Grassland Restoration in California[1]

By David Amme

The Restoration Process

There are four main tools available for grassland restoration and management: 1) Rest, 2) Fire, 3) Grazing, and 4) Technology (Savory 1988). These tools are not necessarily exclusive of each other and when used together or in tandem can be very effective in accomplishing restoration goals.

Rest

The concept of rest as defined here is no application of fire, grazing, or technology. There is both periodic rest and permanent rest. There is a misconception held by the public and many land managers that once livestock grazing is removed from a grassland habitat plant succession proceeds in an orderly manner to the native climax vegetation that existed before disturbance. This is not the case, and in studies throughout California, rested or ungrazed grasslands remains dominated by weedy unpalatable annual grasses such as ripgut brome (*Bromus diandrus*), wild oats (*Avena* spp.), and foxtail (*Hordeum* spp.) (Biswell 1956, White 1966, Bartolome and Gemmill 1981, Saenz and Sawyer 1986, Foin and Hecktner 1986). Plant succession is largely controlled by the litter buildup of annual grasses and competition from the fast-growing annuals (Sinclair and Sampson 1931, Heady 1956, Menke 1989). Plant diversity in ungrazed grassland is actually depressed by the weedy grasses (Heady 1977). There is much evidence, both circumstantial and direct, that indicates grassland rest is detrimental to native annual wildflower displays (Edwards 1992).

Fire

There are many factors that must be taken into consideration when developing a grassland restoration strategy utilizing fire. Most of the grassland plants' above-ground portions die back at least once a year. Grassland plants generally grow rapidly and decompose slowly because of their chemical and physical composition (Mutch 1970, Philpot 1970). Grassland fuels ignite easily and burn readily. Consequently fire is a major decomposition agent and a key nutrient recycler in grasslands (Vogl 1974). Fire increases soil pH and temperatures, creates favorable conditions for the growth of soil fungi, algae, and nitrogen production (Wicklow 1973, Vogl 1979), and suppresses soil pathogens (Parmeter 1977). Generally perennial grasses produce more flowers and seed for a few years following fire (Vogl 1979). Fire also substantially reduces annual grass production and density while greatly increasing the herbaceous forb component (Hervey 1949, Daubenmire 1968). Periodic fires in grassland generally promote perennial grasses and forb production at the expense of woody species (Daubenmire 1968, Vogl 1977).

Indian burning of the grasslands came late in the evolution of California's Mediterranean grassland (Edwards 1992). However, periodic fires set by lightning have occurred in the California grasslands for as long as grasslands have existed and are an important source of natural ignition (Komarek 1968, Heady 1972). Until recently, very little scientific work concerning the effect of fire on the establishment and management of native perennial grasses has been conducted in California's foothill grassland (Heady 1972). It has been generally accepted that the California Mediterranean

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grassland is well adapted to periodic fires (Biswell 1956, Barry 1972). Prescribed fire studies have recently been initiated at Jepson prairie in Solano County (Menke and Langstroth 1987) and in the grasslands of the north coast and sierra foothills (Bartolome 1986). Prescribed burning in late fall or mid-winter has resulted in the reduction of exotic annual plant seed production and the increase of perennial grass seedling establishment (McClaran 1981, Bartolome pers. comm.). In this research, the burn is conducted within a few weeks of the first initiating rain when the introduced annual grasses are 8-10 cm tall. The native perennial grass seedlings emerge more slowly after the annual grasses. Fire kills the introduced seedlings enabling the established native perennial plants and seedlings to have a strong show the next spring. Advantages are that the soils are moist, revegetation is faster, and the burn is cool enough such that buried seed is unaffected. An additional advantage is that the summer herbaceous native forbs have also set and distributed seed before the burn. Timing of the burn allows enough rain to initiate germination coupled with a rainless period sufficient to dry out the litter layer. Fires remain small, slow and controlled when backed into a light wind. This research has been followed-up at the U.C. Sierra Field Station where late fall burning after the annual grasses have germinated resulted in a dramatic increase of seedling recruitment of purple needlegrass (Hatch *et al* 1990).

