California
Native
Grasslands
Association

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California Native Grasslands Association

Mission Statement

The mission of the California Native Grasslands Association is to promote, preserve, and restore the diversity of California's native grasses and grassland ecosystems through education, advocacy, research, and stewardship.

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From the President's Keyboard

Let's bring about a new era for California grasslands, prairies, and rangelands

by Jim Hanson, President

Often when I explain to friends that I spend my spare time working for California's native grasslands, I get polite, but quizzical looks. How does one explain and inspire appreciation for the one-quarter of the State that is usually without stunning geologic features or other immediately evident attractions?

Yet, the more I learn about, observe, and work with this unique ecosystem, the more beguiling it becomes. And if you listen and look closely, you will sense a centuries-old movement afoot in this unique California ecosystem.

It is the quiet movement of rainwater, guided into the soil though root channels and slowly released as groundwater during hot, dry months to supply thirsty industry, farms, trout streams, and people. It is the journey of carbon dioxide taken up from the atmosphere, transformed into the chemical energy to make grassland roots, and deposited as organic carbon molecules in deep, stable soils. It is the movement of pollinators, beneficial insects, and over 500 wildlife species— including nearly 300 species of birds and numerous imperiled species— in and out of grassland hills and valleys and restored native forb, grass, and shrub hedgerows.

We need to keep the native grasses and forbs, know them, and tell their story in order to bring about a new era of respect and appreciation for our State's diverse grassland, prairie, and rangeland ecosystems.

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New Chair of *Grasslands* Editorial Committee

Welcome to Ingrid Morken, a CNGA Board Member who is the new Chair of the *Grasslands* Editorial Committee. She replaces Cathy Little, who stepped down in July to spend more time with her family.

CNGA applauds the hard work and contributions of Cathy Little, both as the *Grasslands* Editorial Committee Chair for the past 1-1/2 years and as a CNGA Board member for the past 2-1/2 years. Thank you Cathy!

Grasslands Submission Guidelines

Send written submissions, as email attachments, to grasslands@cnga.org. All submissions are reviewed by the *Grasslands* Editorial Committee for suitability for publication. Contact the Editorial Committee Chair for formatting specifications: grasslands@cnga.org.

Written submissions include peer-reviewed research reports and non-refereed articles, such as progress reports, observations, field notes, interviews, book reviews, and opinions.

Also considered for publication are high-resolution color photographs. For each issue, the Editorial Committee votes on photos that will be featured on our full-color covers. Photos are selected to reflect the season of each issue. Send photo submissions, as email attachments, to Ingrid Morken at grasslands@cnga.org. Include a caption and credited photographer's name.

Submission deadlines for articles: **Winter 2014** — Nov 15, 2013 **Spring 2014** — Feb 15, 2014 **Summer 2014** — May 15, 2014 **Fall 2014** — Aug 15, 2014

