Valley. This encompasses nearly 162,000 ha of BLM lands in seven counties and over 810,000 ha of private land dominated by annual grasses. The results of this research would also be applicable to the management of over 3.25 million hectares of annual grasslands throughout California and adjoining states.

Products will include peer-reviewed publications in scientific journals; reports in Biological Resources Division (BRD) series; presentations at professional meetings, seminars, and workshops; and informal presentations and consultations with land managers and colleagues.

COOPERATORS:

This study cannot be implemented without a collaborative effort among federal, state and private agencies and the livestock industry. Currently, the following agencies and organizations have committed significant personnel and resources to this study: BLM, FWS, USGS-BRD, San Joaquin Valley Endangered Species Recovery Planning Program, CNLM, CDFG, California State University-Bakersfield, and livestock operators. Permission to carry out the research on Chevron and ARCO lands has been obtained. It is anticipated that other organizations and agencies will also participate in the future.

LITERATURE CITED:

Baker, H.G. 1978. Invasion and replacement in California and neotropical grasslands. Pp. 368-384 *in* J.R. Wilson (ed.) Plant Relations in Pastures. Commonwealth Scientific and Industrial Research organization, Melbourne, Australia. 425 pp.

Barbour, M., B. Pavlik, F. Drysdale, and S. Lindstrom. 1993. California's Changing Landscapes. California Native Plant Society, Sacramento, CA. 246 pp.

Bicak, T.K., R.L. Redmond, and D.A. Jenni. 1982. Effects of grazing on long-billed curlew (*Numenius americanus*) breeding behavior and ecology in southwestern Idaho. Pp. 74-85 *in* J.M. Peek and P.D. Dalke (eds.) Wildlife-Livestock relationships symposium: Proceedings 10. University of Idaho, Forest, Wildlife and Range Experiment Station, Moscow, Idaho. 614 pp.

Biswell, H.H. 1956. Ecology of California grasslands. J. Range Management 9:19-24.

Blumler, M.A. 1992. Some myths about California grasslands and grazers. Fremontia 20:22-27.

Bokdam, J. and M.F. Wallis de Vries. 1992. Forage quality as a limiting factor for cattle grazing in isolated Dutch nature reserves. 1992. Conservation Biology 6:399-408.

Bonhomie, C. D. 1989. Measurements for terrestrial vegetation. John Wiley and Sons, New York, NY. 338 pp.

Bradford, D.F. 1992. Biogeography and endemism in the Central Valley of California. Pp. 65-79 *in* D.F. Williams, S. Byrne, and T.A. Rado (eds.) Endangered and Sensitive Species of the San Joaquin Valley, California. California Energy Commission. 388 pp.

Brown, J.H. and W. McDonald. 1995. Livestock grazing and conservation on southwestern rangelands. Conservation Biology 9:1644-1647.

Brown, J.H. and E.J. Heske. 1990. Control of a desert-grassland transition by a keystone rodent guild. Science 250:1705-1707.

Brussard, P.F., D.D. Murphy, and C.R. Tracy. 1994. Editorial: Cattle and conservation biology -- another view. Conservation Biology 8:919-921.

California Native Plant Society. 1995. Field sampling protocol. Unpublished manuscript. Sacramento, Ca. 8 pp.

