Santa Barbara County Oak Restoration Program

Yearly Progress Report for the Period July 1998 - June 1999

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This progress report summarizes the activities of the Santa Barbara County Oak Restoration Program for the period July 1998 through June 1999. Completed activities for the year can be grouped into four main areas: 1) research on methods for restoration of oaks, 2) research to determine factors limiting natural regeneration of oaks, 3) maintenance of cattle and site infrastructure, and 4) dissemination of information.

I) Research on methods for restoration of oaks and establishment of seedlings and saplings

In the fall of 1998, the oaks on our research site produced extremely few acorns, and thus no acorns were available for a new set of planting experiments. This failure of the acorn crop occurred statewide. Factors responsible for the production of acorns in a given year are not well understood, but Koenig *et. al*. (1994), suggest that wet weather in the previous spring correlates well with low acorn production in the following fall. It has been speculated that heavy spring rain disrupts oak pollination. Thus, whatever the mechanism, the very wet, El Niño weather conditions of winter and spring of 1998, were probably responsible for the lack of acorns in the fall.

Although no new plantings were done this year, we continued to monitor both survivorship and growth of the seedlings which resulted from the previous years' planting.

To review, in the early winter of 1997, we planted acorns using the following design. For each species, *Quercus lobata* and *Q. agrifolia*, we had 21 planting positions per plot: 5 open (Fig. 1A); 5 new open (Fig. 1B); 5 fenced to prevent grazing by large animals such as cattle, deer and pigs (Fig. 1C); 5 caged and fenced to prevent all mammalian grazing, including by animals such as gophers, ground squirrels and rodents (Fig. 1D); and one cage control to test for artifacts of our caging treatment (Fig. 1E). With the exception of treatment B, all planting positions had been dug/established in the previous year.

Treatment B was added to determine whether seedling establishment was affected by re-using planting positions.

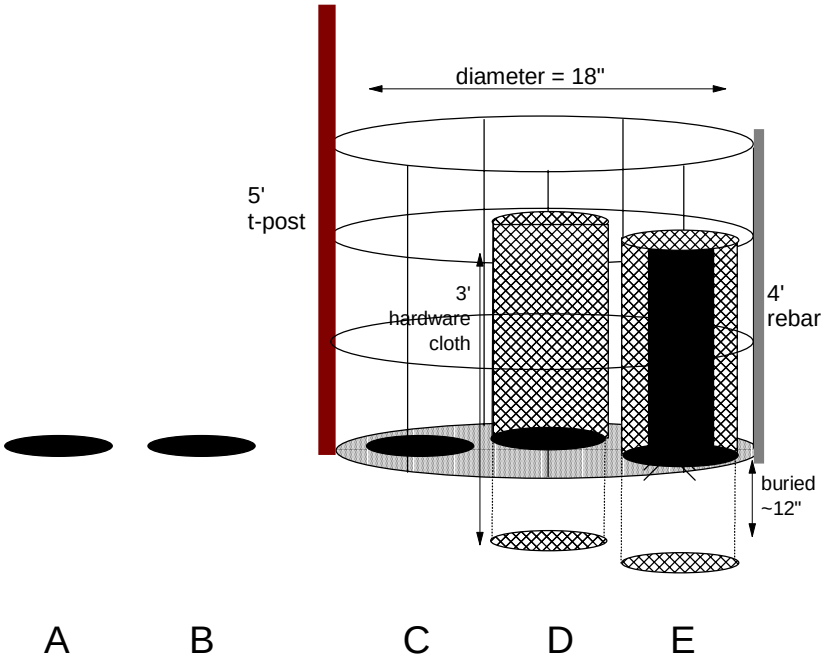

Figure 1. Treatments used for acorn plantings. A: open. B: new open (i.e., dug in 1997). C: fenced to prevent grazing by large animals. D: caged and fenced to prevent grazing and herbivory by both large and small mammals. E: cage control to test for caging artifacts. These treatments are replicated in both 1) plots that are grazed by cattle and 2) plots that are fenced to exclude cattle.

