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RESEARCH REPORTS

Suppressive effects of Zorro fescue (*Vulpia myuros*) on California native perennial grasses

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Many involved in revegetation projects wonder about the effects of introduced annual grasses, such as Zorro fescue, on native perennial grasses when they are combined in seed mixtures. The rationale for including annual grasses in reseeding mixtures seems to be that the quick ground cover and erosion control provided by the annuals outweigh any negative effects they have on the native perennial grass species. The evidence which has accumulated over the years clearly indicates that native perennial grasses are negatively affected by annual grasses (Heady 1989; Harris 1967; Harris and Wilson 1970). In California, results from field studies by Dyer (unpublished data) and Dyer et al. (1996) at Jepson Prairie, a container study by Craig Dremann (1989), and field and container studies by Bartolome and Gemmill (1981) all show that annuals have a strong negative effect on the survival and performance of the California native perennial grass Purple needlegrass (*Nassella pulchra*). Results from the experiment we conducted continue to strengthen the case that annual grasses significantly interfere with the success of native perennial grasses.

We conducted an experiment in Yolo County between 1993 and 1995 to specifically address the question of how the annual grass Zorro fescue (*Vulpia myuros*) affects native grasses when both are planted in erosion control seedings. Preliminary results of this experiment were presented at the 1994 CNGA Annual Meeting. Zorro fescue was selected as the annual competitor primarily because it has been, and continues to be, included in revegetation seed mixtures throughout California. Based on its height and the density of its canopy, the impact of Zorro fescue on native grasses would seem to be minimal compared to other, more robust introduced annual grasses such as Soft chess, Italian ryegrass, and Ripgut brome. Some have hypothesized that Zorro fescue might even act as a nurse plant by suppressing weeds, providing protection from herbivores, and reducing water stress through shading in hot, dry summer months.

We assessed the effects of varying densities of Zorro fescue on a mixture of California native perennial grasses. The perennial grass mixture included the following: Blue wildrye (*Elymus glaucus*) 3 lb/acre, Meadow barley (*Hordeum californicum* ssp *brachyantherum*) 3 lb/acre, California melic (*Melica californica*) 3 lb/acre, Nodding needlegrass (*Nassella cernua*) 3 lb/acre, Purple needlegrass (*Nassella pulchra*) 6 lb/acre, Pine bluegrass (*Poa secunda* ssp *secunda*) 1.5 lb/acre. The total seeding density for the perennial mixture was 19.5 lb/acre. At the time of the study, this was considered a state-of-the-art erosion control seed mixture. The mixture was planted first using a Truax wildflower seeder. The Zorro fescue was broadcast over the mixture in small plots (10 ft by 20 ft) and raked in by hand. Zorro fescue seeding densities were 1, 5, 15 and 30 lb/acre. The native perennial mixture was also grown alone as a control.

The results of our experiment show that increasing seeding densities of Zorro fescue produced both lower above ground biomass and densities of native perennial grasses and weeds. Native perennial grass and weed above ground biomass were suppressed to the same degree. However, perennial grass densities were not

reduced as much as weed densities were by increased seeding densities of Zorro fescue. There was no detectable difference in height of native grass seedlings but biomass per plant decreased with increasing Zorro fescue seeding densities. These results suggest that reduced light levels under the Zorro fescue canopy inhibited growth.

The differential effect of Zorro fescue on native perennial grasses and weeds (i.e. weed densities were more negatively affected than perennial grass densities), might seem to warrant including Zorro fescue in mixtures with native perennial grasses to control weeds. However, before coming to this conclusion it is important to consider the absolute amounts of weeds compared to native grasses and the goals of the reseeding effort. In our experiment, the weed densities and above ground biomass were many times greater than those of perennial grasses. Because weeds are generally prolific seed producers, it is doubtful that reductions in their densities in the first year after seeding would be sufficient to prevent growth of the weed population.

Vegetation establishment and erosion control are two common objectives of reseeding projects. With regard to establishing native perennial grasses, our results clearly show that fewer, smaller native grasses survived when Zorro fescue was present than when it was not. Zorro fescue did not act as a nurse plant for native perennial grasses in this case. When erosion control is of primary concern, one should consider that the amount of protection provided by quick germinating and fast growing annual grasses depends a great deal on the rainfall pattern after seeding. If a rainy season begins with torrential storms, even the annuals may not reduce erosion significantly. Because the absolute amount of weeds did not appear to be reduced enough to be biologically meaningful, perennial grasses were suppressed by the presence of Zorro fescue, and the protection provided by annual grasses against erosion is contingent on weather patterns, it appears unwise to include Zorro fescue in seed mixes with California native perennial grasses. Emphasizing mechanical means of erosion control in the short term may be the best use of resources in order to reach long term vegetation establishment and erosion control goals.

ACKNOWLEDGEMENTS

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Bugg for assistance in planting the experiment and general support. As always, we thank members of our lab at UC Davis for their contributions.

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NOTE: A complete paper reporting these results will be submitted for publication. We will inform the *Grasslands* readership about the location and date of publication as soon as is possible.

EDITOR'S NOTE: This is a nonreviewed article and is included in 'Research Reports' as a preliminary report of scientific content.

Tolerance of Six California Native Perennial Grasses to Several Preemergence Herbicides

W. THOMAS LANINI, RACHAEL F. LONG, and JOHN ANDERSON

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Weeds often provide stiff competition to perennial grass stands, particularly during the first few years after grass establishment. Field studies were conducted to evaluate the tolerance of several established perennial grasses to preemergence herbicides in order to selectively suppress weeds. Grass vigor was reduced by some herbicides, but most had minimal effects. The herbicides that controlled weeds best caused the greatest reduction in grass vigor.

Perennial bunchgrasses once dominated much of California and other western states, prior to the introduction of livestock, agriculture, and invasive weeds. The introduction of livestock combined with drought led to overgrazing many areas. The massive influx of settlers in the 1800's increased the land under cultivation and also led to the introduction of many alien species. These changes have resulted in the native flora becoming almost entirely replaced by introduced annual and perennial weedy plant species, such that today California grasslands are mostly composed of introduced annual species. This shift in the native grass community has resulted in a degradation of rangelands, increased problems in soil erosion and weed control, enhanced fire danger, and loss of wildlife habitat.

To address these concerns, there has been interest and attempts to propagate native perennial grasses for California landscapes, including parks and recreation areas, agricultural and urban areas, and along right-of-ways. Current methods of establishing perennial grass stands include broadcast seeding, drilling, or transplanting. Competition from annual weeds has caused many new plantings to fail, discouraging some people and agencies from using native perennial grasses in revegetation programs. Although many factors affect stand persistence, such as adaptability of the species to the site, competition from invasive annual grass and broadleaf weeds remains the most troublesome and difficult to manage.

Weed management during early development of the perennial grass stand is critical to successful establishment. Once native grass stands achieve full coverage of a site and are properly managed, they are able to compete for light, nutrients, and water, and retard weed invasion. Some weed control measures may be necessary in established perennial grasses where large weed seed banks exist or where grass stands are sparse. Several management tools are available to control weeds in perennial grass stands including tillage, hoeing, mowing, grazing, and use of fire or herbicides. The cultural methods by themselves suppress weeds in most cases, but tend to be costly and time consuming, and may not be feasible or appropriate in some situations such as on hilly land or near urban areas. Chemical weed management by contrast is often a faster and cheaper means of weed control.

Several postemergence broadleaf herbicides have controlled broadleaf weeds in perennial grasses. Preemergence herbicides, including picloram or atrazine will control annual weeds, with low phytotoxicity to perennial grasses. Picloram is not labeled for use in California and atrazine use has been restricted due to its detection in wells.