Cypher, E. A. 1994a. Demography of *Caulanthus californicus*, *Lembertia congdonii*, and *Eriastrum hooveri*, and vegetation characteristics of endangered species populations in the southern San Joaquin Valley and the Carrizo Plain Natural Area in 1993. Unpublished report to the California Department of Fish and Game, Sacramento, CA. 50 pp. + photographs.
Cypher, E. A. 1994b. Progress report on 1994 grazing studies for Kern mallow and San Joaquin woolly-threads. Unpublished report to the Bureau of Land Management, Bakersfield, CA. 22 pp.
Curtin, C.G. 1995. Letters -- Grazing and Advocacy. Biological Conservation 9:233-241.
D'Antonio C.M. and P.M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annu. Rev. Ecol. Syst. 23:63-87.
Degenhardt, W. G. 1966. A method for counting some diurnal ground lizards of the genera *Holbrookia* and *Cnemidophorus* with results from Big Bend National Park. Am. Mid. Nat. 5:61-100.
Edwards, S.W. 1992. Observations on the prehistory and ecology of grazing in California. Fremontia 20:3-11.
Flather, C.H., L.A. Joyce, and C.A. Bloomgarden. 1994. Species endangerment patterns in the United States. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO. General Technical Report RM-241. 42 pp.
Fleischner, T.L. 1996. Letters: Livestock grazing: Reply to Brown and McDonald. Conservation Biology 10:927-929.
Fleischner, T.L. 1994. Ecological costs of livestock grazing in western North America. Conservation Biology 8:629-644.
Germano, D.J. and D.F. Williams. 1993. Field evaluation of using passive integrated transponder (PIT) tags to premanently mark lizards. Herp. Rev. 24:54-56.
Germano, D. J., D. F. Williams, and W. Tordoff III. 1994. Effect of drought on blunt-nosed leopard lizards (*Gambelia sila*). Northwestern Naturalist 75:11-19.
Griggs, F.T. 1992. The remaining biological diversity of the San Joaquin Valley, California. Pp. 11-15 *in* D.F. Williams, S. Byrne, and T.A. Rado (eds.) Endangered and Sensitive Species of the San Joaquin Valley, California. California Energy Commission. 388 pp.
Haydock, K.P. and N.H. Shaw. 1975. The comparative yield methods for estimating dry matter yield of pasture. Austr. J. Exp. Agr. and Animal Husbandry 15:663-670.
Heinz, D. 1995. Letters: Continued grazing, a presupposition. Biological Conservation 9:708-709.
Heske, E.J., J.H. Brown, and Q. Guo. 1993. Effects of kangaroo rat exclusion on vegetation structure and plant species diversity in the Chihuahuan Desert. Oecologia 95:520-524.
Hickman, J. C. 1993. Points of view: does endangered *Chorizanthe valida* do better with grazing? Madroño 40:285-286.
Holechek, J.L., R. Valdez, S.D. Schemnitz, R.D. Pieper, and C.A. Davis. 1982. Manipulation of grazing to improve or maintain wildlife habitat. Wildl. Soc. Bull 10:204-210.
Joslyn, L. 1995. Letters: Grazing and advocacy. Conservation Biology 9:475-478.

Kie, J.G. and E.R. Loft. 1990. Using livestock to manage wildlife habitats: Some examples from California annual grassland and wet meadow communities. Pp. 7-24 *in* K.E. Severson (ed.) Can livestock be used as a tool to enhance wildlife habitat? USDA Forest Service, Rocky Mountain forest and Range Experiment Station, Ft. Collins, Colorado. General Technical Report RM-194. 123 pp.

Martens, E., D. Palmquist, and J.A. Young. 1994. Temperature profiles for germination of cheatgrass versus native perennial bunchgrasses. Pp. 238-243 *in* S.B. Monson and S.G. Kitchen (eds.) Proceedings--Ecology and Management of Annual Rangelands. USDA Forest Service, Intermountain Research Station, Ogden, UT. General Technical Report INT-GTR-313. 416 pp.

Mazer, S. J., and B. A. Hendrickson. 1993. Demography, ecology, and reproductive biology of California jewelflower (*Caulanthus californicus*: Brassicaceae). Unpublished report to the California Department of Fish and Game, Sacramento, CA. 113 pp.

Menke, J.W. 1992. Grazing and fire management for native perennial grass restoration in California grasslands. Fremontia 20:22-25.

Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, New York, NY. 547 pp.

Neal, D.L. 1982. Improvement of Great Basin winter range with livestock grazing. Pp. 61-73 *in* J.M. Peek and P.D. Dalke (eds.) Wildlife-Livestock relationships symposium: Proceedings 10. University of Idaho, Forest, Wildlife and Range Experiment Station, Moscow, Idaho. 614 pp.

