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Adaptive Management for Southern California Grasslands

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Problem Statement

Standard "best management practices" to promote and maintain native biodiversity do not exist for southern California grassland reserves (Figure 1). This is a function of uncertainty regarding grassland community dynamics and the effectiveness of existing management techniques. The purpose of this project is to provide public agencies and entities such as The Nature Conservancy with guidelines for developing adaptive management plans that will address this uncertainty.

Background

Southern California grasslands (Figure 2) have become invaded by non-native grasses and forbs, as well as highly fragmented (Keeley 1990). Remaining grassland areas are threatened by a multitude of interacting influences: urbanization and development, over-grazing, public use, changes in fire regime, climate change, and pollution. This places increasing pressure on the managers of grasslands in public and private reserves to maintain or restore native plant and animal species, especially in rapidly urbanizing southern California. At the same time, grassland areas in southern California are becoming a conservation priority, leading to an increased call for their management.

Figure 1. The southern California project study area. Green line: Natural Communities Conservation Planning (NCCP) program area. Colored polygons: NCCP sub-areas. http://www.dfg.ca.gov/nccp/cssreg.htm.

Figure 2. Grassland area at the Santa Rosa Plateau Ecological Reserve.

Southern California grasslands in existing reserves are generally managed to maintain or restore native grassland vegetation, to decrease the dominance of exotic plant species, to promote the recovery of threatened or endangered species, and/or to promote other animal and plant species of special concern. Common management practices include prescribed burning, planned grazing, seeding, mowing, or no (passive) management. Reserve managers sometimes choose passive management because it demands the least resources, incurs the least risk, and sparks the least public resistance.

Approach

Our approach included the following activities:

1. Comprehensive review and synthesis of literature relevant to grassland ecology and management;
2. Analysis of grassland characteristics in San Diego and Riverside counties using geographic information systems (GIS) tools;
3. Informational interviews with 35 grassland ecologists, managers, and researchers;
4. Development of a suite of conceptual models;
5. Construction of a primer on creating an adaptive management plan for a grassland reserve;

6. Creation of an adaptive management framework for a case study site – the Santa Rosa Plateau Ecological Reserve (SRPER).

Literature Review

The literature relevant to southern California grassland and its management was reviewed. Topics include historical extent and composition of grasslands, succession, and major ecological drivers. The literature review informed the conceptual models and helped to guide the formation of management hypotheses for the case study.

GIS Analysis

The current extent, type, ecological condition, and management status of grassland areas in Riverside and San Diego Counties were examined in order to give context to grassland management in southern California. Grasslands occupy 40,344 ha in San Diego County, 1.4% of which are located in formally designated reserve areas. In Riverside County, there are 63,278 ha of grassland, 6.7% of which are formally protected (these figures exclude conservation easements). In San Diego County, roughly 72% of grassland areas are comprised of non-native grassland types. 98% of grasslands are non-native in Riverside County. Figure 3 shows the fractional area of native and non-native grasslands in San Diego and Riverside Counties as well as the average ecological conditions of those types.

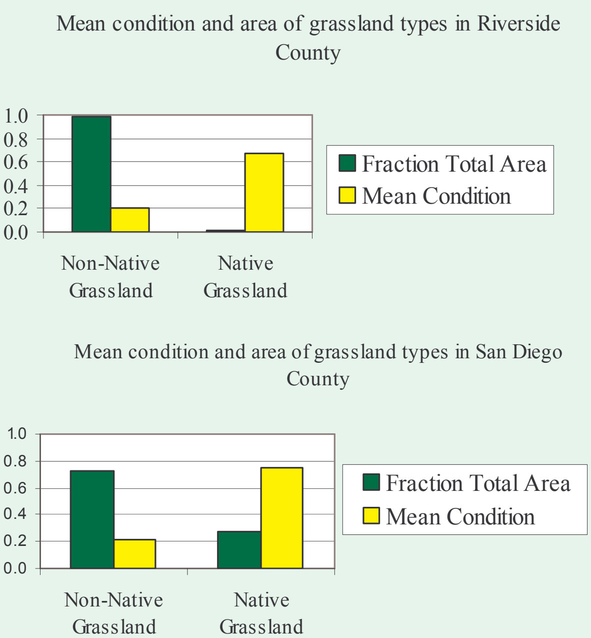


Figure 3. Mean ecological condition and type of grasslands in San Diego and Riverside Counties

The ecological condition value is based on a grid developed by Davis et al. (2003), which assigns a value of 0 to highly degraded areas and a 1 to pristine areas based on road effects, housing impacts, and land conversion in that area. Overall, non-native grassland had condition values near 0.2, while native grassland demonstrated values around 0.6. Compare this to the ecological condition of chaparral (about 0.6), and oak woodland (roughly 0.7).