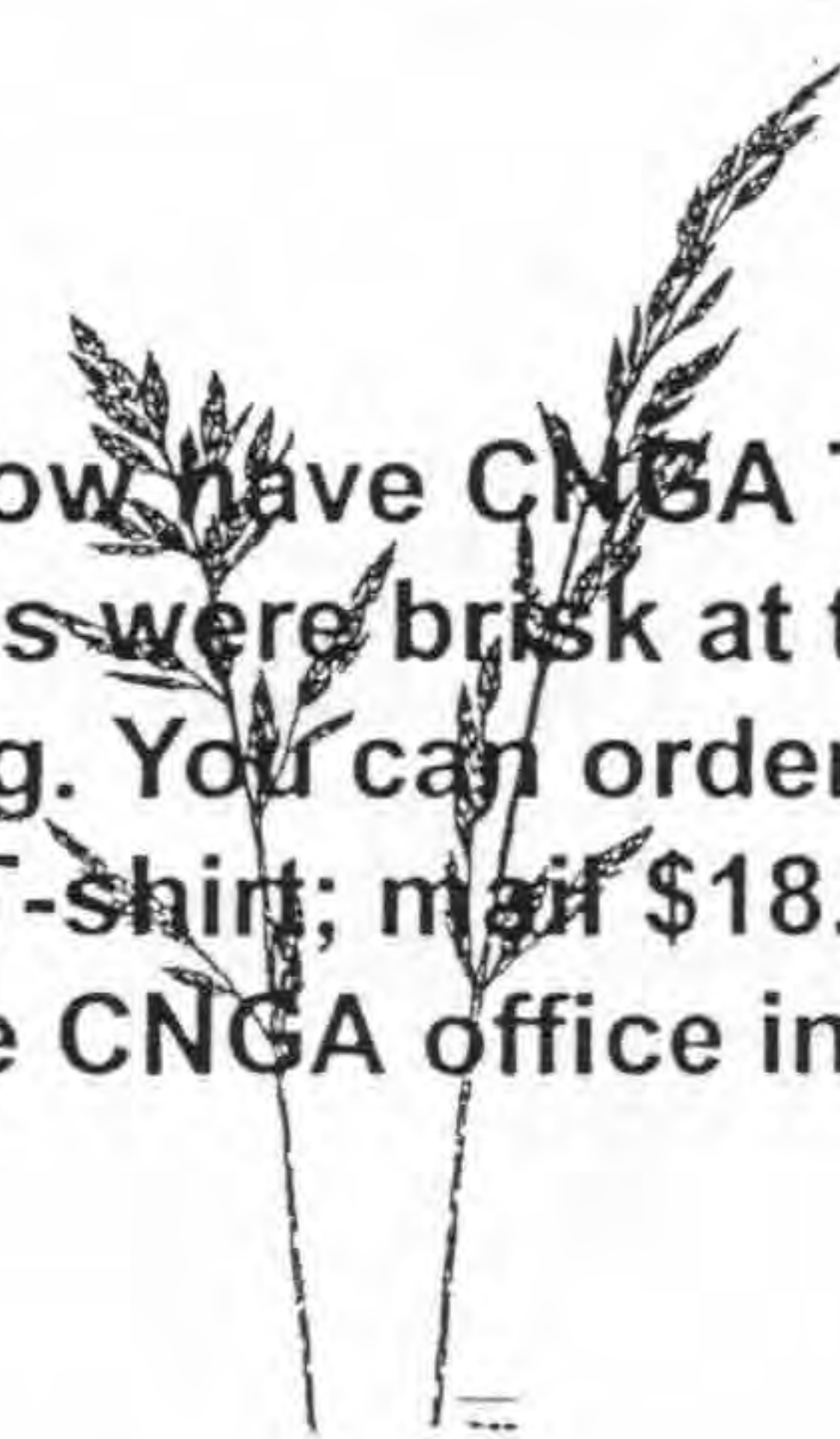
Information on tolerance of California native perennial grass species to preemergence herbicides and the appropriate use rates for California conditions is limited. Therefore, work on non-native perennial grasses was examined for possible leads on candidate herbicides. Two perennial grasses, Kentucky bluegrass (*Poa pratensis*) and tall fescue (*Festuca arundinacea*) were found to be relatively tolerant of chlorsulfuron at rates less than 0.70 oz/a, but at rates up to 4 oz/a, tall fescue growth was reduced by 30%. Six species of container-grown ornamental grasses were found to be tolerant of oxidiazon at 2 lb/a and four of the six species were tolerant to oryzalin at 2 lb/a. Several preemergence herbicides were identified in preliminary studies as having potential to control annual weeds without significant injury to established perennial grasses.

The objective of this study was to evaluate the weed control in and tolerance of six California native perennial grass species to selected preemergence herbicides.

Field studies

Trials were established on September 23, 1992 and November 17, 1993 on established California native grasses: meadow barley (*Hordeum brachyantherum* Nevski); blue wildrye (*Elymus glaucus* Buckley); California melic (*Melica californica* Scribner); Idaho fescue (*Festuca idahoensis* Elmer); nodding needlegrass [*Nassella cernua* (Stebb. & Love) Barkworth]; one-sided bluegrass (*Poa secunda* spp. *secunda* J.S. Presl.). The 1992 trials were located near Rio Vista, California in a soil with 3.3% organic matter, 11% sand, 43% silt, and 46% clay. The 1993 trials were located near Winters, California in a soil with 1.2% organic matter, 17% sand, 45% silt, and 38% clay. Grasses had been planted as monocultures one or more years prior to the initiation of this study, thus each grass species represented a separate trial. In 1992, one location was used for each species, while in 1993, two locations were used for Idaho fescue, California melic, meadow barley, and one-sided bluegrass, and one for the other species. The experiments were arranged in a randomized complete block with three replications, with each plot measuring 10 x 20 ft.

At both locations and in both years, seasonal native grass growth had just started at the time of herbicide application. The herbicides (Table 1) evaluated in these studies were all preemergence herbicides, requiring rainfall or irrigation for activation. Excessive native grass injury was observed in the 1992 studies when chlorsulfuron or oryzalin were used, thus application rates for these were reduced in the 1993 studies. Herbicides were applied using a CO₂ powered backpack sprayer, using 8002 nozzles at 30 PSI and had a spray volume of 25 gal/a. At the Rio Vista site, plots were sprinkler irrigated with 0.75 inches of water following treatment to



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incorporate the herbicides. The Winters site lacked irrigation so applications were timed to coincide with the start of seasonal rainfall. Rainfall from the time of herbicide application to the time of vigor evaluation was 17.45 inches at Rio Vista and 6.68 inches at Winters.

Weed control and grass vigor were evaluated on March 15, 1993 and March 31, 1994. The principal weeds at both sites were winter annuals. Weed species were combined, and percent weed control was visually assessed, noting the weed species which were not controlled. Grass vigor, a visual ranking of grass height, tillering, and color, was evaluated in each plot. A vigor ranking of 5 represented healthy, robust grass, with excellent color. A value of 1 represented grass with no new growth or tillering but still alive. A 0 represented dead grass. Values less than 5 were estimates of percent growth and color reduction. Grass height was measured at the Winters location. Height measurements were made on 4 random individuals in each plot and averaged to give mean grass height for each treatment. Data were subjected to an analysis of variance and means were separated by Fishers F-protected LSD test.

Results and Discussion

Grass vigor varied by species, age of stand at treatment time, herbicide, and weed pressure on the study site (Tables 2). Grass vigor ratings on untreated plots was often less than 5 due to the competition from weeds reducing growth.

Idaho fescue. One-yr-old Idaho fescue was less vigorous when oryzalin or the combination of chlorsulfuron and oryzalin was used, at both study sites (Table 2). The Idaho fescue vigor on oryzalin-treated plots at Winters was reduced in spite of less rainfall and a reduction in the rate of the herbicide. Additionally, at Winters, chlorsulfuron treatment reduced the vigor of Idaho fescue. The reduction in vigor from chlorsulfuron treatment corresponds closely with observations made in other studies. In two-yr-old Idaho fescue plantings, no difference in vigor was observed among treatments. The shallow root system in one-yr-old Idaho fescue, compared to two-yr-old grass, may have resulted in the greater vigor reduction. Height measurements of one-yr-old Idaho fescue indicated that treatment with either chlorsulfuron or oryzalin caused significant height reductions (Table 3). Height of two-yr-old Idaho fescue was not affected by herbicide treatment. Weed competition caused some reduction in two-yr-old Idaho fescue height as indicated by the increased height where simazine provided good weed control (Table 3 and 4). Chlorsulfuron treatment also provided good weed control, while height of two-yr-old Idaho fescue was less than observed on other treatments, indicating that this treatment was still reducing growth. At Rio Vista, weed control was improved by the herbicide treatments with the exception of the simazine treatment (Table 4). Simazine at the 1 lb/a rate was not effective in controlling broadleaf weeds. At Winters, in one-yr-old Idaho fescue, the major weeds were chickweed (*Stellaria media*) and annual sowthistle (*Sonchus oleraceus*). Treating with chlorsulfuron or the combination of chlorsulfuron and oryzalin resulted in complete weed control for the duration of the winter growing season, while other treatments were less effective. In two-yr-old Idaho fescue, chlorsulfuron, the combination of chlorsulfuron and oryzalin, simazine, or oxadiazon all provided good weed control. Oryzalin at the 0.75 lb/a rate and diuron both failed to control the common groundsel (*Senecio vulgaris*) or little mallow (*Malva parviflora*) that were common at this location.

California melic. One-yr-old grass vigor was reduced more in Winters than in Rio Vista (Table 2). Chlorsulfuron in 1992 or chlorsulfuron plus oryzalin treatment in 1993, were the only treatments with vigor ratings significantly lower than untreated grass. In two-yr-old California melic, vigor was not significantly different among treatments. Two-yr-old California melic had higher vigor ratings than one-yr-old grasses at Winters. The larger two-yr-old grasses may have been more competitive with the weeds that were present, improving weed control (Table 4). Also, a deeper root system in the older grass may have reduced the exposure to the preemergence herbicides. Weed control on the one-yr-old California melic did not vary among treatments at Rio Vista, but was significantly increased for the treatments which included chlorsulfuron at Winters (Table 4). All herbicide treatments were significantly better at increasing weed control compared to the untreated in two-yr-old California melic. Although the principal weeds at Winters in California melic plots were similar to those in the Idaho fescue plots, weed

control was greater on the California melic sites and is probably related to the greater height and vigor of California melic (Tables 2 and 3).