Fences were constructed of 4' high, 2" x 4" mesh welded galvanized wire (12 gauge); they were round (diameter = 18") and supported at one side with a 5' t-post, and at the other side with a 4' rebar. Smaller cages to exclude small mammals were cylinders constructed of 3' high hardware cloth (mesh size = 0.5"); they were sealed at the ends with aviary wire. In positions with cages (small mammal exclusion), the cages were set 12" into the ground. Two viable acorns were planted 1-2" below the soil surface, at each planting location. Prior to planting, acorns were dropped into buckets of water. Acorns that floated were discarded; we planted only acorns that sank and appeared viable.

Using this design, we planted 42 acorns per species, or a total of 84 acorns in each of 33 large (50 x 50 m) plots. Fifteen of these large plots are fenced with electric wire to

exclude cattle; fifteen are unfenced and are grazed by cattle, and 3 plots are ungrazed in large ungrazed pastures. Thus a total of 2772 acorns were planted (1386 per species) in 1997.

Seedling emergence (review).

As presented in last year's final report (1997 - 1998), highest seedling emergence was found in locations that were protected from rodents and large grazers (Figure 2.) The exclusion of large grazers (cattle and deer) alone enhanced seedling emergence of only *Q. agrifolia* in grazed plots. Thus most early seedling mortality appears to be due to rodents.

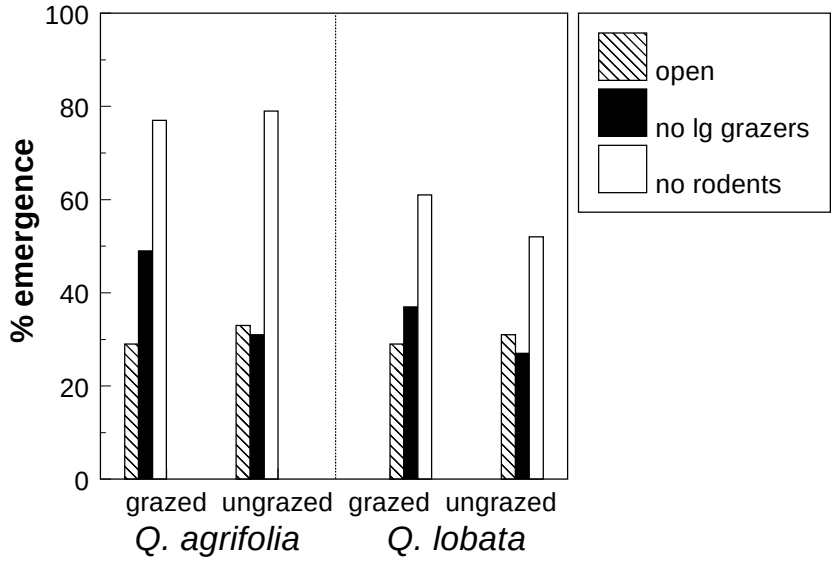

Figure 2. Percent emergence of seedlings in large plots grazed by cattle, vs. those fenced to exclude cattle. Data are total percent emergences for three experimental treatments (see Fig. 1 a, c, and d); May 1998.

Seedling establishment.

In May 1999, we found that the establishment of seedlings followed a similar pattern (Figure 3) to emergence, with the continuation of high mortality of seedlings in the treatments open to small mammals (i.e., open, and no large grazers.) Oak seedling establishment in the treatments that excluded small mammals was 72%, on average,

compared to 16% (no large grazers) and 8% (open). There does not appear to be a significant difference between plots that are grazed by cattle, compared to those that are ungrazed.

