GRASSLANDS

The Newsletter of the California Native Grass Association — February 1992

MYCORRHIZAE AND RESTORATION OF NATIVE GRASSLANDS

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Mycorrhiza ("fungus root") is a mutualism between roots and specialized fungi, an association considered essential to natural plant communities. Mycorrhizae (plural) form a link between the root and the soil. The plant benefits by increased nutrient uptake and the fungus benefits by sugars from the plant. The roots would be able to acquire water and some nutrients on their own, but the mycorrhizal fungi are needed to absorb phosphate.

Mycorrhizal fungi, which must have a host plant when active, are missing from most restoration sites. They may have been carried away in scrapers, and washed away with eroding soil, or starved out of overgrazed plants which cannot photosynthesize enough to support them (Bethlenfalvay et al.1985). They may not return to weedy fields for years (or ever), since relatively few weeds accept the mycorrhizal symbiosis.

Plants without mycorrhizae can be kept healthy through large additions of chemical fertilizer, but the fertilizer will prevent the plant from ever becoming mycorrhizal. The amounts needed to support non-symbiotic plant growth are enormous, largely because the unaided plant is very ineffective at recovering soil phosphorus. Fertilizer recommendations for vegetable crops are as high as 2200 kg/ha (2000 lbs/acre) of 8-16-16 (Brady 1984), enough to supply tissue phosphorus for 25 metric tons/ha (28 U.S. tons/acre) of plant dry weight. If such an outrageous amount of phosphorus were applied to restoration plants, any potential symbiosis would be extinguished.

Plants used in restoration usually languish without mycorrhizal fungi, even though surrounded by growing weeds. The horticulturist's solution is to fertilize (Bluhm 1991), which greatly invigorates the weeds and negates any remaining possibility that the plants will become mycorrhizal. Such a planting will remain viable only so long as artificial inputs, including labor and chemicals for weed control, are continued. It is little wonder that Miller (1985) has characterized restoration without mycorrhizae as "lipstick on a corpse."

Mycorrhizal fungi will eventually move in from undisturbed areas if suitable plants are present, and if they are not being overfertilized. However, mycorrhizal fungi travel more slowly than other kinds of microorganisms. Powell (1979) estimated that vesicular-arbuscular mycorrhiza (VAM), the only kind of mycorrhiza found in grasses, spread from root to root at about a meter per year. This amounts to decades for invasion of many graded sites. The spores of VAM fungi are large, and only the smallest species move freely with the wind. Wind-blown spores land on the surface of the soil and may be useless, as is superficial inoculum in agriculture (Hayman et al 1981). Animal vectors, including earthworms, sow bugs, millipedes (Rabatin and Stinner 1985), and certain rodents (Maser et al. 1978) carry inoculum, but are unlikely to move it from a donor site to a restoration

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PRESIDENT'S MESSAGE

Where from here?
Robert Delzell CNGA President 1990-91

I want to take this oportunity to share some thoughts on future directions for CNGA.

I am pleased to report on the current status of our reseach objectives.

-In cooperation with the University of California , Davis and the USDA, Soil Conservation Service, a literature review is underway.

-Statewide collections of *Elymus* and *Bromus* species are currently being grown in our Berkeley greenhouse for plantings at garden sites in northern and southern California.

-Initiation in 1992 of CNGA data base for recording and publishing information on 42 native grasses we will evaluate.

-Establish and proceed with genetic studies.

-Hire a technical manager to organize and guide these efforts.

The outlook for membership is especially encouraging. Our organization now has over 400 members and is still growing. We can expect funding to accomplish our goals from membership, agencies, foundations, and business in the coming months.

CNGA is reviewing an inter-organizational agreement with the Soil Conservation Service. This agreement, among other provisions, will provide for storage and preservation of seed from rare or newly collected native grasses. CNGA is dedicated to educating people about the values and utility of California native grasses and associated plants. *Grasslands* is one way we inform people about native grasses. We are working on an information packet for our members to educate people interested in establishment and management of grasslands.

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PRESIDENT'S MESSAGE

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Workshops and conferences for 1992 focus on grass taxonomy, post burn restoration, technical and restoration themes.

