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Time-controlled, short duration, high-intensity sheep or cattle grazing for several days in the early spring removes substantial amounts of alien annual plant seed and favors young short-statured seedling perennial grasses. Photographs by the author.

GRAZING AND FIRE MANAGEMENT FOR NATIVE PERENNIAL GRASS RESTORATION IN CALIFORNIA GRASSLANDS

by John W. Menke

Introduced, alien annual grasses and forbs native to southern France, Spain, and Portugal present a formidable obstacle to restoration and enhancement of native perennial grass populations in California foothill and valley grasslands. Their immense seedbanks regularly stock sites with ten thousand or more plants per square meter. Their diverse set of plant growth forms and phenologies cause fierce resource competition for light and water beginning soon after fall germination and often continuing for the entire growing season. Rosette-forming forbs such as filaree (*Erodium* spp.), can block emerging perennial grass seedling emergence, delay early photosynthetic activity and therefore reducing seedling growth rates. Later in the growing season, tall alien annual grasses such as wildoat (*Avena* spp.) and ripgut brome (*Bromus diandrus*) shade out shorter-statured perennial grass seedlings and outcompete for most of the soil water resources before summer.

Specialized alien species exist for nearly every temporal and spatial resource 'opportunity' (niche). For example, summer annual weeds capitalize on abnormally high late-spring rainfall and runoff to swale sites that have heavier textured soils. In the case of yellow star thistle, seeds can remain viable on the soil surface or in litter for up to eight years. These alien competitors evolved during thousands of years of heavy grazing and periodic drought in southern Europe, and thus have many adaptations to compete successfully against our native perennials under

present grassland conditions in California. The alien's capability for producing some seed under the most adverse grazing disturbances and weather regimes assures their survival. To restore native prairie in California, strategies are needed to reduce the competitive edge of alien species. Once perennials become established they are very strong competitors. I will discuss here some promising approaches which have recently been investigated.

Historically in California, minimal efforts have been made to reestablish native perennial grasses on grassland sites. Range managers emphasized the introduction of alien perennial grasses such as *Phalaris*, *Dactylis*, *Agropyron*, *Oryzopsis*, and *Ehrharta* spp. as part of chaparral vegetation type conversions to grassland where alien annual grass competition is low. Grazing and fire management alternatives were not investigated. No thorough investigation has been made of the forage value and grazing tolerance of any native perennial grasses in California. Use of an ecological basis for designing a management scheme was largely ignored and new methods of time-controlled grazing were not available when perennial grass establishment trials were previously attempted in the 1950s and 60s. Too often intense grazing practices such as season-long continuous grazing, known to be tolerated by alien plants, and sometimes an emphasis on closer seasonal grazing needed to maintain seeded introduced annual clovers, e.g., subclover (*Trifolium subterraneum*) and rose clover (*T. hirtum*), in grass dominated communities, led to unsuccessful grazing prescriptions for natives. In the past, little effort has been devoted to designing a grazing management plan, where prescriptions would first be practiced for one to three years to establish a stand, and specialized grazing systems would later be used to maintain and improve a new stand. Some new grazing systems described by Allan Savory and his holistic resource management (HRM) schemes are potentially applicable here.

Grazing as a Restoration Tool

Studies have been conducted on grazing and fire management on grassland at the University of California (UC) Hopland Field Station and at the Jepson Prairie, (owned by The Nature Conservancy and managed by the UC Natural Reserve System. Through their studies of purple needlegrass (Stipa pulchra) Menke and his students Ahmed, Fossum, and Langstroth provide guidelines for a native perennial grass management prescription. Herbivory and periodic fire and natural and necessary process in grassland. They remove litter, recycle nutrients, stimulate tillering, and reduce seedbanks of competitive annual plants. Management of native perennial grasses requires strategic application of grazing and fire to accomplish the restoration goals – *increasing the abundance of native perennial grasses*. Restoration treatments must: a) enhance the vigor of mature perennial grasses, thereby increasing their longevity; b) promote clonal fragmentation of decadent, over-mature plants into multiple, vigorous daughter plants; and c) encourage native grass seed production and increased seedling establishment success.

Time-controlled, short-duration, high intensity sheep or cattle grazing for several days in early spring removes substantial amounts of alien annual plant seed while it is still in inflorescence and opens up the sward canopy to allow light to penetrate to young, short-statured seedling perennials. This grazing event must be timed to allow perennial grass regrowth, flowering and seed set before spring soil moisture is exhausted. It must be intense enough to graze off the grass inflorescences of most alien annual grasses. The result is increased live crown cover for mature perennial grasses, reduced decadent dead-center growth forms in bunchgrasses, and improved light availability to tiller bases which promotes basal bud activation

and new vegetative and reproductive tiller formation. These perennial grass responses constitute what managers term improved plant vigor.