Nodding needlegrass. Vigor of three-yr-old nodding needlegrass was reduced by oryzalin at 2 lb/a rate or chlorsulfuron treatment (Table 2). Neither vigor nor height of two-yr-old nodding needlegrass was significantly affected by treatment, although some trend toward less vigor was noted on the oryzalin-treated grass. The higher treatment rates for chlorsulfuron and oryzalin used in 1992 on the three-yr-old grass may have accounted for the observed reduction in vigor. All herbicide treatments significantly improved weed control in three-yr-old nodding needlegrass (Table 4). Herbicide treatments were generally less effective at increasing weed control in two-yr-old nodding needlegrass compared to three-yr-old grass. The principal escape weed in the two-yr-old nodding needlegrass was field bindweed (*Convolvulus arvensis*), with only chlorsulfuron, oryzalin, or oxadiazon providing weed control greater than observed on untreated plots.

Blue wildrye. Both chlorsulfuron and oryzalin reduced vigor of four-yr-old blue wildrye plants (Table 2), while one-yr-old blue wildrye was not significantly affected by treatment. One-yr-old blue wildrye treated with oryzalin had the lowest vigor ratings. Weed control was significantly improved from all herbicide treatments in one-yr-old blue wildrye (Table 4). No difference in weed control was seen in the four-yr-old blue wildrye, as weed pressure was very low on this site. This site had been burned approximately one month prior to establishing the trial, which resulted in very few annual weeds surviving the fire or emerging after the burn. This also may also have predisposed blue wildrye to herbicide injury.

One-sided bluegrass. One-sided bluegrass vigor was significantly reduced by oryzalin or oryzalin plus chlorsulfuron treatments (Table 2). Reducing the rate of oryzalin or chlorsulfuron in 1993 did not improve the vigor rating in one-sided bluegrass. The Winters site had a dense common chickweed population which reduced vigor in all plots compared to Rio Vista. Simazine reduced the vigor of two-yr-old one-sided bluegrass. The vigor reduction associated with simazine treatment was unexpected, since previous work has shown that the vigor of several native perennial grass species were reduced when simazine had been used at 2 lb/a, but little or no injury at the 1 lb/a rate. The two-yr-old one-sided bluegrass was located a short distance from the other grass species and had different soil characteristics. The soil had less organic matter (0.85%) and more sand (36%) than at the other locations. Treatments which reduced vigor of one-sided bluegrass also reduced height (Table 3). The most dramatic effects were from chlorsulfuron, where height growth was reduced by 50%. Improvements in weed control were greatest in plots where grass vigor reduction was also greatest (Table 2 and 4). Chlorsulfuron provided almost complete control of common chickweed and little mallow; the principal weeds at Winters.

Meadow barley. Vigor of meadow barley did not differ among treatments for any of the age groups evaluated (Table 2). Poor common chickweed control was observed at Winters on all plots not using chlorsulfuron or oryzalin (Table 4). Two-yr-old meadow barley plants generally were less vigorous than one-yr-old plants at Winters. Weed pressure was much greater in the two-yr-old grass plots than in the one-yr-old grass plots. The decreased weed control on the two-yr-old grass plots resulted in more competition and less grass vigor.

Three-yr-old meadow barley displayed increased vigor compared to younger grasses, particularly when oxadiazon, diuron, or simazine were used (Table 2). Although not significant, the injury from oryzalin, chlorsulfuron, or the combination of these two herbicides, was greater in three-yr-old grasses (1992 trial) than in the two-yr-old plants treated in 1993. In 1992, higher rates of chlorsulfuron and oryzalin were used which may have caused the increased injury seen on these plots.

CONCLUSION

Vigor of established perennial bunchgrasses was affected by herbicide treatment. Vigor was generally reduced by dense weed cover. The treatments that consistently controlled the winter annual weeds in these trials were chlorsulfuron or the combination of chlorsulfuron and oryzalin. However, these treatments generally caused some reduction in grass vigor. Rates of chlorsulfuron and oryzalin were both reduced after the first year of study in an attempt to reduce grass injury, with only limited improvement

observed after rates were reduced. Since weed control is still very good at the reduced rates, particularly with chlorsulfuron, further rate reduction may still be possible without reducing weed control and could reduce grass injury.

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Table 1. Preemergence herbicides and application rates evaluated for each study site.

Herbicide	Rio Vista -1992	Winters - 1993
	lb/a	lb/a
Chlorsulfuron	0.06	0.05
Chlorsulfuron + oryzalin	0.03 + 1.0	0.03 + 0.5
Oryzalin	2.0	0.75
Diuron	2.0	2.0
Oxadiazon	2.0	2.0
Simazine	1.0	1.0
Untreated		

Article continued on p. 5-6



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OLDEST GRASS RESEARCHERS HONORED

by Brain Gaylord

reprinted from the Monterey County Herald, Tuesday,
November 12, 1996

If California native grass is standing a little taller today, it's because of the reverence paid it by Beecher Crampton and G. Ledyard Stebbins. "All the grass collecting I've done has had a silver lining," Crampton said to a gathering of the California Native Grass Association in Monterey on Friday. "Look for it if it isn't there — because it's there." Crampton and Stebbins were honored along with Alan Beetle and William Hiesey at the association's annual meeting. Together the four make up the oldest native grass researchers. Hiesey was not present at Friday's meeting.

Crampton, 78, a former professor at the University of California at Davis, hasn't been dissuaded from his mission of promoting native grasses. His 1974 book "Grasses in California" remains a major reference work on the subject. Grass collecting has three objectives, he said: determining the nature of the habitat range or a species, establishing a workable plant library and fostering public awareness. Crampton also warned of the hazards of grass collecting. Through a series of slides, many taken roughly 25 years ago, he humorously warned of blowing sand, bubbling mud springs, cows, barbed-wire fences and confrontations with shotgun-toting inhabitants. "In the back country, I've found that 'I was collecting grass' or 'I was looking for grass' are not the right thing (sic) to sway," he said. In 1958, Crampton stumbled onto his claim to fame: *orcuttia*, a new species of native annual grass collected from a vernal pool. The grass is also widely known as Crampton's tuctoria.

Despite the long shadows cast by Crampton and Stebbins, the state's native grasses have grown around them and their research has formed the backbone of the very group that honored them, which itself has sprouted more than 330 members. Native perennial grasses, which remain green year-round, provide superior erosion control and tolerate drought, roadside traffic and grazing. They also sustain a wide variety of wildlife. Among the goals of the California Native Grass Association are the rescue of long-surviving stands of grass for preservation and learning to use native grasses for ecological restoration and agriculture. Few of the 300 indigenous species of grass can still be found throughout the state and the grasses that Crampton and Stebbins helped research are undergoing an identity crisis of sorts, with name changes. Stebbins, 90, discussed the challenge that the state's ranchers face in trying to keep grazing grass from turning brown in summer, as the less-hardy European hybrid grasses do. The former University of California at Berkeley professor's research interests included plant evolution and crossbreeding native and imported grasses.

Stebbins is credited with having identified nodding needlegrass as a new species of grass. He said he wished for a "fair godmother to make me young again" so he could continue research in the field, adding that the young people don't need a fairy godmother because "you know more techniques now than I ever did."

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Table 2. Vigor* of grass species associated with preemergence herbicide treatment†

Herbicide	Grass species											
	Idaho fescue			California melic			Nodding needlegrass			Blue wildrye		
	RioVista**	Winters		RioVista	Winters		RioVista	Winters		RioVista	Winters	
	1yr	2yr	3yr	1yr	2yr	3yr	1yr	2yr	3yr	1yr	2yr	3yr
Chlorsulfuron	4.5	2.0	3.5	5.0	3.0	4.5	4.0	4.0	3.5	4.0	1.0	1.5
Chlorsulfuron + Oryzalin	2.5	2.0	3.5	3.5	3.5	4.5	2.0	3.5	3.5	2.5	1.0	1.5
Oryzalin	4.0	2.5	3.5	4.5	4.0	4.0	2.0	4.0	4.0	3.0	2.0	3.0
Diuron	5.0	3.5	4.0	5.0	4.0	4.5	4.0	4.5	4.5	4.0	3.0	4.0
Oxadiazon	5.0	3.5	4.0	5.0	3.0	4.5	3.5	4.5	4.5	5.0	2.5	3.5
Simazine	5.0	4.5	5.0	5.0	4.0	4.5	4.0	4.5	4.5	5.0	3.0	4.0
Untreated	5.0	4.0	3.5	4.5	3.5	5.0	3.5	4.5	4.5	5.0	2.5	4.5
LSD .05	0.8	0.8	NS	0.7	0.8	NS	NS	NS	0.6	1.6	1.2	1.4

*Vigor visually evaluated using height, tillering, and color as criteria. 1=low vigor and 5=high vigor.