I have served as your president from the beginning, almost two years now. It has been a very gratifying experience working with such a dedicated board of directors and enthusiastic membership. Continue your support. Stay actively involved. CNGA is truly an organization with a bright future in plant development and environmental restoration.

MYCORRHIZAE

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site until the project has vegetation to attract them. Rapid invasion of inoculum has been documented in favorable circumstances, but counter-examples are also common. In one case, foothill needle grass (*Stipa lepida*) failed to become mycorrhizal until its third year in the field, even though sources of inoculum were closer, and animal traffic greater, than on many restoration sites.

What mycorrhizae do for the plant

The effects of mycorrhizae on native perennial grasses became dramatically evident in a recent growth response test. Two sets of plants were grown in identical conditions except that one set was inoculated with mycorrhizal fungi. The results with three species of *Stipa* are shown in table 1. Two of the species were still diverging rapidly when the test was terminated (figures 1 and 2), with a 20-fold difference in the case of nodding needle grass (*S. cernua*). The results of tests like these depend heavily on growing conditions, but it is clear that the mycorrhizal plants would be far better able to establish and compete with weeds at the restoration site.

Plants that depend upon mycorrhizae for nutrient uptake are said to be "mycotrophic" There are also facultatively mycotrophic and non-mycotrophic plants; the later gain no benefit from the symbiosis (Janos 1980). The ability to form mycorrhizae is described with the terms "host" and "non-host" (Tester et al. 1987). Host status and mycotrophy are distinct concepts, even though the terms are sometimes confused.

Many annual grasses, especially those of disturbed sites, appear to be non-mycotrophic. That is, they can be made mycorrhizal, but realize little benefit. Perennial grasses, in contrast to annuals, are commonly mycotrophic, and are rarely found in the field without the symbiosis.

Table 1

LEAF AREA (mm^2) AT FINAL HARVEST IN MYCORRHIZAL AND NON-MYCORRHIZAL NATIVE GRASSES

	Stipa cernua	*Stipa lepida*	*Stipa pulchra*
Mean leaf area, non-mycorrhizal	291	1214	141
Mean leaf area, mycorrhizal	5676	6377	290
t statistic	41.2**	3.26**	3.55**
Weeks of growth	22	22	5

**Statistically significant ($p<0.01$)

Mycorrhizal plants have been shown to be more drought tolerant than otherwise comparable non-mycorrhizal plants (Safir et al. 1971). There is no suggestion that the hyphae of VAM actually bring in more water; only that drought tolerance is improved. The improvement is most likely an indirect benefit of better phosphorus nutrition (Nelsen 1987).

What mycorrhizae do for the soil

Mycorrhizae have effects on the soil that may be even more important than their effects on individual plants. The fungal filaments, called hyphae, bind small soil particles into aggregates (Tisdall and Oades 1979, Miller 1985). Aggregated soil is resistant to erosion, since it possesses channels that allow water to percolate downward instead of flowing on the surface. Also, roots are confined mainly to the channels created by soil aggregation, since most kinds cannot grow into pores less than their own diameter (Taylor 1974). There are almost certainly plant species that cannot be successfully introduced until soil structure has been re-established.

Current applications for mycorrhizae

Until recently, inoculation with mycorrhizal fungi has been limited to the forestry industry and to university research work. Large paper companies, U.S. Forest Service, U.S. Department of Agriculture, and the governments of Australia, Brazil, Great Britain, India, and New Zealand have invested heavily in mycorrhizal research. Even so, commercial sources of mycorrhizal fungus have been erratic. Both farmers and nurserymen have resisted the use of mycorrhiza, which requires fundamental changes of procedures, and which may be of more benefit to the customer than to the grower.

In the absence of commercial inocu[illegible] a good way to inoculate a restoration site is to apply salvaged top soil. Unfortunately, top soil is usually not available except in mitigation work, where it may come from the site to be destroyed. Otherwise, existing natural habitat must be sacrificed to provide top soil, or weed-infested soil might be used which later turns out to contain little inoculum.