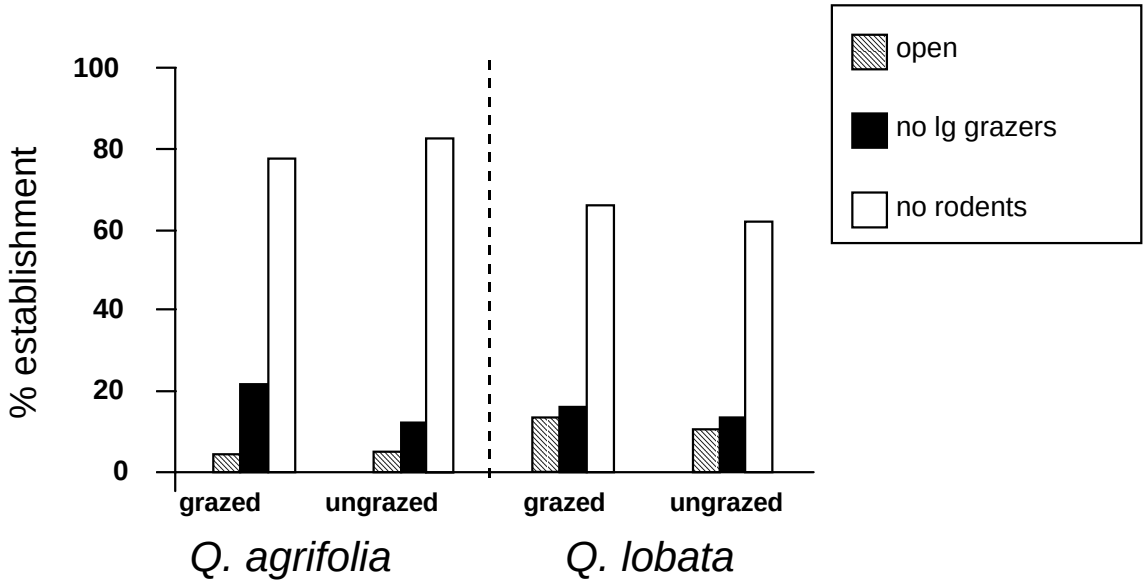

Figure 3. Effects of experimental grazing and other factors on seedling establishment of 2 species of oaks. Data are percent of acorns planted that resulted in a surviving, established seedling. Acorns were planted in winter 1997 - 1998; seedling establishment data from May 1999.

Including all treatments and both species, 26% of the acorns planted in 1997, are now established seedlings (see photos, Appendix 1). In terms of actual seedling numbers, there are currently 703 established one-year-old seedlings (340 *Q. lobata*, and 363 *Q. agrifolia*.) Sixty-six percent of these seedlings are in the treatment protected from rodents (Table 1.)

Quercus lobata	treatment	# in cattle grazed plots	# in ungrazed plots
	no rodents	95	107
	open	40	38
	no large grazers	24	23
	cage control	5	8
	total	*164*	*176*

Quercus agrifolia	treatment	# in cattle grazed plots	# in ungrazed plots
	no rodents	113	147
	open	14	19
	no large grazers	32	22
	cage control	9	7
	total	*168*	*195*

Table 1. Total number of established one-year-old oak seedlings in experimental treatments (all areas combined). Data from May 1999.

The height of one-year old seedlings also varied among treatments (Figure 4). *Q. lobata* seedlings range in height from 18 to 630 mm (1 to 25 inches) with a mean of 185 mm (7.5”). *Q. agrifolia* seedlings range from 10 to 540 mm (0.5 - 21 inches) with a mean of 169 mm (6.5”). Seedlings protected from rodents were, on average, taller than those in other treatments; those in large plots that are ungrazed by cattle appear to be slightly larger than those in areas that are being grazed.