**Rio Vista trials were established in 1992 and Winters in 1993. In 1992, higher rates of chlorsulfuron and oryzalin were used, which may have caused the increased injury seen on some plots.

Data were subjected to an analysis of variance and means were separated by Fishers F-protected LSD test.

Table 3. Grass height at Winters, 4.5 months after treatment with preemergence herbicide.

Herbicide	Grass Species											
	Idaho fescue			California melic			Nodding needlegrass			Blue wildrye		
	1yr	2yr	3yr	1yr	2yr	3yr	1yr	2yr	3yr	1yr	2yr	3yr
Chlorsulfuron	7.9	13.0	19.7	21.3	21.3	21.3	11.4	11.4	11.4	7.5	11.4	10.2
Chlorsulfuron + Oryzalin	6.7	15.0	19.3	21.3	21.3	21.3	9.8	9.8	9.8	7.1	13.0	9.4
Oryzalin	11.0	18.5	22.0	21.3	21.3	21.3	9.1	9.1	9.1	15.7	13.0	11.0
Diuron	13.0	17.7	21.3	21.7	21.7	21.7	9.8	9.8	9.8	16.9	10.2	11.4
Oxadiazon	13.4	16.5	20.5	23.2	23.2	23.2	9.4	9.4	9.4	17.3	15.7	11.4
Simazine	13.0	19.7	19.7	25.6	25.6	25.6	0.2	0.2	0.2	17.7	12.2	11.4
Untreated	15.4	15.7	21.3	24.4	24.4	24.4	10.2	10.2	10.2	15.0	15.4	13.8
LSD .05	3.9	NS	NS	NS	NS	NS	NS	NS	NS	3.9	NS	NS

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The Native Grass Database Group

California Native Grasses--Basic and Applied Technology

A single source reference is needed for practical and technical information on California native grasses. Basic information has been lacking for the professional user and non-professional enthusiast for erosion and fire control, restoration plantings and ecologically sound landscaping. This basic information is the foundation for proper species selection and plant establishment. The proposed text will compile currently diffused information into a single reference filling the existing information gap. Also included are: a user-friendly approach for identifying native grasses; information on how to acquire seeds and plants; line drawings of native grasses; and photographs of native grasses in their natural habitat.

The book is being written by the Native Grass Database Group consisting of a coalition of individuals with diverse backgrounds dedicated to the promotion and utilization of California native grasses. The authors and producers of the book are Kevin Rice and Eric Knapp- UC Davis, Chris Meacham- Jepson Herbarium, Ann Dennis- US Forest Service, Dan Strait- US Fish & Wildlife Service, Bruce Potterton- Potterton West, Lance Walheim- horticultural author and Frank Chan- Native Plant Resources. A major sponsor and an important resource for the book is the Jepson Herbarium of UC Berkeley. In addition, one of the goals of the book is to include contributors who have been active in the native grass movement.

The approximate completion of the book is scheduled for the late Fall or early Winter of 1998.

Carmel Valley Field Day -- 1996

Mark Stromberg

On May 25, CNGA members gathered at the University of California's Hastings Natural History Reservation in upper Carmel Valley. After our breakfast rolls, tea or strong coffee, Mark Stromberg gave a brief introduction to the reserve. Paul Kephart presented a brief overview of his restoration efforts in Carmel Valley ranches, and we proceeded to see a relict stand of *Nassella pulchra* that had not been grazed for 60 years. Also on the reserve, we inspected a steep hillside of road-cut spill that had been deposited after flood repairs in 1995. Restoration included terraces with native grasses and shrubs.

Next on the tour was an 8 acre site on Carmel Ranch Company. Tim Curran (Manager) met with us, and Mike and Linda Markkula of Rana Creek Ranch joined the group. We hiked to a relict stand of *Nassella pulchra* that had been grazed continuously for over 200 years for a quick comparison. We moved on to an old field under restoration as cattle pasture. Five years ago, we started the management of several native perennial grasses which were drilled into the site in a winter planting (see: *Grasslands* No. 4 (1) 1994). Successive burning, herbicide treatments, timed grazing, and mowing (at "dough" stage of exotic annual grasses) produced an ever increasing abundance of *Elymus glaucus* on this deep, sandy old field. Although we planted several other grasses, the wildrye is now the dominant grass. A co-dominant is *Bromus carinatus*. Summer fire seemed to burn out most of the large annual exotic grasses, but stimulated the *Erodium* (filaree) so that a subsequent early winter herbicide application was necessary. An abundance of *Vulpia* is present and covers the areas between the large *Elymus*. This pasture was never removed from a seasonal grazing regime during the time it was restored to native grasses.

Paul Kephart then hosted a tour of the new native plant business at Rana Creek Ranch. In addition to the usual fields of grasses, Paul demonstrated the underground irrigation system on raised beds. Subsurface pipes, buried about 20" below the surface, leak water along the rows. The pipes contain herbicide that prevents roots from invading the pipe. This system can reduce weeds as no

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Table 4. Weed control¹ with preemergence herbicide treatment in native grass plots.

	Grass Species											
	Idaho fescue			California melic			Nodding needlegrass			Blue wildrye		
	RioVista ² Winters			RioVista Winters			RioVista Winters			RioVista Winters		
	1yr	2yr	3yr	1yr	2yr	3yr	1yr	2yr	3yr	1yr	2yr	3yr
Herbicide	75	100	95	95	95	95	85	95	95	90	100	100
Chlorsulfuron	95	100	95	95	95	95	95	95	95	95	100	100
Chlorsulfuron +												
Oryzalin	85	15	15	80	80	80	95	75	75	95	100	100
Oryzalin	75	45	30	85	85	85	80	45	45	80	100	100
Diuron	90	30	75	85	85	85	95	85	85	90	100	100
Oxadiazon	45	45	95	95	95	95	85	60	60	85	100	100
Simazine	40	0	0	3	3	3	55	50	50	65	100	100
Untreated	25	20	22	28	26	26	22	20	20	16	NS	NS
LSD .05												

¹Weed control was visually evaluated 5.5 months and 4.5 months after treatment at Rio Vista and Winters, respectively, with 0 = no control and 100 = complete control.

²Rio Vista trials were established in 1992 and Winters in 1993. Data were subjected to an analysis of variance and means were separated by Fishers F-protected LSD test.

surface water is present for germination between planted plugs or seed rows. The system also allows one to add fertilizers or other agricultural condiments to the water. A computer tracks well depth, amount of water pumped and keeps detailed records from a complete weather station. Paul also showed us the irrigated pasture Rana Creek planted to a mix of native perennial grasses.

Lunch was a grand affair hosted by Mike Markkula at Rana Creek Ranch. Dick Lundy (Ranch Manager) worked the barbecue in a masterful presentation of chicken and tri-tip and grilled vegetables. Dana Lundy and Kate Richter helped put on the lunch. We had to pry several folks from the shaded picnic tables to load up the vehicles for the rest of the trip!

Rob Reynolds, of Carmel Ranch Company, next showed us one of several old barley fields planted with a mix of native perennial grasses last winter. Star thistle infests these old fields. Grazing, mowing and herbicides- the usual start-up for a native grass program- are also what is necessary to control the star thistle. We hope the competition with the native grasses and the aggressive weed control program will generate a vigorous, perennial pasture for this ranch.

Moving on down Carmel Valley Road, we toured the seed production fields at Rancho San Carlos. Rancho San Carlos, just southeast of Carmel, is an area under study for low density home sites on 2,000 acres of land nestled in 18,000 acres of dedicated open space. Local *Koeleria cristata*, *N. pulchra*, *E. glaucus*, *Festuca rubra*, *H. brachyantherum californicum* and *B. carinatus* are now in production for local restoration and for use around home sites for mown lawns or as landscaping. We looked over their turf trials of *Deschampsia cespitosa* var. *holciformis*, *E. glaucus* (San Simeon), *F. rubra* and *N. pulchra*. These trials were of interest to the Pebble Beach Company as they suggested uses of native grasses in their famous golf courses. This led us to the last stop of the day.

Joey Dorrell-Canepa and Steve Canepa, with help from Ted Horton in the administration, are leading the efforts to use native grasses in the golf courses owned by the Pebble Beach Company. Joey showed us her plantings on the dune areas of the Spanish Bay course. Along with many rare and endangered plants, Joey has worked *Deschampsia cespitosa* into the landscape. Scampering to avoid getting beamed by golfers, we admired the restored areas! Strains of bagpipe music surrounded us as we entered the bus for a sunset tour to the main Lodge at Pebble Beach. On the Pebble Beach Links, Steve Canepa is using *Deschampsia cespitosa* between the main courses. As usual, weeds are a major problem. Steve is experimenting with several fertilizers and herbicides on his turf trials. As the sun set over the Pacific, we enjoyed the golden light of sunset through these natives.