On an inner coast range site in San Joaquin County (Site 300, Lawrence Livermore National Laboratory), yearly prescribed fires conducted in May over a period of 26 years resulted in a dramatic increase of the native bunchgrass *Poa scabrella* (Taylor and Davilla 1986). In this case the grassland is dry and dormant by May and the native perennial grass being enhanced (*Poa scabrella*) is early-maturing and early-dormant. This grassland area with over 158 plant taxa was characterized by Taylor and Davilla to be one of the three largest native perennial grasslands in California. At the Jepson prairie, summer burning stimulates perennial bunchgrass fragmentation into two or more vigorous "daughter plants" (Menke 1992). Today periodic prescribed fire is the preferred tool for grassland restoration utilized by the California Department of Parks and Recreation and The Nature Conservancy (Amme and Pitschel 1990). Menke (1992) cautions against frequent prescribed burning because of the volatilization of nitrogen and sulfur. Any management tool that exposes the ground to wind and water erosion should be used judiciously and with clear vegetation objectives (Savory 1988). Fires at too infrequent of an interval, especially on productive soils where the aboveground biomass (yield) is great, can lead to native perennial grass mortality (Menke 1992) and in some cases valley oak (*Q. lobata*) mortality (Griffin pers. comm.).

Grazing

Grazing as well as periodic fire is a natural and necessary process in the grassland landscape (Edwards 1992). Grazing has similar effects as fire: litter removal, nutrient recycling, basal tiller stimulation, and seed bank reduction of competitive annual plants (Menke 1992). Today in California there is a tendency to graze close in the California "annual-type" grassland in order to encourage more nutritious herbs and grasses (*Erodium, Trifolium, Medicago, Bromus mollis*, etc.). Because of this, the grazing burden on the California Foothill Grassland is substantially higher than would be recommended for perennial bunchgrass management throughout the rest of western North America (Menke 1989). In short, Foothill Grassland habitat is historically and currently being managed as an "annual-type". Generally the grassland is grazed continuously throughout the year or primary growing season with little regard to species composition or diversity. The primary factor that is used to govern grazing intensity on the annual-type grassland is maintaining residual dry matter (RDM) levels at the end of the summer for erosion control purposes (Clawson *et al.* 1982). Continuous grazing leads to heavy overgrazing of preferred areas, the deterioration of the riparian zone and wetlands, the increase of unpalatable weeds, thistles, and exotic annuals, and the gradual erosion of the top soil resource.

A more holistic approach to grazing, utilizing techniques for the enhancement of native perennial grasses and sustained resource management (plant, wildlife, soil, water), is a relatively new concept in California grassland management. Recently, new grazing management systems have been introduced that mimic natural grazing processes under the heading of holistic resource management (HRM) (Savory 1988). The key feature of these grazing techniques is not so much the intensity of plant defoliation but the time allowed for plant recovery between defoliation events (Voisin 1959). Actual livestock numbers can be high, but the amount of time livestock spends on any particular area is limited. This time will vary according to type and number of livestock, terrain, pasture size, rainfall, air and soil temperatures, and plant growth rates. Technological advances made in electric fence design have made HRM programs possible. Information and techniques derived from HRM schemes are applicable to native Foothill Grassland habitat restoration (Menke 1992).

Technology

There are several tools available in the technology category including mowing, herbicide application, and seeding and planting of native perennial grasses. Mowing management involves considerations similar to both periodic burning and livestock grazing. Mowing must be employed with specific vegetation goals and with consideration for the season, height, and frequency of mowing as well as cutting removal. An important study by Love (1944) tests the effect of management (both grazing and mowing) on the establishment of perennial grasses. Love found that early spring mowing with removal of cut material prevents additions of annual grass seed into the soil seed bank, reduces competition for light and moisture, stimulates perennial grass tillering, and promotes perennial grass seedling establishment. Similar results were found on mulch manipulation trials at the U.C. Hopland Field Station, Mendocino County (Heady 1956, Heady *et al.* 1991). Reducing or eliminating the annual plant litter layer inhibits the establishment of weedy annual range grasses (Evans and Young 1970). Early spring mowing is an accepted worthwhile practice in the establishment and management of native perennial grasses in the face of stiff annual grass competition (Bartolome pers. com., Menke pers. com.).