Noss, R.F. 1994. Editorial: Cows and conservation biology. Conservation Biology 8:613-616.

Noss, R.F. 1996. Livestock grazing: replies to Brown and McDonald. Conservation Biology 10:927-929.

Peek, J.M. and P.D. Dalke, (eds.). 1982. Wildlife-livestock Relationships Symposium: Proceedings 10. University of Idaho, Forest, Wildlife and Range Experiment Station, Moscow, Idaho. 614 pp.

Price, M.V., R.L. Goldingay, L.S. Szychowski, and N.M. Waser. 1994. Managing habitat for the endangered Stephens' kangaroo rat (*Dipodomys stephensi*): Effects of shrub removal. Am. Midl. Nat. 131:9-16.

Rosenstock, S.S. 1996. Shrub-grassland small mammal and vegetation respopnses to rest from grazing. J. Range Manage. 49:199-203.

San Joaquin Valley Biological Technical Committee. 1993. A biological framework for natural lands and endangered species in the Souther San Joaquin Valley. Draft report. 26 pp + appendices.

Schiffman, P.M. 1994. Promotion of exotic weed establishment by endangered giant kangaroo rats (*Dipodomys ingens*) in a California grassland. Biodiversity and Conservation 3:524-537.

Schooley, R.L. B. Van Horne, and K..P. Burnham. 1993. Passive integrated transponders for marking free-ranging townsend's ground squirrels. Jour. Mamm. 74:480-484.

Schooley, R.L., P.B. Sharpe, and B. Van Horne. 1996. Can shrub cover increase predation risk for a desert rodent? Can. J. Zool. 74:157-163.

Severson, K.E. (ed.). 1990. Can livestock be used as a tool to enhance wildlife habitat? USDA Forest Service, Rocky Mountain forest and Range Experiment Station, Ft. Collins, Colorado. General Technical Report RM-194. 123 pp.

Shaw, W.T. 1934. The ability of the giant kangaroo rat as a harvester and storer of seeds. J. Mammal. 15:275-286.

Vallentine, J. F., and A.R. Stevens. 1994. Use of livestock to control cheatgrass--a review. Pp. 202-206 *in* S.B. Monson and S.G. Kitchen (eds.) Proceedings--Ecology and Management of Annual Rangelands. USDA Forest Service, Intermountain Research Station, Ogden, UT. General Technical Report INT-GTR-313. 416 pp.

Wallis de Vries, M.F. 1995. Large herbivores and the design of large-scale nature reserves in Western Europe. Conservation Biology 9:25-33.

Wester, L. 1981. Composition of native grasslands in the San Joaquin Valley, California. Madroño 28:231-241.

Williams, D.F. 1992a. Introduction. Pp. ix-xi *in* D.F. Williams, S. Byrne, and T.A. Rado (eds.) Endangered and Sensitive Species of the San Joaquin Valley, California. California Energy Commission. 388 pp.

Williams, D.F. 1992b. Geographic distribution and population status of the giant kangaroo rat, *Dipodomys ingens* (Rodentia, Heteromyidae). Pp. 301-328 in D.F. Williams, S. Byrne, and T.A. Rado (eds.) Endangered and Sensitive Species of the San Joaquin Valley, California. California Energy Commission. 388 pp.

Williams, D.F. and D.J. Germano. 1991. Effects of livestock grazing on endangered species at Pixley National Wildlife Refuge, Tulare County, California. Final Report (Order No. 10181-11764BW), Kern National Wildlife Refuge, Delano, CA. 33 pp.