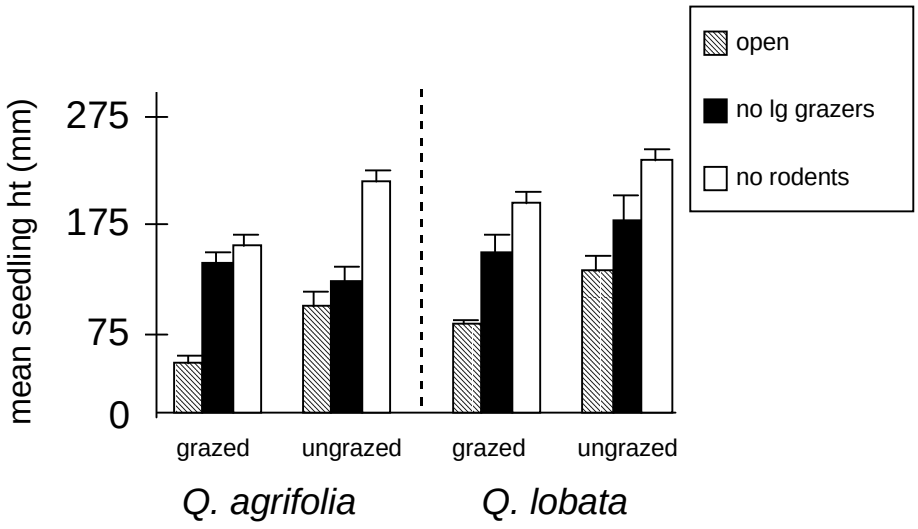

Figure 4. Effects of experimental grazing and other factors on seedling height. Data are mean seedling heights (plus 1 s.e.) per planting location in Spring 1999. Seedlings emerged in Spring 1998, and thus were one-year old individuals

Corroborating previous findings with seedling emergence, there were no significant differences between cage controls and fenced "open" locations (Figure 1, treatments C and E) on seedling establishment. Figure 5 presents comparison of these two treatments for May 1999 results. This finding indicates that our cages that exclude rodents, do not have unknown secondary effects or "caging artifacts".

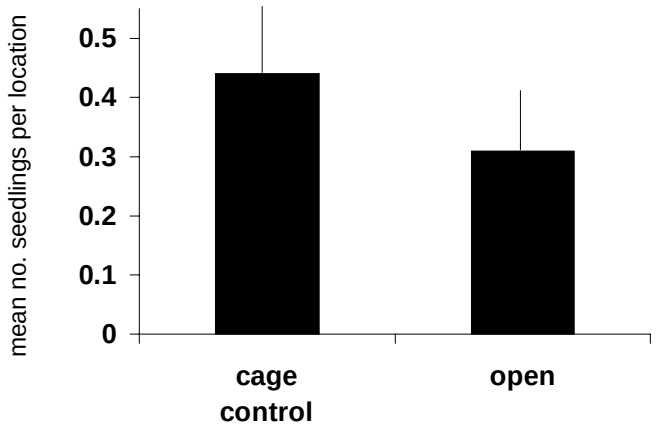

Figure 5. Result of secondary caging effects on oak seedling establishment. Data are mean number of seedlings (plus 1 s.e.) present in May 1999 per planting location for cage controls (half cages) and open treatments. Seedlings emerged in spring 1998. Paired comparison tests reveal no significant difference between treatments.

A total of 18 two-year-old established seedlings have survived since planting in 1996. There are presently 6 two-year old *Q. agrifolia* seedlings, and 12 two-year old *Q. lobata*. Our results suggest that the treatment which was most successful in terms of oak seedling survivorship was that which excluded small mammals (Figure 6.) There are no seedlings surviving from the 1996 - 1997 planting that were in the open. In addition, there are more seedlings present in areas that are grazed by cattle than in ungrazed areas (11 vs. 7).