The seemingly obvious procedure of spraying inoculum with a hydroseed mix is ineffective. Even if inoculum were readily available and inexpensive, any that comes to rest on the surface of the soil is not in contact with the roots and cannot lead to mycorrhizal colonization (Hayman et al. 1981). Inoculum can be injected into the soil with certain kinds of farm machinery (Menge and Timmer 1982), but the soil must be level and free of debris. The method of choice for inoculating in restoration, under current technology, is pre-inoculated container plants. Most of the plants may still come from seed, but "carrier" plants may be distributed through the site to provide mycorrhizal fungi.

The container plants that carry the inoculum can be integrated into the restored native flora. Especially good hosts among California native grasses include California brome (*Bromus carinatus*) and foothill needle grass (*Stipa lepida*). Pre-inoculated plants will spread the fungi along their gr[illegible] root systems while seedlings begin to grow. Since the rate of spread may be only one meter per year (Powell 1979), carrier plants must be close together to get rapid inoculation of the seedlings. The number of plants

MYCORRHIZAE

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increases geometrically with decreased planting distance, so there is always a compromise between spacing and economy.

An important strategy is the use of facultative mycotrophs between carrier plants. A facultative mycotroph is a species that can survive without mycorrhizae, but is still able to propagate inoculum from the carrier plants. We need to find facultative mycotrophs among our native grasses; the best prospects will be those which have somewhat weedy behavior in their natural habitats.

Another strategy in restoration is to attract animal vectors: try providing local deposits of organic matter for sow bugs and millipedes, or clumping larger container-grown bunch grasses to attract rodents.

Choice of mycorrhizal fungi

Mycorrhizal fungi differ physiologically from each other, and must be chosen for the specific site conditions (Trappe 1977). Soil pH is the main property that determines compatibility (Hayman and Tavares 1985, Mosse 1975). A mixture of fungi from near the site [illegible]ight for the climate, soil, and vegetation ([illegible]aft 1983, Perry et al. 1987). It is also consistent with the use of local genetic material in habitat restoration (Millar and Libby 1989).

Tree of Life nursery has been shipping mycorrhizal container plants with "generic" fungi for several years. Recently, we have been inoculating contract-grown "carrier" and container plants with fungi cultured from the restoration site. The program has been well-received by the restoration industry, where the need for mycorrhizal plant material has become clearly evident (Miller 1985).

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Use of Elymus Glaucus by the USDA Soil Conservation Service 1944-1950

Summary

by Ted Adams

From 1944 through 1950, plant testing by the SCS emphasized *Elymus glaucus*. Featured with this species were the following: *Bromus marginatus*, *Danthonia californica*, *Festuca rubra*, and *Stipa* spp. Evaluations of these species followed the standard 3-phase SCS program.

During the 7 year period, fluctations in annual rainfall were consistent with the erratic nature of this phenomenon. Below normal rainfall was more common, especially in southern California.

The outstanding strain of *E. glaucus* was P-10128 from Sebastopol. Where complete expression of genetic potential was possible (Pleasanton PMC), this accession compared favorably in forage yield with tall fescue when grown in rod rows. The average yield was 2 to 3 tons per acre, and for the several accessions of *E. glaucus* tested, the range in yield was 2,600 to 8,700 lbs. per acre when cut in the hay stage during the second growing season. P-10128 was rust resistent for most of each year, and its seed production potential approached 200 lbs. per acre.

Three ecotypes of *E. glaucus* were recognized: hay type—tall, high yielding; pasture type—dwarf, leafy, poor seed producer; intermediate type—intermediate in stature, vigorous, and leafy. P-10128 is an early maturing hay type.

E. glaucus is considered a short-lived perennial. As such, it was the best of a group of perennials in this category tested in northern California (Siskiyou County) where it reached full development early.

P-10128 does well in both high and low fertility soils and in extremes of rainfall in the coastal fog belt. At King City, this accession was completely drought tolerant at approximately 9 inches of annual precipitation. (Early maturity contributes to drought tolerance.) Under this low rainfall regime, P-10128 maintained its stand and spread by volunteering. It dominated annuals where proper grazing was practiced, an observation made also in plantings near Ukiah and Willits in Northern California.