Here is a list of the participants; if you want to get in touch with any of them, contact me- I kept a list of addresses, etc. Jerry Allison, Bruce Berlin, Steve Canepa, Susan Callopy, Jerome Domurat, Joey Dorrell-Canepa, Rebecca Dye, Dennis Fox, Crisand Giles, David Gilpin, Ward Hastings, Hank Helbush, Paul Kephart, Lenora Kirby, Louise Lacey, Gloria Lee, Donna Linquist, Donna Logsdon, Lloyd Mason, John Menke, Hugh Musser, Richard Nichols, Julie Oliver, John Pritchard, Lawrence Ray, Diane Renshaw, Linda Spahr, Dan Strait, Mark Stromberg, Steven Talley, Scott Volmer, Sally Walter, George Work.

Native grass ecotypes and their revolutionary implications for geneticists, biodiversity, conservation, taxonomy, evolutionary sciences, and ecological restoration in California.

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Ecotypes are no secret! Ecotypes are biological realities known for 116 years in Europe and 90 years in America. One hundred years ago, researchers perplexed by the variations of species found in extreme environments, collected specimens from the Alps and the sea coasts, grew them in common gardens, and confirmed that extreme environments created genetically fixed ecotypes.

AN ECOTYPE is an organism whose physical structure has recorded over time the local environment, and those records are genetically fixed. Plant ecotypes record: the local elevation, frost-free days, latitude, precipitation, soil fertility, soil moisture, soil type, sun and shade, temperatures, and wind speed. Simply put, ecotypes allow us to see life's environmental connections.

What can ecotypes teach us about the environment? We don't

know because we don't understand what they're trying to tell us. However, I am confident that in the very near future, ecotype knowledge will be useful for geneticists, taxonomists, the evolutionary sciences and ecological restoration practitioners; and will be critical for discussing biodiversity and conservation.

Implications for genetic studies

When the environment bends a biome's genetics, the grasses are among the first to bend, at least in an immediately obvious fashion. The ability to read ecotype variations in grasses is like having a key to translating the ecotype language for all the plants in an area. Native grasses, as sensitive ecotypic indicators, can become as important for studying native plant genetics as the fruit fly is indispensable for the study of animal genetics.

Implications for biodiversity and conservation & taxonomy

The Linnean classification system of genus and species limits our view of life to think of plants and animals as scientific binomial names. The Linnean system can give us a false confidence that as long as you know the species, you don't need to look further. The Linnean system restricts our ability to conserve and protect biodiversity in plant communities. We need the ability to express ecological adaptations of a species to a particular habitat. Grinnell & Miller (1944) were able to accomplish this when they related bird subspecies to life zones, and ecological formations. Their Screech owl, and Song sparrow subspecies are the equivalent of bird ecotypes. The conservation of biodiversity needs attention below the species level, to the ecological level—to the ecotype level.

Study of native grass ecotypes will renew Clements, Turesson, Gregor and Lawrence's idea of creating a new taxonomic language relating the species and its ecotypes to the habitat that created them. Turesson (1925) suggested reorganizing botanical varieties and subspecies names to reflect their ecological origin; or as he said, "Parallel differentiation makes a uniform naming possible."

Frederic Clements, America's first major ecotype researcher, wrote in 1908 that species have a connection to their environment. Clements' contribution changed the concept of species. No longer would a species just be an assemblage of morphological structures. Through ecotypes, he reconnected species to their habitats.

Focusing on the relationship between species and habitat, Göte Turesson wrote in 1925, "With the increase in our knowledge of ecotypes, now in its beginning, a natural system of life-forms will doubtlessly be built up. There can be no doubt as to the great importance of such a system for the understanding of the inter-relations of plants and habitat."

Ecotype taxonomy would be useful for the ecologist and ecological restorationist to discuss the variations they encounter and work with. Four years ago Dr. Theunissen (1992), a researcher in South Africa, began investigations of grasses with the goal of creating such an ecotype classification system.

Implications for ecology and ecological restoration practitioners

Ecotype knowledge is valuable for the ecologist and ecological restoration practitioner. Knowing what constitutes a local ecotype, what makes it important and how far away it can be moved will give certain practitioners a distinct economic advantage. The person with ecotype knowledge will have an edge over other restorationists who only know what species to plant! Turesson (1925, 1931) outlined nine environmental extremes that created unique populations of ecotypes.

Table 1. Turesson's environmental extremes that create ecotypes.

- 1.) Typical local lowland or inland populations that all other ecotypes were compared with = typical.
- 2.) Limestone or other rock formations (calcareous) = alfar.
- 3.) Shifting dune populations (prostrate, fast-growing stolons to avoid being buried by sand) = arenarius
- 4.) Coastal bluffs or stationary dunes, with fast drying soils = campestris
- 5.) Elevational ecotypic varieties,
 - a.) Subalpine = subalpinus
 - b.) Alpine = alpinus
- 6.) Latitudinal ecotypic variation
- 7.) Edges of the species range (i.e. the extreme northern and southern points of the area of distribution).
- 8.) Saline soils (fleshy leaves) = salinus.

My common garden studies of *Bromus carinatus* ecotypes shared many of the same environmental conditions that Turesson found:

Table 2. Dremann's environmental extremes that create ecotypes

- 1.) Typical woodland form, that all other ecotypes were compared with.
- 2.) Serpentine soil, dries out quickly, nutrient poor and toxic minerals, plants are dwarfed and set seed quickly.
- 3.) Sand dune populations, plants prostrate to keep sand stable around the roots; sand dried out quickly so plants set seed quickly.
- 4.) Windswept coastal bluffs or windswept hilltops.
- 5.) Elevational ecotypic variations.
- 6.) Latitudinal ecotypic variation from south to north.
- 7.) Boundaries between two biomes, like the point of contact between a grassland and a forest, or woodland and desert, etc.
- 8.) Areas of known endemism for other species.
- 9.) At the low or high annual precipitation area for the species.
- 10.) Cold air pockets.
- 11.) Isolated valleys, or geographically isolated populations.

Implications for evolutionary sciences

Native grass ecotypes show what I call *spatial evolution*, or evolution flowing over geographic space, with the genetic material flowing over the land and molding itself to particular soils, rainfall, elevations, or other environmental conditions. Folds and creases in the land make folds and creases in populations—creating spatial evolution and unique ecotypes. Ecotypes on the fringe of the species' range will undoubtedly transform themselves into new species over time.

My common garden studies on *Bromus carinatus* indicated relationships between populations (Fig. 1):

Another fascinating possibility Turesson speculated about in 1925: with ecotypes, we may be able to discover the center of origin of native plant species. Utilizing Turesson's idea and those of Vavilov's (1951) for finding the centers of cultivated plants—the centers of origin for native species might be found.

Ecotypes and who needs them

To rebuild the natural environment around us, ecotypes will be the bricks we will need for the foundations.

Farmers, ranchers and orchard managers who covet their topsoil; to keep topsoil in their fields, out of streams, to control water pollution: they'll need native ecotypes.

Miners longing to revegetate mined areas according to the California Surface Mining and Reclamation Act of 1975, they'll need help from the ecotypes.

Caltrans (California Department of Transportation) and canal owners, wishing to stop herbiciding canal banks and along roadsides, to plant vegetation that keeps out exotic weeds; they'll need to seek out native ecotypes.

The Forest Service and BLM wanting to keep serpentine roadcuts, granitic ski slopes and abandoned gold mines from eroding and washing into salmon streams; they'll depend on local ecotypes as the glue to hold those slopes together.

Ecotypes can furnish endless applications for bioremediation and knowledge of their functions can create whole new areas of biological research. Ecotype knowledge will be as startling and useful to us, as the knowledge of antibiotics was useful for the practice of modern medicine. To guarantee the possibilities of this future, we need to begin the preservation of native grass refugia.

