Problems Encountered while Mimicking Nature in Vegetation Management: An Example from a Fire-prone Vegetation

V. Thomas Parker
Department of Biology, San Francisco State University
1600 Holloway Ave., San Francisco, CA 94132

Abstract: Preservation of natural areas often requires management. Techniques that mimic natural disturbance generally seem to work best. Fire, for example, is used to manage California chaparral, a "fire-adapted" vegetation type. Prescribed burns, however, can differ from the natural fire regime in intensity, season, frequency and environmental conditions. Variation in each parameter can have considerable impact on vegetation recovery. The greatest impact is on regeneration of plant populations from dormant seeds resident in the soil, but post-fire resprouting by some species also can be considerably reduced. This paper addresses deviations of managed fires from the natural fire regime and the subsequent problems that can be encountered managing California chaparral.

INTRODUCTION

Protected natural areas vary in the intensity and frequency of management needed, depending on the vegetation type and how different it is from the desired composition. Areas surrounding a protected site may be highly modified, and provide a source of undesired species. Few places exist unaltered by past activities of man, like farming, grazing and logging—disturbances that may have allowed encroachment by a number of non-native species. In many areas our landscapes have become so modified that many natural processes have been drastically altered. Wildfires, for example, are limited near urban areas, in some places, due to a fire-suppression policy, but in others due to breaks in the landscape caused by development. Management may be necessary in such cases to maintain the vegetation or return to a more natural state.

Attempts to mimic natural disturbances have been quite successful as a management technique (e.g. Gill, 1977; Johnson and Bradshaw, 1979; van der Valk, 1981; van der Valk and Pederson, 1989; Mallick and Gimingham, 1985, Keddy et al., 1989). Although some plant communities are quite resilient after disturbance, there must be a careful evaluation of vegetation response and survival. No action at all is actually an active management decision, because some species are favored by this policy. Ultimately, successful vegetation management depends upon carefully maintaining community dynamics in a way that preserves species diversity, favoring some at one time, others later. The goal then becomes one of insuring that management does not result in the accidental elimination of desirable species.

Ironically, any intervention to maintain diversity favors some species at the cost of other species (Parker, 1987a; Keddy et al., 1989). This process may be exploited in the name of "enhancing" populations of rare and endangered species, since elimination of undesirable species presumably allows enhancement of native species. At the same time, many variables are not controllable (e.g. seasonal weather). Preferred species may be reduced or eliminated by such factors, and space may be opened up for invasive species to become established.

A further problem comes in the guise of mimicking natural disturbances. If management is similar in characteristics to a natural disturbance, then it is assumed that the native species will respond predictably. While this is often the case, there are circumstances where the management technique is not as good a mimic as is presumed, and expectations, in some cases, may color the evaluation of the project. Because disturbances change community structure and population age classes, long-term changes in the vegetation due to large shifts in species recovery may already be in operation prior to problems being discovered.

An objective of this article is to provide examples of management problems encountered when employing large disturbance techniques believed to mimic natural processes in California chaparral. The chaparral is an evergreen shrub-dominated community that experiences severe drought each summer and is prone to, and maintained by, fire. While few other community types may offer the exact problems encountered in chaparral management, the types of errors that can be made when managing this community are common to many areas. I will discuss vegetation management from the perspective of uncovering problems prior to the implementation of a policy.

MANAGEMENT AND THE DYNAMICS OF PLANT COMMUNITIES

Local plant communities are collections of species that vary greatly in the temporal and spatial characteristics of their population dynamics. Managing such a collection requires an understanding of individual species life histories, the influence of management on their population responses, and the longer-term interactions among the populations. Most treatments involve a disturbance of the habitat that affords a number of species an opportunity for regeneration. Development of a vegetation management policy should involve the seeking of an understanding of what to disrupt, how to disrupt, and what will regenerate afterwards.

In the case of chaparral, the dominant shrubs are burned, opening up the habitat for regeneration and reducing fuel for wildfires. Prescribed burning therefore has been believed to be the ideal way of managing chaparral vegetation, but there are some critical reassessments in progress in response to occasional problems with regeneration.

Problems Where Words Stand for Concepts:

Many of the problems with chaparral management are based upon a misunderstanding of our use of words that seem clearly defined at first. For example, "fire-adapted" and "regeneration" actually are more properly thought of as concept-words that encompass several different characteristics. Because managers may come from a variety of backgrounds, they may inadvertently interpret these concept words literally; this becomes one of the major problems in vegetation management, and may be blamed on a failure of researchers to clearly express their meanings.

Under natural conditions, chaparral can experience an intense canopy fire and respond with considerable growth and regeneration within a year (e.g. Hanes, 1977; Keeley and Keeley, 1988). Actually, chaparral is adapted to a particular fire regime (Gill, 1975; Gill and
Groses, 1981). The community does not tolerate all fire, but is adapted to certain types of fires with a given range of intensities, that come at a particular season of the year, within a range of frequencies (Fig. 1) (Gill and Groses, 1981). Environmental conditions at the time of a fire also affect the response of the vegetation (Parker, 1987a). Chaparral may not respond well to fires out of season, or that occur too often, at too low an intensity or under moist conditions.