In mixtures of perennial grasses, forbs, and legumes, *E. glaucus* and *B. marginatus*

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CNGA TECHNOLOGY COMMITTEE REPORT

Committee Chairman: David Amme

Common Garden Program

This fall the CNGA Technology Committee received approval from the Board of Directors to begin propagation of native grasses for use in cooperative common gardens throughout the State. Rented greenhouse space was found in Berkeley and CNGA hired Susan Camel of Albany to germinate, measure, and pot up over 20 different species of native perennial grasses to be used for evaluation in the common gardens. As of the middle of January over 6100 native grasses have been potted up into "super stubby" liner containers and will be ready for planting by the end of the month. The production cost including the cost for rent, materials and labor is 35 cents per liner.

One of the primary purposes of the common garden program is to grow and evaluate several accessions of the same species collected throughout the State in order to determine adaptability and variability. There are approximately 100 plants of each accession. The program has 6 accessions of purple needlegrass (*Stipa pulchra*), 6 accessions of nodding needlegrass (*S. cernua*), 8 accessions of foothill stipa (*S. lepida*), 4 accessions of meadow barley (*Hordeum brachyantherum*), 16 accessions of California brome (*Bromus carinatus*), 2 accessions of mountain brome (B. marginatus), and 17 accessions of blue wildrye (*Elymus glaucus*). The program has approximately 100 plants each of *Bromus maritimus, Deschampsia caespitosa, D. elongata, Festuca rubra, F. idahoensis, F. californica, Stipa comata, Poa macrantha, Sitanion jubatum, Melica californica, M. imperfecta, Tricetum canescens,* and *Elymus trachycalus*. In addition, there are small quantities of *Agropyron spicatum* (*Pseudorigneria spicata*),*Danthonia californica, Muhlenbergia rigens,* and *Calamagrostis nutkaensis*. Seed and plant material was donated to CNGA by John Anderson, myself, Everett Butts, Paul Kephart, Rich Reiner, Fred Sproul, and Scott Stewart.

Literature Review

At the last Technical Committee meeting it was agreed to begin the review of the SCS Technical Reports at the Lockeford Plant Material Center Library. Ted Adams, myself, John Anderson, Gene Bishop, Brown, and Dave Dyer met at the Lockeford PMC and began the process of reviewing the PMC files. Ted Adams agreed to chair the meeting and the Literature Review Sub-committee was born. Based on the $500 made available for this project by the Board of Directors, Cini Brown agreed to review the Technical Reports from 1944 to 1950 and write a report for the committee. Cini wrote an excellent report focusing on the development of blue wildrye (*Elymus glaucus*). The report is in the process of being reviewed by the members of the Technical Committee and hopefully will serve as a basis for a more indepth study. See Ted Adam's summary of the report below.

USE OF ELYMUS GLAUCUS

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both withstood competition from introduced annuals better than other species (of perennial grass). These observations were recorded at the Sunol Field Evaluation Planting near Pleasanton.

Elymus glaucus makes early fall recovery if old growth is removed. However, early fall grazing of new growth of perennials reduced plant vigor under traditional grazing schemes. In the dryer climates of southern California (San Fernando), species of the genus *Stipa* performed better than *E. glaucus.*

Native Perennial Grass Establishment and Management

by Paul Kephart and David Amme

The purpose of this article is to review principles and practices which lead to successful and thriving native perennial grassland stands. Even with appropriate seeding and fertilizing techniques, seedings of perennial grasses need close attention and management during the first year. Unlike the annual grasses, most perennial grasses, both native and non-native, grow slowly the first year and take two years to develop into good stands. Weed competition and drought can make or break a successful seeding. A thorough and detailed plan that includes scheduling and allocation of resources should precede native grass plantings.