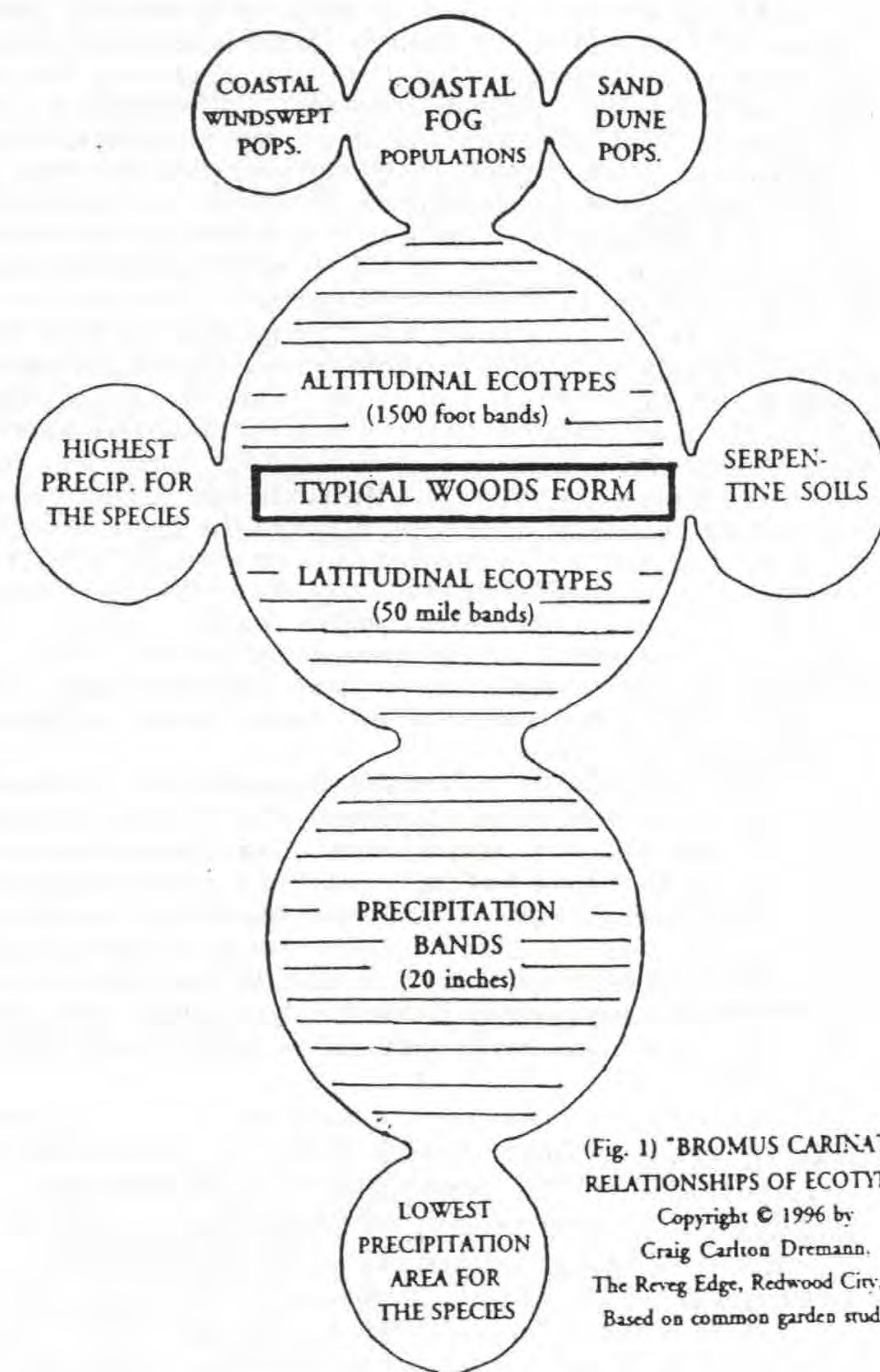
Establishing ecotype refugia in California

California's extremes and diversity is enormous. We have 300 species of native grasses and great extremes and diversity in our soils, elevations ranging from -282 feet below sea level to 14,000 foot peaks, precipitation from near zero to over 100 inches, and dozens of native plant communities. These extremes and diversity demand preservation of our native grass genetics on a grand scale. To accomplish this, I estimate we need a minimum of one native grass preserve for every USGS 7.5 minute quad., or one every 250 square miles, which equals about 600 preserves for the state of California.

Within these preserves, or refugia, we would be banking future genetic material, models of the community structure, and wonders for future generations to discover. These preserved refugia, like the

relict areas in India researched by Gadgil & Vartak (1976), may even take on a sacred aspect in the future, to become our earth altars, where we go to learn the secrets of Nature. We need to preserve those 600 sacred relict refugia for California's future, one acre in exchange for every 1,000 we've taken for our own use.

Every seed company in California selling native grass seed and every person who plants native grass seed or plants depends on the existence of our relict grass stands for their original genetic material. Now is the time for the relict stands to depend on us, for their continued survival. In exchange for the gifts they have given us in the past, we must guarantee that their gifts will be available for the future.



(Fig. 1) "BROMUS CARINATUS RELATIONSHIPS OF ECOTYPES"
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The Reveg Edge, Redwood City, Ca.
Based on common garden studies.

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ANNOUNCEMENTS

The California Native Grass Association invites you to join the Quail Ridge Wilderness Conservancy in a natural history and cultural history boating and hiking tour of the Quail Ridge Reserve on Lake Berryessa
Saturday, May 17, 1997

This fun and very important fundraiser will help the California Native Grass Association in its ongoing efforts to develop, promote, and restore native California grasslands and to educate the public on the value of native grasses. It will also help the Quail Ridge Wilderness Conservancy in its efforts to establish a museum on the Quail Ridge Reserve, and to protect the diverse natural area of the Reserve.

The Quail Ridge Reserve, located on a 2,000-acre peninsula overlooking Lake Berryessa in eastern Napa County, is home to one of the finest stands of native oak-perennial grass savannahs in the entire state. There are 14 species of native perennial grasses at the Reserve, including stands of *Nasella pulchra* and *N. lepida*, *Melica californica* and *M. torreyana*, *Bromus carinatus*, and *Elymus glaucus*. Numerous oak species abound, and the number and variety of wildflowers growing on the Reserve is astounding. Over 60 varieties of butterflies have been seen. The variety of birds using the area is impressive, including bald eagles which are increasingly common around the Reserve. Native Americans used the area extensively. We will spend a large part of the tour learning about the Natural and Cultural history of the area.

This all-day trip will begin, rain or shine, at 10:00 a.m. when we will leave Markley Cove Resort for the south side of Lake Berryessa aboard a comfortable 35-seat capacity watercruiser equipped with a canopy, propane grill, and toilet facilities. We will begin the adventure by exploring the south lake by boat for about one hour. We will then land the boat and take a two hour hiking tour of the Quail Ridge Reserve during which we will observe the native grasses and other native plants, and learn about the natural and human history of the area from Dr. Frank Maurer, Executive Director of the Quail Ridge Wilderness Conservancy. We will particularly focus on the native grass/oak woodland habitats. After a lunch break we will cruise the main lake, exploring for another 1 1/2 hours while we learn more about the history and culture of the area. We will finish the adventure by exploring the east side of the lake where we will look for eagles and other wildlife before returning to Markley Cove approximately at sunset. Be sure to bring a picnic lunch and supper or evening snack, along with drinking water and any other beverage of your choice, sun and wind protection (hat, sunscreen, jacket), binoculars, and a camera if you wish. The boat is wheel chair accessible. (If you use a wheelchair, please call for details.)

We are all very busy and need a break from our hectic lives to enjoy one of the truly spectacular natural areas of the State. You'll get plenty of fresh air and exercise, and will be helping the California Native Grass Association and Quail Ridge Wilderness Conservancy which both need your support. The tour will be especially well suited for older children and families who are interested in the natural and cultural history of northern California. For information on the event contact Dan Strait at (916) 487-0747. For the purchase of tickets, call Markley Cove Resort (credit cards accepted) at (707) 966-2134. Be sure to register early because there will be room for only 35 participants. Those who register for the event by March 1, 1997 will receive a free pack of assorted California native grass writing cards, a \$10 value, so please register early! Cards will be handed-out the day of the outing.

For those not able to attend the May 17th outing, the Quail Ridge Wilderness Conservancy will be having additional boating and hiking tours of the Quail Ridge Reserve all Winter and Spring. Every day at Quail Ridge is a unique adventure. For information about additional outings contact Frank Maurer at (916) 758-1387.

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President's Address

Mark Stromberg

California Native Grass Association
Annual General Membership Meeting
Friday, November 8, 1996

This year's meeting explored two important topics facing those who are working with native grasses in California; 1) the problem of weed control, and 2) the matter of how to consider the genetic variability of native grasses and the importance of protecting the genetic integrity of native grass ecotypes in our revegetation efforts. We also honored special invitees, Professors Alan A. Beetle, Beecher Crampton, and G. Ledyard Stebbins, and Wm. Hiesey, four of the pioneers in the fields of native grass ecology, taxonomy, species distribution, evolution, and more. Much of what we know today about California native grasses is a direct result of research and publication that these men conducted beginning in the 1930's, and which continues today. Each was given a crystal plaque to commemorate our recognition of their work.

We were pleased to meet Dr. Alan Beetle Professor Emeritus, University of Wyoming, Laramie who was able to visit with his old friends, Dr. Crampton and Dr. Stebbins. Beecher Crampton Lecturer Emeritus, University of California, Davis gave a wonderful talk on the "Adventures in Grass Collecting". Several members of his family were present, and his talk was video-taped by students in the CSU-Monterey Bay's Watershed Institute. Copies of this videotape, featuring Dr. Stebbins as well, will be available in 1997 from CNGA. Beecher Crampton's jaunts across California resulted in his popular UC-Press book, "Grasses of California". Sometimes he had a time explaining to curious farmers that he really was out "looking for grass". Beecher's eloquent and crisply enunciated take-home message was to find the silver lining in all of our work with native grasses. It will be there.