Summer or 'dormant-season' high-intensity livestock grazing is a second alterative treatment to increase the abundance of native grasses. Accumulation of dead stem bases due to lack of fire and grazing causes self-shading of newly emerging tillers on bunchgrass and the formation of decadent plants over time. This commonly occurs on land protected from grazing for several years or in pastures grazed continuously at light to moderate intensity where animal distribution problems are common and many perennials are left ungrazed most years. High intensity grazing in either spring or summer removes dead stem bases, litter or 'thatch' build-up uniformly over a management unit. Livestock 'hoof action' or trampling puts dead material in contact with decomposer bacteria and invertebrates in the soil which speeds nutrient recycling and litter turnover. So long as the high-intensity grazing is infrequent, perennial grass plant carbohydrate metabolism is not severely disrupted and plants are maintained in the community. Allowing at least one month to six weeks spring growth after grazing when soil moisture is not limiting is a critical element of the grazing prescription. Spring grazing should be timed to maximize seed removal from alien grasses.

Summer grazing should occur in mid-summer near maximum plant dormancy, realizing that most native perennials do not become fully dormant on California valley and foothill sites. Summer grazing does not reap the added benefit of alien annual plant seed removal like that for spring grazing, therefore it is a second choice alternative. It may be applied prior to summer burning to reduce fire intensity. Prescribed grazing constitutes the primary component of the first phase of a perennial grass restoration program; prescribed fire is the second component.

And Prescribed Burning

J. Bartolome and his students at UC-Berkeley have studied spring burning effects and have found that prescribed burning in late spring reduces alien annual plant seed production, and the resulting size of the seedbank, and increases perennial grass seedling establishment due to litter removal and lowered competition. Burning in late spring when seeds are still contained in the inflorescence reduces annual plant density and competition with perennial grasses the following year. Substantial density reductions in annual grasses with flammable caryopses (seeds) is a primary objective of summer burning. Results to date indicate that summer burning stimulates perennial bunchgrasses to fragment into two or more, vigorous daughter plants. However, some consideration needs to be given to the fuel loading before burning. On productive sites where aboveground biomasses can reach high level (>2,500 kg/ha), some previous grazing or mowing is necessary before summer burning to avoid high (twenty percent or more) mortality of mature perennial grasses due to high fire intensity. A one to three percent mortality rate on decadent perennials can be expected with summer fire but because of fragmentation a higher density of vigorous individuals will be present post-fire. Total reliance on burning as a management tool is questionable since liability from potential fire escapes, smoke restrictions, and time required to get permits makes burning as a management alternative difficult to implement in many situations.

Once target density goals for native perennials are reached, more frequent grazing and practical (economic) use of the forage resource will be possible depending upon the objectives for the landscape. So long as adequate time for post-grazing regrowth is provided for most

Prescribed burning in the late spring reduces alien annual plant seed production favoring perennial grass seedling establishment.

years, established native perennial grasses are resilient to grazing. Grazing restrictions and infrequent, high-intensity, short duration grazing will be needed every few years to establish cohorts of seedling perennials to increase or maintain the desired native plant population.

While fire causes a reduction in seed production the perennial grasses the first year post-fire, the effect is gone by the second or third year after a fire. Although some perennials are lost in the fire, the benefits from greater native grass seedling establishment makes up for this loss. Overall there is a net benefit from periodic burning. Literature from other grassland research and our own data (Menke and K. Rice, unpublished data) indicate that volatilization of nitrogen and sulfur exceeds sixty percent of the above-ground standing crop of these nutrients, so very frequent burning should be avoided. Since the time required for the composition of alien annual species to return to a pre-fire status is about three years, burning every third or fourth year is recommended.

While more costly artificial reseeding and other plant establishment procedures (plugs) are possible, prescribed grazing and burning are useful tools to restore or maintain the abundance of native perennial grasses in California grassland where remnant populations are present, where managers take the long-term view, and where large acreages are involved. Certainly, reseeding permits goals to reached more rapidly. Newly seeded native grass stands need grazing and burning treatments beginning the second or third year following establishment to reduce the same light and water competition factors discussed above for mature stands.

Seeding of competitive annual grasses such as ryegrass (*Lolium multiflorum*) in a mixture with perennials should be avoided if the primary objective is to establish native perennial grasses. Once perennials have become established, seeding of annual clover may be a compatible option for livestock producers, but the competitive effects of these annuals on native perennial grass seedlings is unknown and needs to be studied before it is applied on a large scale.

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Benefits of Perennial Grasses

Perennial grasses lengthen the grazing season and increase green forage availability, they have greater capacity to stabilize surface and sub-soils once established, they hold nutrients more tightly and recycle them more efficiently than annuals, they are less flammable than alien annuals, and they help to build soil organic matter, thereby increasing site fertility and sustained productivity. Additionally, they present a more aesthetically pleasing textured landscape appearance and increase the biodiversity of the flora and associated fauna. Unfortunately, perennial grasses are slower than many lien annuals in establishing themselves, growing soil-stabilizing root systems, and providing general soil protection. Where little or no annual plant seedbank exists some seedling of annual grasses may be necessary to gain immediate soil protection; however this practice will reduce perennial grass establishment success.

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