Determining the fundamental goals of seeding native perennial grasses is critical because management techniques will vary in scope, investment, and landscape description. Broad catagories of goals are: 1) Grass seed production—objectives are a high seed yield, superior quality, and profitable grass seeding, 2) Range and pastureland improvement—objectives are a successful transition to perennial high quality forage, established a minimum mechanical, petroleum based technology and investment, 3) Roadside stabilization—objectives are a low maintenance, California-climate-adapted ground cover that controls erosion, suppresses weeds, and provides ecologically sound management, 4) Habitat restoration—objectives are a biologically diverse plant and animal community and a foundation for natural processes and/or succession, 5) Urban landscape—objectives are dependable and predictable growth and flowering characteristics for aesthetic design and low water use, and 6) A sustainable agricultural landscape —objectives are low-maintenance buffer areas that serve as habitat to beneficial insects and wildlife.

Establishment Techniques

Common perennial grass establishment methods include broadcast, drill, or hydroseeding and plug or liner planting. In a range setting where some native perennial grasses already exist, controlled grazing and prescribed burning are other methods of perennial grass establishment. Late fall to late winter are the best times to sow perennial grasses. Cool temperatures and periodic rains help retain soil moisture for seedling emergence and root development. Important objectives for successful perennial grass establishment include: 1) reducing the weed seedbank, 2) creating a firm seedbed, 3) burying seed at the proper depth, 4) providing adequate moisture during germination, and 5) controlling weed competition.

For sites that can be disturbed, mechanical and chemical (herbicide) treatments can be used to begin the process of weed seed bank reduction. Early fall rains or pre-irrigation causes annual grasses and weeds to germinate before perennial grasses are seeded. Annuals can be killed by light cultivation or application of a non-selective herbicide. If harrowing or disking is performed, it is important not to cultivate too deep or weed seed will be brought to the surface again. Cultivated or disturbed soils require rolling and compaction. A compacted, firm seed bed preserves moisture through capillary action and holds seed in place. Burying the seed just below the soil surface is the optimum seeding technique. A rule of thumb for planting is to plant seeds as deep as seven times the width of the seed.

Broadleaf herbicide treatments help establish perennial grasses and can play an important role in managing grass stands. Wicking or spot spraying are examples of specific plant applications. There is an arsenal of herbicides that kill annual grasses, broadleaf forbs, and specific plants. Certain chemicals will kill annual grasses without damaging established perennials. It is important to check with the local farm advisor or herbicide specialist for specific product information before deciding how to use the herbicides or whether or not herbicides are necessary to reach the landscape goal.

Where herbicides and soil disturbance techniques are not possible, higher seed rates and multi-species seed mixes have proven successful. This is best accomplished by using range or native grass seed drills. These drills plant seed just below the surface without soil tillage. Mechanical broadcast seeding with harrowing (lightly scratching the soil surface) is also successful, especially with complex seed mixes. However it is important to note that follow-up management either with mowing equipment or grazing animals is essential for controlling weed competition to insure perennial grass establishment when resident weeds cannot be controlled.

Broadcast seeding, drill seeding, hydro-seeding and native straw mulches are successful methods especially on steep slopes and roadbanks where the erosion potential is great. Native grass hay that has been flailed contains as much as two pounds of seed per 100 pound bale. Crimping this hay into banks or covering the hay with netting reduces erosion and suppresses broadleaf weeds.

Adequate irrigation or rain during early germination is important to prevent crusting of the soil surface. This is often the case with disturbed or cultivated soils. One technique employed to break crusting is a light ring rolling or harrowing prior to seedling emergence. On rangeland and non-cultivated sites, livestock impact simulates mechanical cultivation and aids perennial grass establishment. Excited animals disturb the soil surface and their hooves compress broadcasted seed into impressions where moisture collects. Native grass hay and seed supplement seed mixes can make four legged range improvers out of livestock.

Container planting either with grown plugs (liners) or dug rhizomes are effective in establishing native perennial grasses. However, the cost for plugs and rhizomes is much higher than seed. Cost varies upon the species grown, type of plug, and numbers of plugs grown. Plug and rhizome planting are often the best methods of introducing native perennial grasses for steep slopes, buffer strips, and small critical areas. Plug planting is especially applicable in urban landscape settings. Planting plugs of rhizomatous native grasses such as creeping wildrye (*Leymus triticoides*) can often pass cost/benefit analysis where the spacing of plugs are over two feet apart and a closed stand is achieved the following year.