Dr. G. Ledyard Stebbins, Professor Emeritus, University of California, Davis, (now 90 years old) gave a wonderful talk on "The Grasses of California: Past, Present and Future". Dr. Stebbins, now helped with a wheelchair, was able to stand up and deliver a spirited, spritely talk without notes. Dr. Stebbins spent years looking for autopolyploids (grasses crossed with other grasses, based on duplicating sets of chromosome) between natives. Such crosses in other plants have produced impressive agricultural seed stock. For many years, Dr. Stebbins was funded by the agronomic community to find and cross native species for increased forage production. He found out a great deal about the genetics of our grasses, but did not find the "wonder" grass.

Other presentations included:

"Weed Control Using Herbicides, by Rachael Long, UC Cooperative Extension Service. Working with Dr. John Anderson, (who also presented at the meeting), and Dr. W. Lanini, Rachael and others have tested several pre-emergent herbicides on native grasses with good success. Her findings are in a recent publication with other: "Preemergence herbicides have little effect on vigor of perennial grasses" in California Agriculture Vol 50 #5, pp. 38-41 (reprinted in this *Grasslands*).

Tony Norris, Licensed Pest Control Advisor, and now superintendent of Parks and Landscaping, City of Richmond, gave a great talk on "Weed Control in the Urban/Grassland Interface". Chemical mowing and seeding with the wrong mixes are just two of many challenges faced by landscape managers.

Dr. John Anderson, of Hedgerow Farms, discussed "Weed Control Strategies for Establishing Native Grasses". One of the most important considerations in establishing natives is weed control. Mow, spray, hoe, graze. Repeat as needed the first 3 years. Then, go from there. John has a great publication, "Establishing Permanent Grassland Habitat with California Native Perennial Grasses". This "how-to" booklet is in Valley Habitats, No. 14, Published by the Ducks Unlimited Western Regional Office, 3074 Gold Canal Drive, Rancho Cordova, CA 95670. (916) 852-2000. Check it out.

Scott Stewart of ConservaSeed, spoke on "Selecting Gene Pools: Site Specificity versus Regional Specificity- An Argument for a Regional Approach". Scott bluntly faced the quandary seed producers must struggle with; environmentalists are pushing for local genetic seed stock, but commercial seed producers cannot provide such small quantities economically. Based on data from Dr.

Eric Knapp, Scott argues for definition of a local region using genetics (eg. the Central Valley) and having federal and state agencies approve the use of seeds for that region if the seed production fields include founder materials from various environments in that region.

Indeed, Dr. Knapp, Agronomy Department, University of California, Davis, speaking on "Patterns of Genetic Variation in Native Grasses: Implications for Restoration" pointed out several such regions which could be defined on genetic similarities. Dr. Knapp's important work, in conjunction with other at UC-Davis, is the first to show that native California grasses are quite similar genetically over long distances in a given climatic, geographic and topographic zone (Fog zone along coast, Central Valley, etc.).

Craig Dremann, Redwood Seed Company, talking on "Native Grass Ecotypes: What they can tell us About the Whole Environment" gave a characteristically diverse, spirited and entertaining talk on his observations of ecotypes, or locally adapted forms of various species of native grasses. His observations of ecotypes are very complimentary to the genetic patterns suggested by Eric Knapp. Paying such attention to ecotypes will enhance the success of any California restoration of grasslands.

Native Plant Industry Future is High Quality

Chip Sundstrom, California Crop Improvement Association,
Davis, CA Gene Bishop, USDA Natural Resources Conservation
Service, Lockeford, CA

The native plant industry has a bright future and there is no need to fear the development of guidelines that help verify the genetic origin of native species. The demand for native species is increasing significantly for revegetation, stabilization, and reclamation efforts, and there is a need to clarify the various ways of collecting and multiplying seed stocks. One way to better understand the forthcoming guidelines is to walk through an example of how the seed of a native species is collected, multiplied, labeled, and sold without compromising the genetic diversity of the ecotype.

So, let's look at a fictitious ecotype of blue wildrye (*Elymus glaucus*) which we will call 'High Sierra'. The seed of this particular ecotype will be collected north of Lake Tahoe, in California, at an elevation of 7000 feet and is adapted to elevations between 6000 to 8000 feet. Grower Jones is interested in selling Source Identified Seed to the U.S. Forest Service (Fig. 1). Source Identified seed is seed collected from the original area of adaptation only and sold without cultivation. While collecting his seed, Mr. Jones identifies the collection site for the California Crop Improvement Association and is issued a Source Identified tag, which will be attached to each bag to assure Source Identification. This program will be offered in 1997. Since Source Identified seed is not cultivated, Mr. Jones must return to the original site to collect seed if he wishes to sell additional 'High Sierra' seed. Although Mr. Jones can sell Source Identified seed for planting anywhere, its best performance should be found in the area of original collection. Since this is a wildland collected seed, purity and germination will generally be lower than if the seed were cultivated. Mr. Jones realizes that California State Seed Law does not require him to provide a purity and germination analysis tag because the seed was not cultivated.

Mr. Jones, however, was so impressed with his Source Identified ecotype of blue wildrye, that he also wants to cultivate/produce his own seed under the name 'High Sierra'. He can produce this seed in two ways: as Common Seed or as Certified Seed (Fig. 1). Mr. Jones may prefer to produce/cultivate Common Seed because of the lack of standards for multiplication of Common Seed. Ethically, however, he realizes he must always return to the original collection site for breeder seed in order to maintain ecotype purity. Because he cultivates the seed, Mr. Jones understands that he now must provide a purity and germination analysis tag and he is bound by "truth in labeling" to provide accurate information.

After a few years of growing common seed, Mr. Jones recognizes that 'High Sierra' blue wildrye has identifiable and

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reproducible characteristics which he would like to market. For these reasons, he chooses to produce/cultivate Certified Seed. After collecting data that supports his claims and identifying his original collection site, he meets with California Crop Improvement Association to enter his cultivar in their certification program. The original seed collection is called breeders seed and this seed must be maintained (either in storage or by additional collections from the original collection site). Mr. Jones plants a portion of the Breeders Seed to produce Foundation Seed and the California Crop Improvement Association assists him in maintaining the superior crop characteristics which he desires to market. Ordinarily, Foundation Seed is used to produce Certified Seed for sale commercially (Fig. 1). When Mr. Jones' crop of 'High Sierra' meets agreed upon purity and germination standards, the Crop Improvement Association will provide him with a blue Certificated Seed tag, which is attached to each bag to assure standards have been met. Because he cultivated this seed, California State Seed Law mandates that he also provide a purity and germination analysis tag. Purity and germination will generally be higher than source identified seed.

It is clear that Mr. Jones has several options for collecting, producing, and marketing 'High Sierra' blue wildrye. Each option has certain advantages and disadvantages to be taken into consideration. It should be noted that in California, flower seed, either source identified or cultivated, does not require an analysis tag. There is increasing interest on the part of federal, state, and county agencies involved in reclamation efforts to purchase and use native plant species. These agencies are demanding high quality and identifiable sources of seed; therefore, it is important that seed quality standards be developed.

The USDA Natural Resources Conservation Service and the California Crop Improvement Association are currently developing source identified and certification standards for California native grasses. These programs will be offered in early 1997.