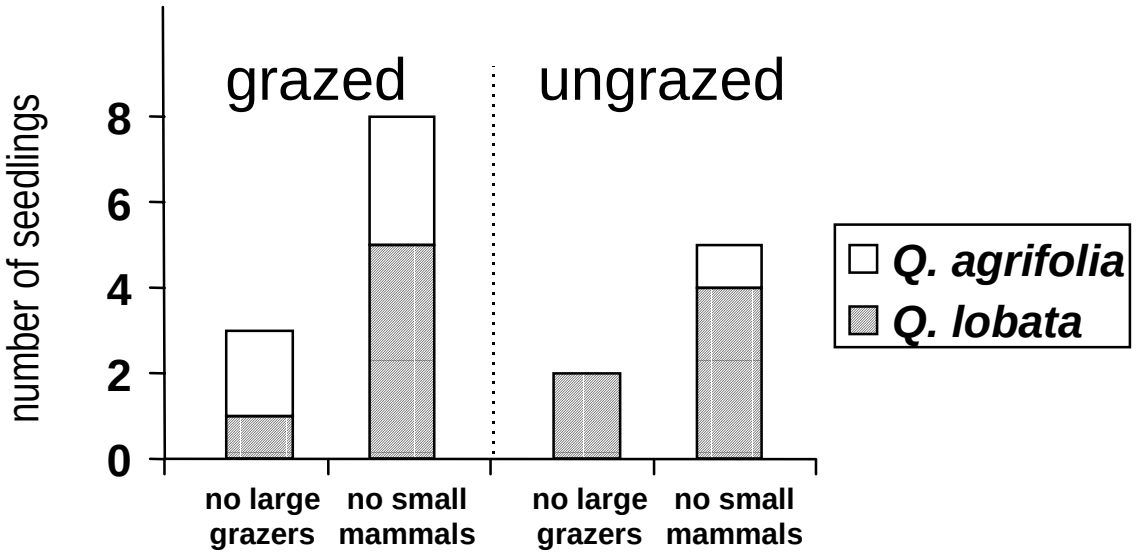

Figure 6. Effects of experimental treatments on 2 yr-old oak seedling recruitment. Data are total number of 2 yr - old seedlings, planted in 1996 - 1997, alive in May 1999. Treatments are: plots grazed by cattle vs. ungrazed by cattle (large plots enclosed with electric fence); within these, treatments are: fenced to exclude large grazers such as cattle, deer, and pigs; and caged to exclude both small mammals (gophers and ground squirrels) and large grazers

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Two-year old *Q. lobata* seedlings range in height from 120 to 430 mm (5 to 17 inches) and are, on average, larger than the one-year-old seedlings (mean = 243 mm, or 9.5”). Two-year old *Q. agrifolia* seedlings range from 110 to 340 mm (0.5 - 21 inches) with a mean of 243 mm (9.6”), and are also larger than the one-year old seedlings, on average.

Results from our first two planting experiments (1996 - 1997, and 1997 - 1998) suggest that seed predation and herbivory by small mammals (most likely gophers and ground squirrels) are a significant “bottleneck” to oak seedling recruitment on the landscape scale. Comparing results from both years (one dry, one wet) also indicates that a lack of late winter rainfall can significantly reduce oak establishment.

II) Research to determine factors limiting natural regeneration of oaks

a) Location and mapping of oak seedlings. In the summer of 1997, we surveyed a sub-sample of our experimental plots in savannas to locate naturally established oak seedlings (n = 6 plots; total area = 1.5 hectares). Results are summarized in Table 1.

			Number of seedlings			
	Location	area surveyed (ha)	*Q. lobata*	*Q. agrifolia*	*Q. douglasii*	total
1998	Lisque	0.5	63	87	38	188
	Mesa	0.5	41	76	3	120
	"Airstrip"	0.5	0	22	0	22
	totals	1.5	104	185	41	330
	adjusted totals	per 4.5 ha	312	555	123	990
1997	*totals*	4.5	38	151	427	616
1996	*totals*	4.5	0	2	13	15

Table 1. Results of seedling survey, July 1998, and July 1997 and 1996. Data are total numbers of seedlings (natural recruits) for each species at each location. Total area surveyed in 1998 was 1.5 ha (6 plots); the area surveyed in previous years was 4.5 ha (18 plots). For comparison, the estimated totals ("adjusted") are given for 1998 based on numbers of seedlings per 4.5 ha.

There were a total of 330 seedlings, significantly more per area than were found in the same plots in 1996 or 1997. The majority of seedlings (57%) were found in the lower Lisque drainage; for the first time since we have surveyed our plots, the cleared "Airstrip" had *Q. agrifolia* seedlings. The most striking finding was that the numbers of live and

valley oak seedlings were much greater than have been observed in either of the previous two years; in particular, valley oak seedlings were an order of magnitude more abundant. We believe that this high natural recruitment was due to two factors: a mast year for acorn production, and a very wet winter (El Niño.)

Most seedlings were located in grazed plots (195 in grazed plots, 135 in fenced/ungrazed plots). Our data suggest that the effects of grazing on seedling recruitment may vary among oak species (Figure 7); although there were more live oak (*Q. agrifolia*) and blue oak seedlings (*Q. douglasii*) found in ungrazed plots than in grazed plots, valley oaks (*Q. lobata*) were more abundant in grazed plots.