The use of fertilizers and their rates depends on soil type and fertility, species response, and performance goals. Soil testing should always precede a native perennial grass seeding. The goals and choice of the perennials to be seeded also has important bearing on the use of fertilizers. The faster growing native perennial grasses such as California brome (*Bromus carinatus*), meadow barley (*Hordeum brachyantherum*), blue wildrye (*Elymus glaucus*), and slender wheatgrass (*E. trachycalus*) respond favorably to added fertilizer during the establishment phase. Slower growing native perennial grasses such as needlegrass and creeping wildrye show little improved response to fertilizer during the establishment phase. In low-input rangeland settings where annual grasses and weeds are dominant, fertilization during the establishment phase is clearly counterproductive. Nitrogen fertilizers stimulate the faster growing annual grasses and weeds, outcompeting the slower growing perennials. Second year fertilization programs are more beneficial in this situation becasuse the perennial grasses are well-established and are able to utilize nutrients more efficiently. In an agricultural or irrigated pasture setting where the annual grasses and weeds can be more closely controlled, fertilizers are effective during the establishment period.

Management

Follow-up management of a seeded site is just as important (if not more important) to a successful perennial grass stand as is the careful attention paid to the actual seeding operation. The most important objective for a first year management program is to favor perennial plant cover over annual grasses and weeds. Carefully timed mowings, planned grazings, prescribed burns, or a combination of these management practices is needed to achieve this objective. Annual grasses and weeds grow faster and reach reproductive maturity earlier than native perennial grasses. Precise timing of mowing events will alter the balance of reproductive success between the annuals and perennials. The timing, height, and frequency of a mowing schedule are designed to reduce direct competition from annual grasses and weeds and to stimulate tillering and root growth. The mowing season and frequency should be adapted to plant size and growth rates. Close mowing with the removal of residue (clippings) in the early spring greatly favors perennial grass establishment and prolonged vigor. Mowing reduces potential production of annual grass seed, provides a competitive edge for perennials, stimulates tiller production, and preserves available moisture in the soil.

Two or three mowings are needed during the first year after initial seeding. The most important mowing is the early spring mowing. Depending on the amount of rainfall and the wet season temperatures this is usually accomplished near the end of March. Late spring/early summer mowing usually results in the gradual expansion of noxious biennial weeds such as yellow star thistle. By the middle of June the perennial grasses should be allowed to dry out and go dormant. A fall mowing enhances perennial grass regrowth and provides light and space for emerging seedlings as well as reducing the potential fire hazard.

Grazing can be an important restoration tool for establishing and maintaining native perennial grass stands. When planning grazing frequency and intensity it is important to allow the the native perennial grasses adequate time to recover after the grazing event. Overgrazing (chronic and severe defoliation) occurs when livestock stay in a pasture too long or return to a pasture too soon. The most severely stressed native perennial grass should be targeted for close monitoring to determine the grazing plan. Rest periods for pastures determines the grazing period. The more pasture units the better. Planned grazing reduces annual grass seed production and direct competition by annual grasses. Grazing increases light at the plant base which stimulates basal bud growth. Planned grazing allows the native perennial grasses to produce seed and aids in seed dispersal and planting. Temporary electric fences are indispensable for controlling livestock movement and degree of utilization. Planned grazing requires water and fence development but most importantly successful grazing requires dedicated managers who put extra time and money into managing livestock in an ecological and sustainable manner.