**FIRE REGIME COMPONENTS**

**TYPE**
- e.g. Surface vs Canopy

**INTENSITY**

**FREQUENCY**

**TIMING**
- e.g. Dormant season vs Growing Season
- Dry season vs Wet Season

**SOIL CONDITIONS**
- e.g. Wet soil vs Dry Soil
- Soil Type

Figure 1. Fire regime and the components that make up the characteristics to which plants adapt. Variation in any one of the components can change the fire regime.

Similar layers of complexity exist for the various modes of regeneration found within a single community. Management practices will always interfere with some populations while promoting others, as in chaparral, where fire leads to recruitment of specific groups of species. Some chaparral species regenerate in older stands, while others regenerate only in post-fire years (Keeley and Keeley, 1988; Parker and Kelly, 1989). Chaparral life histories differ in the ways in which species respond to fire and in population changes afterwards (Fig. 2). Shrubs that resprout after fire but recruit seedlings only in older stands are termed obligate sprouters. Shrubs killed by fire and dependent upon seeds stored in the soil are termed obligate seeders. Facultative sprouters are shrubs that both resprout and recruit from dormant seed banks. Additional important groups are post-fire annuals and short-lived perennials, which are present only as dormant seeds at the time of a fire. Successful recruitment by other herbaceous perennials may be restricted to the post-fire years when sufficient light is available for growth prior to the closing of the canopy.

**Failures in Chaparral Management:**

Only a few years after a fire, sprouters will again form a closed canopy if they are the dominant species. Vegetation at a site appears to regenerate, yet population sizes may be reduced by mortality in the fire or some species may have been eliminated. How is a manager to evaluate these types of possibilities? One approach is to examine the general population responses to a particular management treatment, and to determine which classes are most vulnerable to such a disturbance. For chaparral, the groups most vulnerable are those whose populations are most reduced by fire. Obligate-seeding shrubs and post-fire species lack an established population following a fire and are dependent upon recruitment from dormant seed banks the following spring (Keeley and Keeley, 1988; Parker and Kelly, 1989). These two groups include most of the rare and endangered chaparral species, including over 40 taxa just between Arctostaphylos and Ceanothus (Parker, 1987a). When most of the sensitive species in the most vulnerable categories are found, greater care than usual will be required, and management should be aimed at the needs of those species.

Figure 2. Population responses of four common chaparral species to fire. In each example, large changes in population size have taken place after a fire (indicated by an arrow). Obligate seeders are shrubs killed by fire, regenerating from dormant seeds in the soil. Facultative sprouters are shrubs that also have a seed bank reserve in the soil, but also resprout from established plants. Obligate sprouters are shrubs that only survive fire by resprouting and recruiting new individuals in older stands. Post-fire annuals are a group of herbaceous species that arise from a dormant soil seed bank and are seen only in a few post-fire years. The time scale is a fire cycle that varies from 30-100+ years.

Historically, prescribed burning of chaparral was developed as a method of vegetation conversion for range improvement (Sampson, 1944; Biswell, 1974). With the advent of urban encroachment into steep, mountainous chaparral, prescribed burning is often advanced as a method of fuel reduction for safety purposes. Now that many watershed managers have incorporated preservation of species diversity as an important objective, they are being advised that prescribed burning will keep their vegetation healthy. Subsequently, prescribed burning is being used somewhat indiscriminately for three incompatible objectives, even though chaparral is adapted not to fire in general, but to a particular fire regime. In service of range development and fuel reduction goals, fires are often applied at variance with the natural fire regime, usually out-of-season under inappropriate conditions and far too frequently. Natural regeneration is disrupted and chaparral is ultimately replaced by other plant communities. To maintain the health of the community, attempts should be made to mimic the natural fire regime, so that chaparral regeneration proceeds normally.

A prescription for a burn in the chaparral should be made carefully, to make sure that the fire is controllable. Because of the amount of fuel available on steep terrain, burns are often restricted to winter when moisture and cool temperatures reduce the intensity and speed of the fire, yet obligate seeders and post-fire recruiters rely entirely on dor-
mant seed banks for regeneration. Winter burns differ in timing, intensity and other conditions from a natural fire.

Timing of fires seems to only be a problem for seed bank recruitment when fires occur late into the season (Kelly and Parker, unpublished). This has also been found to be the case in similar vegetation types in other parts of the world (e.g., Bond, 1984). Germination may fail when burns occur late in the winter at a time when soils are drying. Invasive and weedy species do establish, however, and resprouting shrubs become larger. The first season after fire, considerably more nutrients are available than in the second season. Consequently, the native vegetation does not germinate and establish from the seed bank until the second year, and undergoes considerable mortality from predation, loss to erosion and competition from established plants.