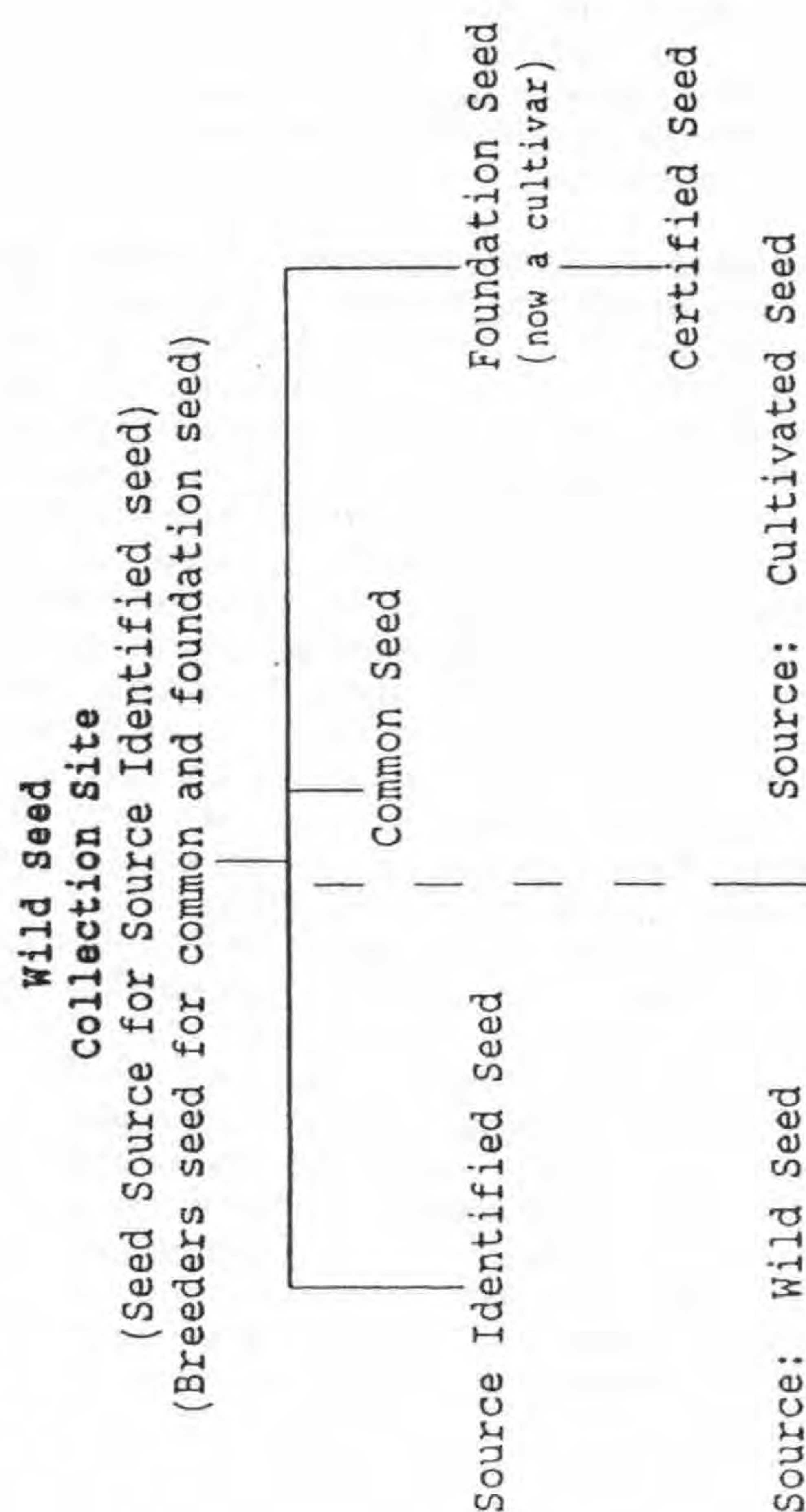


Figure 1



*Specializing in the production of
California native grass seed and the
establishment of
native grassland ecosystems*

Our seed is from bioregional sites in the North Central Valley, Valley Foothills, and Central Inner Coast Range. Single species and seed mixes are available for many landscaping and restoration needs. Our seed is grown, cleaned, and tested to provide a quality product of known origin. We also provide custom growing and consulting.



For more information and a catalogue, please call, fax, or write; Hedgerow Farms, 21740 County Rd. 88, Winters, CA 95694, Ph. (916) 662-4570, Fax (916) 668-8369.

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Specializing in native grass transplant

- * Inexpensive plugs—cell size 1 1/4" x 1 1/4" x 3"
- * Price dependent on quantity and grass species
- * Must receive seed/order for propagation by Aug. 1 for delivery in October-November
- * Fall propagation for mid winter/early spring planting
- * Custom seed collecting services available

Price per species/accession

- \$.05 each for 20,000+
- \$.07 each for 10,000-20,000
- \$.10 each for 5000-10,000
- \$.12 each for 5000 or less

Remember: Collect seed now for propagation in fall. Plan for plugs to be ready in 6-8 weeks after planting in greenhouses. Warm season grasses must be started by May 1st.

List of all native grasses of California as accepted in the list of names supplied by John T. Kartesz for the USDA PLANTS database—with permission from
Chris Meacham, Jepson Herbarium

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Dr. John T. Kartesz is Director of the Biota of North America Program of the North Carolina Botanical Garden

Achnatherum aridum
Achnatherum coronatum
Achnatherum diegoense
Achnatherum hymenoides
Achnatherum latiglume
Achnatherum lemmonii
Achnatherum lettermanii
Achnatherum nelsonii
Achnatherum nevadense
Achnatherum occidentale
Achnatherum occidentale ssp. *californicum*
Achnatherum occidentale ssp. *occidentale*
Achnatherum occidentale ssp. *pubescens*
Achnatherum parishii
Achnatherum pinetorum
Achnatherum speciosum
Achnatherum stillmanii
Achnatherum thurberianum
Achnatherum webberi
Agrostis blasdalei
Agrostis californica
Agrostis eliottiana
Agrostis exarata
Agrostis hallii
Agrostis hendersonii
Agrostis hooveri
Agrostis humilis
Agrostis idahoensis
Agrostis microphylla
Agrostis oregonensis
Agrostis pallens
Agrostis scabra
Agrostis thurberiana
Agrostis variabilis
Alopecurus aequalis
Alopecurus carolinianus
Alopecurus geniculatus
Alopecurus saccatus
Andropogon glomeratus var. *scabriglumis*
Aristida adscensionis
Aristida californica var. *californica*
Aristida divaricata
Aristida oligantha
Aristida purpurea
Aristida purpurea var. *fendleriana*
Aristida purpurea var. *longiseta*
Aristida purpurea var. *nealleyi*
Aristida purpurea var. *parishii*
Aristida purpurea var. *purpurea*
Aristida purpurea var. *wrightii*
Aristida temipes var. *gentilis*
Beckmannia syzigachne
Blepharidachne kingii
Bothriochloa barbinodis
Bouteloua aristidoides var. *aristidoides*
Bouteloua barbata
Bouteloua curtipendula
Bouteloua eriopoda
Bouteloua gracilis
Bouteloua trifida
Bromus anomalus
Bromus arizonicus
Bromus carinatus
Bromus ciliatus
Bromus grandis

Bromus laevis
Bromus maritimus
Bromus orcuttianus
Bromus suksdorfii
Bromus vulgaris
Calamagrostis bolanderi
Calamagrostis breweri
Calamagrostis canadensis
Calamagrostis foliosa
Calamagrostis koelerioides
Calamagrostis nutkaensis
Calamagrostis ophitidis
Calamagrostis purpurascens
Calamagrostis rubescens
Calamagrostis stricta
Calamagrostis stricta ssp. *inexpansa*
Calamagrostis stricta ssp. *stricta*
Cinna bolanderi
Cinna latifolia
Danthonia californica
Danthonia intermedia
Danthonia unispicata
Deschampsia cespitosa
Deschampsia cespitosa ssp. *cespitosa*
Deschampsia cespitosa ssp. *holciformis*
Deschampsia danthonioides
Deschampsia elongata
Dichanthelium acuminatum var. *acuminatum*
Dichanthelium acuminatum var. *acuminatum*
Dichanthelium acuminatum var. *lindheimeri*
Dichanthelium oligosanthos var. *scribnerianum*
Dissanthelium californicum
Distichlis spicata
Elymus elymoides
Elymus elymoides ssp. *brevifolius*
Elymus elymoides ssp. *californicus*
Elymus elymoides ssp. *elymoides*
Elymus elymoides ssp. *hordeoides*
Elymus glaucus
Elymus glaucus ssp. *glaucus*
Elymus glaucus ssp. *jepsonii*
Elymus glaucus ssp. *virescens*
Elymus lanceolatus
Elymus multisetus
Elymus scribneri
Elymus sierrae
Elymus stebbinsii
Elymus trachycaulus
Elymus trachycaulus ssp. *subsecundus*
Elymus trachycaulus ssp. *trachycaulus*
Enneapogon desvauxii
Eragrostis hypnoides
Eragrostis lutescens
Eragrostis mexicana
Eragrostis mexicana ssp. *mexicana*
Eragrostis mexicana ssp. *virescens*
Eragrostis pectinacea
Eragrostis pectinacea var. *miserrima*
Eragrostis pectinacea var. *pectinacea*
Eriochloa acuminata var. *acuminata*
Eriochloa aristata
Erioneuron pilosum
Erioneuron pulchellum
Festuca brachyphylla ssp. *breviculmis*
Festuca californica
Festuca elmeri
Festuca idahoensis
Festuca kingii
Festuca minutiflora
Festuca occidentalis
Festuca rubra
Festuca saximontana var. *purpusiana*
Festuca subulata

Festuca subuliflora
Festuca viridula
Glyceria borealis
Glyceria elata
Glyceria grandis
Glyceria leptostachya
Glyceria occidentalis
Glyceria striata
Hesperostipa comata
Hesperostipa comata ssp. *comata*
Hesperostipa comata ssp. *intermedia*
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 Poa bolanderi
 Poa confinis
 Poa douglasii
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 Poa glauca ssp. rupicola
 Poa howellii
 Poa keckii
 Poa kelloggii
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 Poa lettermanii
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 Poa napensis
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 Trisetum cernuum
 Trisetum cernuum var. canescens
 Trisetum cernuum var. cernuum
 Trisetum spicatum
 Trisetum wolfii

Tuctoria greenei
 Tuctoria mucronata
 Vahlodea atropurpurea
 Vulpia microstachys
 Vulpia microstachys var. ciliata
 Vulpia microstachys var. confusa
 Vulpia microstachys var. microstachys
 Vulpia microstachys var. pauciflora
 Vulpia octoflora
 Vulpia octoflora var. hirtella
 Vulpia octoflora var. octoflora

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