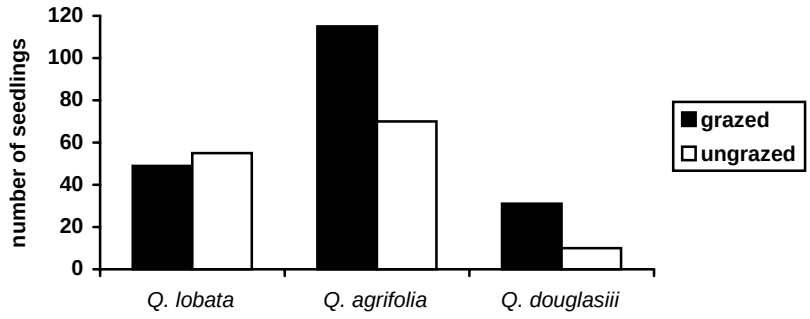

Figure 7. Effect of grazing on natural seedling establishment of *Quercus lobata*, *Q. agrifolia*, and *Q. douglasii*. Data are total numbers of seedlings in plots grazed by cattle (area = 0.75 hectares), and ungrazed/fenced plots (0.75 hectares), July 1998.

A student intern, Samantha Olson, who worked with us in July - August 1998 to help locate seedlings, used the data on natural seedling recruitment for her final project, entitled “Hydrologic Relationships of Valley Oak (*Q. lobata*, Nee) and their Effect on Seedling Emergence and Seedling to Sapling Mortality”. This report can be seen on the web at http://www.icess.ucsb.edu/esrg/SURP/crseo.html (go to 1998; go to "student's and their projects"; go to Samantha Olson.)

b) Understory vegetation monitoring. In April - May 1999, we monitored the permanent understory vegetation quadrats. These permanent sampling quadrats were established in May 1996 within our large experimental plots to characterize the understory vegetation, and to examine effects of cattle grazing on the herbaceous vegetation of oak savannas and woodlands. Within each plot, using a stratified random design, we located 10 rectangular quadrats (100cm x 50cm), the corners of which were marked with metal spikes to facilitate resampling over the 10 year study period. For each quadrat, we record all plant species present, their percent cover, and the location of the quadrat relative to oak tree canopy. Ten quadrats for each of our 52 plots are sampled, for a total of 520 quadrats. The data will be entered and analyzed during the next study year (1999 - 2000.)

The data collected in Spring 1998 was entered and preliminary ordination analysis conducted. The species list for Spring 1998 is attached (Appendix 2)

c) Biomass sampling to estimate pasture productivity. In order to determine the productivity of the pastures, as well as to compare herbaceous biomass among plots where we have planted oaks, we collected plant samples from two savanna sites. Within each of our large 50 x 50 m plots in Lisque Canyon and on the Mesa, we established three permanent quadrats; quadrats were 12.5 cm x 200 cm. These were established in both grazed and ungrazed plots. For those in grazed plots, we clipped and collected all vegetation to ground level, a day before cattle entered the pastures. Since cattle grazed all pastures over three rotations during 1999, this sampling was conducted three times. The sum of these collections will provide an estimate of the total herbaceous biomass produced in each plot. For comparison, we also clipped and collected samples from ungrazed plots at the end of the growing season. This comparison will allow us to determine the effect of rotational grazing on annual herbaceous productivity. All samples are currently in the laboratory where they are being sorted (live grass, dead grass, live forb, dead forb), dried, and weighed.

III) Maintenance of cattle and site infrastructure

a) Maintenance of cattle herd for experimental grazing. Cal Poly San Luis Obispo, Animal Sciences Department, manages financial issues, shipping, care and maintenance of the cattle herd. Mike Hall, who coordinates this portion of our program, provided financial summaries for the cattle operation from the year 1998 - 1999. At Sedgwick Ranch, Cal Poly managed a total of 146 cow / calf pairs (owned by a local 3rd party) grazed on a fee basis during the grass growing season (November 1998 - June 1999). Total animal units days were 43,573.