Williams, D.F. and D.J. Germano. 1992. Recovery of endangered kangaroo rats in the San Joaquin Valley, California. 1992 Transactions of the Western Section of The Wildlife Society 28:93-106

Williams, D.F., D.J. Germano, and W. Tordoff III. 1993. Population studies of endangered kangaroo rats and blunt-nosed leopard lizards in the Carrizo Plain Natural Area, California. California Dept. Fish and Game, Nongame , Bird and Mammal Section Report 93-01:1-114

Williams, D.F. and K.S. Kilburn. 1992. The conservation status of the endemic mammals of the San Joaquin Faunal Region, California. Pp. 329-345 *in* D.F. Williams, S. Byrne, and T.A. Rado (eds.) Endangered and Sensitive Species of the San Joaquin Valley, California. California Energy Commission. 388 pp.

Table 1. Animal and plant species and their listing status occurring in the western
San Joaquin Valley.

Giant kangaroo rat (*Dipodomys ingens*)	FE	CE
Tipton kangaroo rat (*Dipodomys nitratoides nitratoides*)	FE	CE
Short-nosed kangaroo rat (*Dipodomys nitratoides brevinasus*)	C2	SSC
San Joaquin antelope squirrel (*Ammospermophilis nelsoni*)	C2	CT
San Joaquin kit fox (*Vulpes macrotis mutica*)	FE	CT
Mountain plover (*Charadrius montanus*)	C2	SSC
Swainson's hawk (*Buteo swainsoni*)	C3	CT
Loggerhead shrike (*Lanius ludovicianus*)	C2	---
California tiger salamander (*Ambystoma californiense*)	C2	---
Blunt-nosed leopard lizard (*Gambelia silus*)	FE	CE
California jewelflower (*Caulanthus californicus*)	FE	CE
Kern mallow (*Eremalche parryi* spp. *kernensis*)	FE	---
San Joaquin woolly-threads (*Lembertia congdonii*)	FE	---
Hoover's woolly-star (*Eriastrum hooveri*)	FT	---

FE=Federally Endangered; Federally Threatened; C2=Federal Candidate Species, Category 2; C3=Federal Candidate Species, Category 3; CE=California Endangered; CT=California Threatened; SSC=California Species of Special Concern

BUDGET

The two budget scenarios below are for the LNA study site only. Budget 1 includes costs for a "bare-bones" approach. Budget 2 includes the "bare-bones" expenses plus costs for expanded research and techniques (e.g., population estimation, demographics, behavior, plant clipping studies, PIT-tagging, and radio-tracking). We estimate that adding the Pixley study site would double the figures in buget 1 or 2. Neither budget includes in-kind contributions, such as fencing materials and employee salaries, from the various cooperating insititutions.

Budget 1 - "bare-bones"

	Year 1	Year 2	Year 3	Year 4	Year 5
Salaries/benefits					
Contract personnel	22,000	24,000	26,000	28,000	30,000
Equipment and supplies					
Fencing materials, installed	33,000	-0-	-0-	-0-	-0-
Water system	23,000	-0-	-0-	-0-	-0-
Enclosure maintenance	-0-	2,000	2,500	3,000	3,500
Misc.	10,000	2,000	2,200	2,400	2,600
Travel	1,000	1,200	1,400	1,600	1,800
Vehicles	1,800	2,000	2,200	2,400	2,600
Total	90,800	31,200	34,600	37,400	40,500

Budget 2 - "bare-bones" plus expanded research

	Year 1	Year 2	Year 3	Year 4	Year 5
Salaries/benefits					
Contract personnel	60,000	62,000	64,000	66,000	68,000
Equipment and supplies					
Fencing materials, installed	33,000	-0-	-0-	-0-	-0-
Water troughs	23,000	-0-	-0-	-0-	-0-
Enclosure maintenance	-0-	2,000	2,500	3,000	3,500
Misc.	10,000	2,000	2,100	2,200	2,300
Travel	1,000	1,100	1,200	1,300	1,400
Vehicles	3,200	3,300	3,400	3,500	3,600
PIT tags	5,000	2,000	2,200	2,400	2,600
Radio-tags	4,500	1,800	1,900	2,000	2,100
Misc. repairs, etc.	1,000	1,200	1,400	1,600	1,800
Total	140,700	75,400	78,700	82,000	85,300

APPROVALS:

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