

**Longterm Effects of Nitrogen Fertilizer on Coastal Sage Scrub Vegetation
at Lake Skinner**

Request for funding from the Skinner-Shipley/Riverside County Endowment

Funding requested: \$13,694

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Research Aims

A nitrogen fertilization experiment was initiated in 1994 near the north shore of Lake Skinner in the Western Riverside County Multispecies Preserve. The objective of the research was to determine the effects of nitrogen on coastal sage scrub (CSS) vegetation. The nitrogen fertilizer was applied to mimic the effects of anthropogenic nitrogen deposition. Nitrogen deposition is increasing worldwide, especially in urbanized and agricultural regions such as southern California (Padgett et al. 1999, Allen et al. 2006). As described below, the exotic grasses responded with elevated biomass within the first few years after fertilization began, but the native forbs did not begin to respond with decreased cover until 11 growing seasons had passed.

I discontinued fertilization with N in 2005 to determine whether soil N and impacts on vegetation will decline over time. In a study in Colorado grassland (Milchunas and Lauenroth 199_) the vegetation response persisted for 15 years after fertilization was discontinued. Land managers often ask me whether elevated soil N will decline if air pollution regulations are strengthened and atmospheric deposition decreases, but few data are available to shed light on this topic. The Milchunas and Lauenroth (199_) study indicates that effects of N fertilization are persistent. The objective of the proposed research is to determine whether there is recovery after N inputs cease.

This research has been funded since 1994 by a series of grants from the National Science Foundation, the USDA-NRI Ecosystems Program, and the Environmental Protection Agency, plus one year from the Shipley-Skinner Endowment. I currently have no funding for this site, as my research program has moved to the desert. Therefore, I request funding from the Shipley-Skinner Endowment to continue the work for another year.

Background and Rationale

Elevated N is known to change the species composition of many vegetation types. The best known examples come from the Netherlands, where N deposition has reduced the diversity of native species-rich pastures (Bobbink et al. 1998). Plant species richness also declined along a N deposition gradient in southern England (Science 2003). A study of historic vegetation change showed that the CSS of the Riverside-Perris Plain has declining shrub density over the past 60 years (Minnich and Dezzani 1998), especially near urban areas. This change is attributed to exotic invasions, urbanization, fragmentation, and frequent fire, that are all recognized as threats to the biodiversity of California shrublands. Nitrogen deposition is causing an additional conservation problem in the preservation of diversity, but one that has not been adequately quantified.

The amount of nitrogen deposition affecting southern California CSS ranges from more than 30 kg/ha/year in the Riverside area to less than 5 kg/ha/yr at Lake Skinner (Padgett et al 1999). Elevated N affects growth of native and invasive species differently. Greenhouse experiments show that both the native and the exotic plants have increased growth with elevated N (Padgett and Allen 1999), but an exotic grass, *Bromus madritensis*, had greater 15N uptake than the native *Artemisia californica* (Yoshida and Allen 2004). After two years of fertilization in the Mojave Desert, exotic grasses increased in biomass and native richness declined in some sites (Allen et al. 2006). However, the plots at Lake Skinner showed no impact on native forb cover until 2004 even though exotic grasses were higher in biomass most years (Fig. 1). I attribute the difference in timing of response to N of the desert vs. CSS to differences in ecosystem fertility. CSS plants are adapted to higher levels of soil nutrients and are capable of responding to N almost as much as exotic grasses. The small differences in N growth response of the native and exotic plants of CSS have taken longer to manifest themselves than in the desert, where the exotic grasses are more nitrophilous than the native desert forbs. The outcome is that the CSS fertilization study has taken much longer than expected to show vegetation shifts in response to N. Publications reporting the lack of response of native species to N in the field have appeared in several conference proceeding volumes (Allen et al. 1998, 2005, Allen 2004), although there have been microbial responses to N (Sigüenza et al. 2006, in press). Now that the native forbs have responded negatively to N additional publications will be forthcoming.

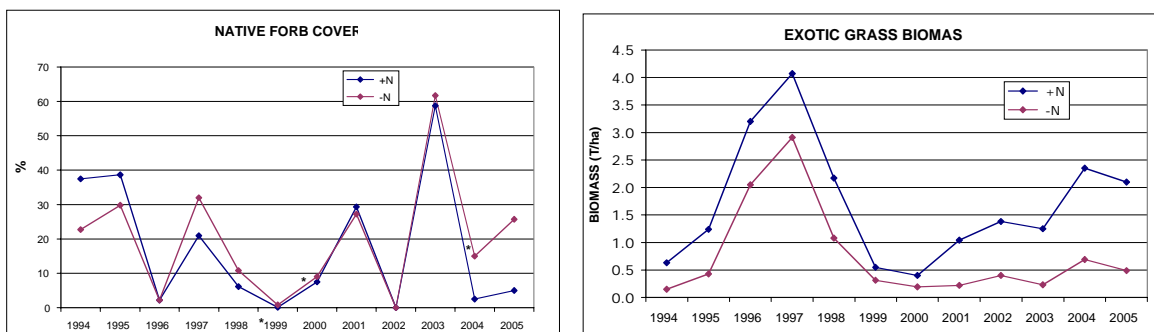


Figure 1. Native forb cover and exotic grass biomass in response to N fertilizer at Lake Skinner from 1994 to 2005.

Methods

Lake Skinner site was fertilized yearly with two doses of 30 kg/ha N as NH_4NO_3 , a total of 60 kg/ha/yr from 1994 to 2005. This level was chosen to simulate double the amount that is deposited at the high N deposition sites in northern Riverside County. A total of 40 5X5m plots were set up, 10 fertilized and 10 unfertilized in a site burned in November 1993. Sampling was done again in spring 2006 since the cessation of N fertilization, and would be done again in 2007 with continued funding.

Field sampling begins each season at germination following the first rains, and the ends in July/August when the shrubs have attained maximum size. Sampling consists of density counts and percent cover assessment in four permanent 0.5 X 1.0 m quadrats in each 5 X 5 m plot. Biomass is determined by double sampling of additional quadrats for biomass assessment (permanent quadrats are not harvested), and plant tissue N is analyzed. Soil samples are collected from each plot to determine total N and extractable nitrate and ammonium. The data will be subjected to analysis of variance using dominant species and species groups. These data will be added to those from previous years and subject to repeated measures analysis. Multivariate analyses will also be done as appropriate, e.g., discriminant function analysis to compare treatment groups.

Budget

GSR IV, Summer 2006 @ 49%, \$1,596 per month	4,788
Fringe for Summer 2006 @ 3%	144
GSR IV, Spring 2007 @ 49%, \$1,644 per month	4,932
Fringe for Spring 2007 @ 3%	148
Student Fees for Spring Qtr	2,858
Total Salaries & Benefits	12,870
Travel to field site (10 trips X 90 mi. X \$.36	324
Supplies, soil and plant tissue N analyses	500
Total	13,694

Budget justification

Leela Rao will be in the fourth year of her Ph.D. program and is well qualified to do the proposed research. During the summer of 2006 she would help with the sample and data analyses for the spring 2006 data collection, which is complete except for shrub data. In spring 2007 she will do the field work to continue the study for one more year. A small amount of travel money is requested for visits to the field. Most of the plant and soil N analyses will be done at the ANR Analytical Laboratory at UC Davis, so the supply budget reflects these laboratory costs.

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