Interviews

Thirty-five grassland managers, ecologists and researchers[1] were informally interviewed in order to identify major uncertainties and constraints in grassland management, as well as to determine which management tools are most important in southern California. This information was used to create the conceptual models and case study. There were six recurring themes that emerged from the interviews:

- **Grasslands are undervalued by the public, as well as conservation organizations and scientists.** Grasslands are "humble" ecosystems, and are also prime areas for urban development and conversion to agricultural use, and are not studied extensively.
- **Management is hindered by the lack of a historic reference state.** There exists large uncertainty and disagreement about both the historic extent and historic composition of grassland in California, translating into a lack of a baseline state to aim management goals toward.
- **There has been little study of both positive and negative effects of planned cattle grazing.** As a result, disagreement exists about the purpose, utility and appropriateness of using cattle grazing as an ecological management tool.
- **There is a need for better understanding of the relationships between plant community composition and fire regime.** Uncertainty exists about the historic and current fire regimes and

[1] Edith Allen, Julie Ammel, John Anderson, Cameron Barrows, W. James Barry, James Bartolome, Carole Bell, Tina Carlsen, Sandy DeSimone, Margot Griswold, Jon E. Keeley, Lenora Kirby, Dawn Lawson, Megan Lulow, Jaymee Marty, Rich Minnich, Andrew Moyes, Thomas Oberbauer, Elizabeth Painter, Zachary Principe, Rich Reiner, Hugh Safford, Orrin Sage, Paula Schiffman, Eric Seabloom, Trish Smith, Wayne Spencer, Fred Sproul, John Stechman, Mark Stromberg, Michael Stroud, Robert Taylor, Mark Webb, Michael P. Williams, Robin Wills, Truman Young

their ecological effects in today's California annual grassland.

- **There is a lack of management-focused California grassland research.** This contrasts with the tradition of management-focused research that is the case with some other ecological systems. As a result, there is a deficiency of accepted theory about fundamental ecological processes and management approaches.
- **Adaptive management is a popular idea, but an unpopular phrase.** The term has been used too often as a catch-all to describe less scientifically rigorous management practices.

Conceptual models

Conceptual models were created to model grassland ecosystems in southern California and to represent hypothesized interactions within grassland systems, key uncertainties, important threats, and possible management interventions. They are used in the case study to highlight areas of uncertainty, which can then be investigated through adaptive management.

Three types of conceptual models were constructed:

1. **Grassland models**. This set of models includes a regional-scale model and more detailed sub-models of vernal pool grassland, the effects of prescribed fire and the effects of planned grazing on grassland.
2. **Phenograms**. These models take the form of a calendar of life history events for grassland plant species, and can be used (and stacked with phenograms for different target species) to identify the most effective timing of management activities for specific goals (Figure 4).