Prescribed burning promotes the spread of native perennial grasses. Fire reduces the cover and vigor of annual grasses and weeds, recycles nutrients and minerals retained in aboveground biomass, provides the optimum seed bed and conditions for perennial grass seedling establishment and renews old decadent bunchgrasses. Long-lived perennial grasses such as creeping wildrye, purple needlegrass (*Stipa pulchra*), nodding needlegrass (*S. cernua*), foothill stipa (*S. lepida*), pine bluegrass (*Poa scabrella*), foothill melic (*Melica imperfecta*) and California melic (*M. californica*) are known to respond well to the frequent use of late summer and early fall fires. Idaho fescue (*Festuca idahoensis*), western fescue (*F. californica*) and short-lived perennials such as California brome, meadow barley, blue wildrye, and slender wheatgrass, are more sensitive to frequent fires. Annual cutting of brush and weeds for a fire break defines areas for a burning and seeding program. Prior mowing or grazing reduces fire risks and provides optimum burning temperatures. The limiting factors when using prescribed fire is a lack of a specific objective and the political and cultural backlash that sometimes accompanies proposed prescribed burns.

With preplanning and clearly st... objectives, establishment and management of native perennial grasses will lead to a rewarding, long-term, perennial grassland for the restorationist, land manager, and urban landscape designer.

NEWS BRIEFS & TRENDS

Threatened Native Grassland!!!

A coastal native grassland will soon vanish under buildings and parking lots in the city of Richmond. U.C. planners and developers ignor the pleas of environmentalists to save this rare habitat that has been used for ecological research for the past 26 years.

Native grasses are the predominate cover over 15 acres. Of this, 8.6 acres are considered pristine. This prairie has native grass cover reaching 90%! California Oatgrass Danthonia Californica, and Purple needlegrass Stipa pulchra occur with the greatest frequency and California Brome Bromus carinatus, squirreltail sitanion hystrix, and meadow barley Hordeum brachyantherum are found in the swale areas. Associated species include: Aster exilis, Carex sp., Grindelia sp., Helocharis sp., Hemizonia luulaefolia, Juncus bufonius, Lupinus sp., Orthocarpus sp., Sida Hederacea, sisrynchium bellum, and Wyethia angustifolia. Construction plans could be modified if you choose to dissent. Write letters of concern to:

Vice Chancellor J.L. Heilbron
Chancellors's office 200 California Hall
University of California, Berkeley, Ca.
94720

Southern California Academy of Sciences Annual Meeting

May 1-2 1992 A two day Symposium.

Session 1: Intereface between Ecology and Land development in California. Friday May 1.
Session 2: Urban Wildlife and Corridors. Friday May 1.
Session 3: Land Use and Mitigation. Saturday May 2.
Session 4: Ecosystem Restoration. Saturday May 2.
Organizer: Dr. Jon Keeley, Biology Department, Occidental College Los Angeles 90041 (fax: 213-259-2958)
Abstracts due February 15

California Immigrants: People, Plants and Animals

is the theme of the California History Institute
University of the Pacific Stockton, California
April 23-25,1992

For registration information :
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Letters to the Editor

Dear Grasslands Editor,

Two comments on Steven W. Edwards' reply to Judith Lowry's July 1991, Notes on Native Grasses article:

(1) The ice age megafauna were not big-time grass eaters, and that's why they are extinct! See "New sources of Dietary Data for Extinct Herbivores" by Akersten, Foppe, and Jefferson in Quarterly Research, 1988 (30: 92-97).

The bunchgrasses were so unaccustomed to grazing by the herbivores remaining after the Ice Ages, that when we made a pound-for- pound substitution of cattle for the native herbivores, the bunchgrasses succumbed! Now, in 1991, the cattle biomass is nearly three times the pre-1760 herbivore biomass and rising!

(2) Our firm just completed a San Francisco Bay Area bunchgrass survey along roadsides. We surveyed 5,120 sq. miles of nine counties and found 108 bunchgrasss locations. The roadside bunchgrass stands occurred in un-disturbed soils above the roadcut.

The bunchgrasses abruptly ended at the fencelines and only in one case were they found in the grazed fields beyond.

Wherever bunchgrasses were growing on poor soils of the roadcuts, those grass plants originated from seeds dropped intact from prairies above the roadcut on un-disturbed soils. The inescapable conclusion was that the prairies surveyed along those roadsides existed not because of the soil they grew on, but because they were undisturbed and protected from European herbivore grazing.

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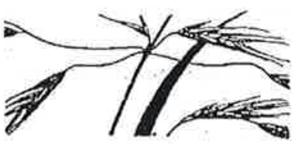

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