The net income to the Cal Poly Foundation from the Sedgwick cattle operation (fiscal year ’98 - ’99) was $5218, which will help offset previous losses (e.g., fiscal year ’96 - ’97). Cal Poly foresees continued long-term cooperation with the grazing projects at Sedgwick Ranch. A copy of Mike Hall's financial report is attached (Appendix 3).

b) Maintenance and infrastructure improvement. With assistance from Cal Poly students, we completed the following improvements to support the grazing operation for the SB Co. Oak Restoration Project: 1) installed a 10,000 gallon water storage tank in Figueroa Canyon; 2) replaced 2,500 feet of water line in Figueroa Canyon; 3) repaired working corrals; 4) installed approximately 1 mile of new fence along the road in lower Figueroa Canyon; 5) installed approximately 1 mile of new fence along the creek and pastures in Figueroa Canyon to improve use of paddocks by cattle, and to protect the riparian habitat; 6) repaired and maintained existing fences, exclosures, tanks, troughs, and water pipe.

IV) Dissemination of information

a) Tours of project site. We led tours of our project site for groups interested in learning about the Santa Barbara County Oak Restoration Project. These included researchers from both U.S. and foreign universities, and other interested members of the public

b) Participation in public events. We participated in a forum on oaks in the Santa Ynez Valley, sponsored by Women's Environmental Watch; in Los Olivos (October 1998); we described the work of the Oak Restoration Program and, based on our research, what we currently know about recruitment of valley and live oaks. We also presented information about the Santa Barbara County Oak Restoration project at the community Earth Day Fair (April 17, 1999) in Santa Ynez. Information included goals of the project, present findings, information about oaks of the Santa Ynez Valley, photos of the site, etc.

c) Presentation for Board of Supervisors. We had the opportunity to make a presentation on the SB Co. Oak Restoration Project to the Santa Barbara County Board of Supervisors and interested members of the public. All members of the board were present. We described the project from it's inception (original Request for Proposal) to the present, including goals, research approach, cooperative and volunteer efforts, current results, and work planned. Following the presentation, the board and members of the public gave their full support to the project and it's continuation.

d) Participation in Valley Oak Symposium. We presented a talk entitled "Status, Trends, and Impacts" at the symposium "A Future for Valley Oaks: Developing Partnerships for the Next Century." The symposium took place in Visalia, CA, in June 1999. A copy of the meeting program is attached (Appendix 4.) The slide presentation for the talk by Frank Davis can be viewed at our web-site (under presentations).

e) Maintenance of project web-site. We have a web-site to make information about the project goals and results, available to those with access to the internet. We continue to develop this site, and associated resources. The web-site address is: http://www.biogeog.ucsb.edu/projects/oak/oak.html.

f) Meeting with Cal Poly staff and administrators. Through a cooperative agreement with the University of California Santa Barbara, all aspects of the cattle operation required to run our experiments are coordinated by Cal Poly San Luis Obispo. To facilitate cooperation and support between Cal Poly and UCSB research efforts at Sedgwick Ranch, we hosted a meeting at the field site in January 1999. Attending were Santa Barbara County Oak Project researchers, the Sedgwick Ranch manager, and Cal

Poly staff and administrators, including Mike Hall, Beef Cattle Specialist in the Animal Science Department (our primary contact at Cal Poly), Andy Thulin, Head of the Animal Sciences Department, and Mark Shelton, Associate Dean, College of Agriculture.

Literature cited

Walter D. Koenig, Ronald L. Mumme, William J. Carmen, Mark T. Stanback. 1994. Acorn production by oaks in central coastal California - variation within and among years. Ecology, Vol. 75, No. 1., pp. 99-109.

Appendix

1. Photographs of established seedlings.
2. Plant species list - vegetation plots Spring 1998.
3. Financial report on grazing project at Sedgwick Ranch. Final 1998 – 1999. Submitted to Cal Poly Foundation Business Office by Mike Hall, Animal Science Dept., Cal Poly San Luis Obispo.
4. Valley Oak Symposium Agenda