Selective and non-selective herbicides are available for initial weed control and seedling establishment of native perennial grasses and herbaceous species (Anderson 1992). Herbicides do not distinguish between beneficial native plants and competitive noxious weeds. Therefore herbicide treatments are most applicable on greatly disturbed sites where native flora is absent; otherwise there is a possibility that important native plants (both annual and perennial) will be destroyed. Disturbed sites and areas cleared of trees and shrubs should be seeded with a mix of fast-growing native perennial grasses to mitigate erosion, provide competition against weed establishment, and encourage the natural establishment of other native grasses, forbs, and woody plants. The primary native perennial grasses that can be utilized in this general purpose, erosion control setting are California brome, blue wildrye, and meadow barley. Seeding techniques available include broadcast seeding, hydroseeding, drilling, and spreading native perennial grass straw (Kephart and Amme 1992). The preferred method of seeding in areas where machinery access is difficult or impossible is broadcast seeding coupled with a light raking to bury or cover the seed.

Plug planting of selected, long-lived native perennial grasses (purple needlegrass, California fescue, tufted hairgrass, etc.) is another important restoration technique for areas that are compacted, shady or vernally wet (Amme 1985). Recently on Mount Tamalpais, a plug planting of Idaho fescue was successfully used to obliterate the old eroded Laurel Del Trail from Rock Springs. The plugs used in this project are 3 cm. square at the top and taper down to a 7.5 cm. point. The plant plugs are grown in a rigid 200-cell tray (Plastimer container). Plugs should be grown in the late summer so they are ready to plant as early as possible in the fall when the soil has been deeply moistened with the first major rains. Depending upon drought, rain occurrences, and temperatures, plug planting of slow growing perennial grasses (*Stipa* and *Festuca* spp.) can be delayed until the end of January and still be successful. If rainfall is low or absent, occasional deep supplemental watering will be necessary for successful establishment.

Monitoring

A proper restoration project requires a means of evaluating success. Monitoring grassland restoration is necessary for determining treatment success and adjusting treatments. Success may be measured by native plant diversity, weed reduction, site equilibrium, and vegetation stability. A restoration program requires permanent transects and plots, control sites, treatment areas on different soil types and exposures, replicated treatments, and a fast and efficient means of recording plant composition, cover, frequency, and other biotic factors.

Three types of permanent plots are needed to monitor grassland restoration treatments: 1) Large permanent 30X30 meter plots to monitor the effects of management on trees and shrubs and to evaluate their regeneration; 2) Five to fifteen permanent 1x1 meter quadrats on a 10 to 30 meter transect to monitor the effects of management on scrub habitat and weedy shrub infestations; and 3) Ten permanent 20x50 cm quadrats on a 10 meter transect to monitor the effects of management on grassland habitat. The number of transects and plots depend upon the size of the area to be treated and the number of different vegetation/habitat types in the treatment area. The number of tree and shrub plots should minimally contain at least 20 trees and 150 shrubs. At least ten grassland transects are required to adequately monitor a grassland area up to an acre in size. Prior to establishing plots, it is important to "stratify" or subdivide the habitat into different vegetation/soil types. Plots should always be placed randomly in order to fully evaluate treatment effects. Choosing "representative" sites without randomization and limiting sampling to those areas could mask the degradation of a particular area within a site. Controlled plots should be paired, that is, chosen to be as similar as possible to treatment plots in history, aspect, exposure, cover, and species composition. The plots and transects should be monitored in the peak flowering period in the spring (May), as well as, in the late summer (August). Areas where yield (primary production) information is to be gathered should not be gathered in the plots/transects but rather from similar representative locations near the plot/transect. Plot and transect information must be recorded before and after treatments and each year after treatment for at least four years or until the next treatment occurs.

Each plot should have a master description/history data sheet that includes the following information:

- Exact location
- Description of site
- Physical parameters (slope, aspect, soil series)
- Soil description (% sand, silt, clay, organic matter)
- Vertebrate signs (deer, gophers, ground squirrels, mice, etc.)
- Management history including grazing, cultivation, mowing, and/or exotic plant planting

All plots should be girded and mapped on data sheets as accurately as possible. Information to be gathered at each plot and in each quadrat needs to include:

- Species composition
- Tree and shrub stem locations, numbers, diameters, and canopy (cover)
- Perennial grass numbers, basal diameter, and cover class
- Annual grass and forb densities and cover (by class/category)
- Yield samples (primary production) of the grassland areas from all plots/transects

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