Reduction of fire intensity in prescribed burns affects species that have hard seed coats. Stimulation for germination usually requires a heat pulse in the soil. When fire intensity is reduced, heat movement in soil is greatly reduced, especially if the soils are moist; there may be insufficient heat to stimulate germination. For example, in southern California some stands are dominated by two shrubs, a facultative sprouter, Adenostoma fasciculatum H. & A., and an obligate seeder, Ceanothus gregii Gray. Burns experimentally conducted during January proved to be too low in intensity to stimulate germination in the hard-seeded Ceanothus, and the stands now lack this obligate seeder (Tom White, USFS, pers. comm.). Fires in this area are now set under conditions promoting greater intensities to insure recruitment from Ceanothus.

Recruitment is also limited in another class of species found in soil seed banks. In this group of species, seeds lack hard seed coats. Germination is cues in a variety of ways, but seeds absorb water each year when moisture is available whether or not germination has been stimulated. Prescribed burns generally occur when moisture is present in the soil to reduce fire intensity. When seeds become imbibed, however, their heat tolerance is reduced. Seeds of species able to tolerate considerable temperatures under dry conditions (as in the normal fire regime), die at temperatures as low as 70° C (Sweeney, 1956; Kelly and Parker, 1984; Parker, 1987a; Rogers and Parker, 1988). Variations in the fire regime affect other aspects of vegetation recovery as well. For example, as prescribed burns vary from the normal season of burning (fall), rates of mortality increase among established individuals of the facultative sprouter, Adenostoma fasciculatum (Biswell, 1974; Florence, 1985; Parker, 1987b). If fires become too frequent, populations of obligate seeders may be killed without further recruitment (Zedler et al., 1983). Increasing fire frequency can also restrict recruitment of obligate sprouters that normally occurs in older stands.

**CONCLUSIONS**

Initial management treatments should be assumed to be highly experimental. Observations after deviations from the natural fireregime in chaparral during prescribed burns indicate that recovery is not automatic but can be reduced, even in this fire-adapted vegetation. Different groups of species respond or are sensitive to different sets of conditions. Increased fire frequencies in chaparral will devastate certain species, but not significantly influence others over the short term. It is important to understand the potential response of a particular suite of species to a particular management treatment.

A necessary step in planning a management treatment is to determine the groups of species whose life history characteristics or adaptations are most vulnerable to a particular treatment, and proceed accordingly. Good examples of life history approaches are van der Valk's (1981), van der Valk and Pederson's (1989) wetland management clas-sifications and Noble and Slayter's (1977, 1980) "vital attributes" for species in fire-prone habitats (see Hobbs et al., 1984).

Typically, there will be certain species whose populations are more seriously reduced by a treatment, but there may also be other groups of species that will endure the same environmental "sieve." If a given treatment fails to regenerate a group of species, they may not survive to the next opportunity. For example, if fires fail to regenerate obligate seeders, these shrubs are then eliminated from the vegetation. It is fundamental to develop an understanding of species life histories and conditions important for each stage of their life cycles.

While the first step is to classify taxa into ecological response groups (like chaparral obligate seeders), it must be remembered that each species has unique life history characteristics. Because species respond differently, as in reproducing at different rates, having different mortality rates and special sensitivities to different ranges of temperature, all such eccentricities should be taken into account. Managers should avoid a uniformity of treatments and applications in order to help maintain species diversity and ecologically based groupings.

Finally, just as species are unique in their responses, so are the sites where they grow. For example, chaparral differs in its responses depending upon soil type, aspect and slope. One type of prescribed burn will not be effective for the gamut of chaparral diversity. A population on a serpentine soil site may suffer great mortality and poor recruitment, compared to plants of the same species on adjacent sandstone derived soil in the same fire (Parker, 1987b). The differences in soil conditions in this case resulted in differences in soil drying rates, nutrition and physiological status of the established plants. Thus, any community supporting the same groups of species may vary in responses when other conditions change.

Vegetation management encompasses many basic and applied disciplines. Opinions about any particular management tactic are consequently disparate. After experimentation with management techniques at a given site, there is no excuse for failing to understand responses of the community to disturbance, but until sufficient information is available, it is necessary to carry out limited and thoughtful treatments, monitored and evaluated, if valuable species are not to be lost from the association.

**ACKNOWLEDGMENTS**

I would like to thank V. R. Kelly, C. Rogers, S. Hammer, D. Kelly and M. Wood for help in field work and laboratory experiments associated with chaparral. Some of the information presented here was from research supported by the Marin Municipal Water District, Corte Madera, CA, and the Rare Plant Project of the California Department of Fish and Game. I would also like to thank Jason Greenlee and an anonymous reviewer for their help in making the manuscript readable.

**LITERATURE CITED**


Ecosystem Management:
Rare Species and Significant Habitats

Edited by
Richard S. Mitchell
Biological Survey
New York State Museum

Charles J. Sheviak
Biological Survey
New York State Museum

Donald J. Leopold
State University of New York
College of Environmental Science and Forestry

Proceedings of the 15th Annual Natural Areas Conference

1990
Bulletin No. 471
New York State Museum

New York State Museum
The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Albany, New York 12230