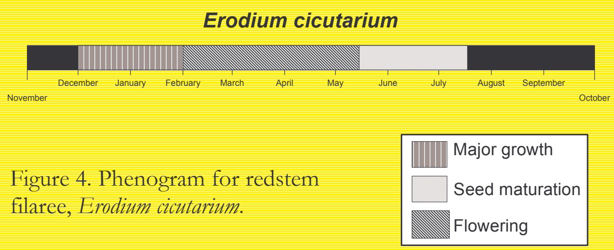
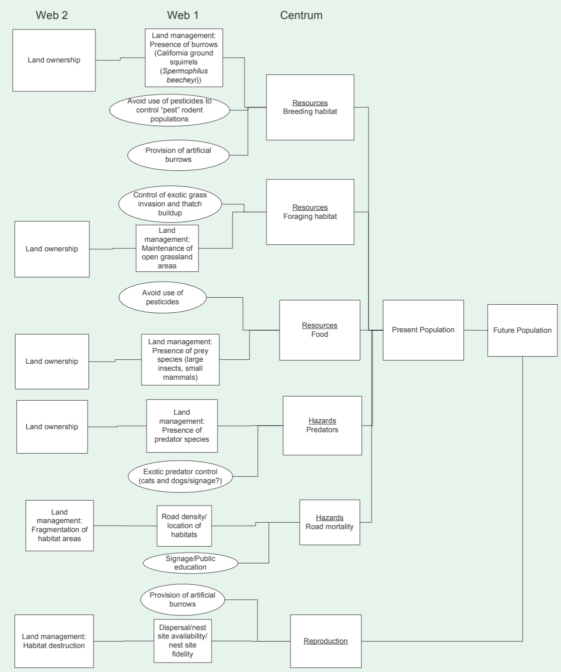


Figure 4. Phenogram for redstem filaree, *Erodium cicutarium*.

3. **Envirograms**[2]. These models are used to represent the factors affecting the abundance of specific animal species (Figure 5).

[2] Based on the format described by James et al. (1997)

Accompanying the phenograms and envirograms are fact sheets for each species, which include information on the species' distribution, threats to the species, and information on their management, ecology, reproduction, and habitat requirements.



Envirogram for the Burrowing Owl (*Athene cunicularia*). Potential management practices are noted in ovals. This envirogram format was developed by James et al, 1997.

Figure 5. An envirogram for the burrowing owl, *Athene cunicularia*. Potential management actions are noted in ovals.

Some of the key uncertainties affecting both plants and animals on southern California grassland systems that are highlighted in these models include weather variability, historic grassland management, historic fire regimes, and the effects of altering the timing, intensity, and frequency of management activities (such as prescribed burning and planned grazing).

Adaptive Management Guidelines

Figure 6 shows the key aspects of an adaptive approach to ecosystem management. Adaptive management is "a process in which management activities are implemented in spite of uncertainty about their effects, the effects of management are measured and evaluated, and the results are applied to future decisions." (Elzinga et al. 2001).

Guidelines were created from review and synthesis of literature on adaptive ecosystem management that can assist grassland managers as they move through the steps of creating an adaptive management plan.

Figure 6. Hallmarks of an adaptive ecosystem management approach.

- Placing learning as a central goal;
- Identification of key uncertainties about the relationships between system components and about effects of management activity, using models;
- Formulation of hypotheses about the system's behavior in the context of these uncertainties;
- Experimentation (including replication and control) through active management to test one or more hypotheses;
- Monitoring to assess the outcomes of the experiment(s);
- Using monitoring results to feedback and adapt the management approach when learning occurs.

Case Study—Adaptive Management for the Santa Rosa Plateau Ecological Reserve

Currently, SRPER is managed primarily through prescribed burning on an annual basis with an average fire return interval of 7-10 years for each of the 19 burn units. An average of 200 ha are burned per year (Figure 7), and burn sites are chosen each year based on their condition (such as thatch build-up) and the years since last burned.

We suggest a more rigorous experimental burning program for some burn units. This replicated experimental program is stratified by soil type and vegetation type to test the effects of a two treatments: a 3-year and a 7-year average fire return interval. This program would be implemented in existing burn units in order to avoid the cost of creating new units, as well as to avoid an increase in the total number of hectares burned on average. To avoid significant increases in the cost of the management program, the majority of the burn units currently in place would continue to be managed as they are now. These minor changes would allow managers of SRPER to reduce, over time, the uncertainty surrounding the effects of fire frequency on grassland.

Conclusions

Grasslands in southern California have been fragmented, heavily invaded, and otherwise degraded, making management a necessity. There is a large amount of uncertainty surrounding the management of grasslands in southern California, including uncertainty regarding the effect of controlled burns and fire return interval on grassland community composition. If management is conducted through an experimental adaptive management framework, progress can be made toward eliminating some of that uncertainty. We recommend modifications to the management program currently in place at the SRPER that will allow learning to be a larger part of the management process without significantly increasing the cost of the program.

Figure 7. Perennial grass post-burn at the SRPER.

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