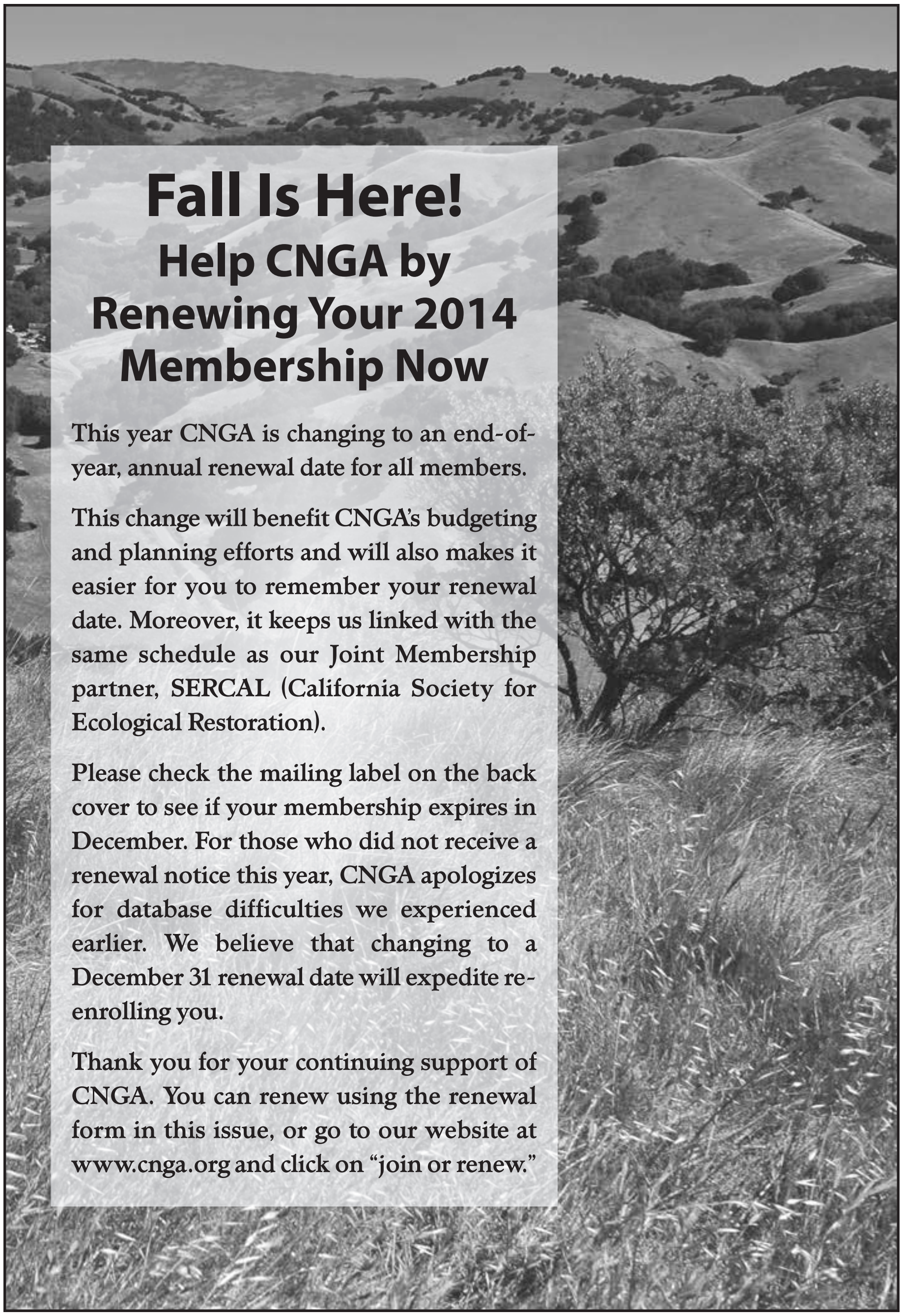
President's Keyboard continued

Scientists in ecology, soils, and bio-meteorology at our California universities tell us we are *just beginning* to understand and measure the ecological services obtained from grassland ecosystems. That is why CNGA has expanded the coverage of research in our quarterly *Grasslands* journal.

Popular belief explains that losses to native grasslands and wildflowers happened in the 200+ years of land use and misuse following European settlement of North America. However, without stronger governmental policy and informed management, this loss is continues today. That is why CNGA has joined with chapters of the California Native Plant Society and community organizations to advocate for development plans that protect rare native plant communities, such as native grasslands. Examples of such advocacy are at Pt. Molate in Richmond; Walker Ridge immediately west of the renowned Bear Valley wildflower area and the site of a proposed 29-turbine wind development by a Canadian company; and Oakland's Knowland Park highlands, where the remarkable native prairie and maritime chaparral is still being pursued by the Oakland Zoo for development as a conservation theme park.

The losses to biodiversity and irreplaceable beauty being reported today are immense. As Bay Area radio personality Wes "Scoop" Nisker says, "If you don't like the news, go out and make some of your own." Whether you are primarily impelled by an affinity for native grasses, wildflowers, and wildlife; a respect for the ecological benefits of grasslands; your working relationship with the land, or simply an appreciation for the quiet and openness, we need to make some new news for the State's diverse grassland ecosystems.

Let's bring about a new era of knowledge, communication, and conservation of our grassland, prairie, and rangeland ecosystems. I urge you to **renew your membership before the holidays so CNGA will start 2014 off and running.** In fact, renew your contribution to each organization that you believe can make a difference. **It's a good investment in our future.**



Fall Is Here!

Help CNGA by Renewing Your 2014 Membership Now

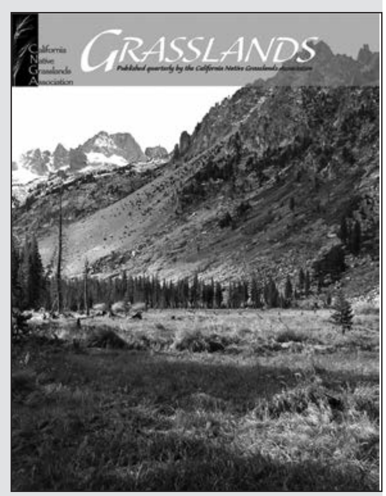
This year CNGA is changing to an end-of-year, annual renewal date for all members.

This change will benefit CNGA's budgeting and planning efforts and will also makes it easier for you to remember your renewal date. Moreover, it keeps us linked with the same schedule as our Joint Membership partner, SERCAL (California Society for Ecological Restoration).

Please check the mailing label on the back cover to see if your membership expires in December. For those who did not receive a renewal notice this year, CNGA apologizes for database difficulties we experienced earlier. We believe that changing to a December 31 renewal date will expedite re-enrolling you.

Thank you for your continuing support of CNGA. You can renew using the renewal form in this issue, or go to our website at www.cnga.org and click on "join or renew."

In this issue



The Value of Native Grassland Species in Riparian Restoration Projects

by Andrew Rayburn, Certified Ecologist, Restoration Ecologist, River Partners

Introduction

Prior to the start of large-scale riparian restoration efforts in the late 20th century, more than 95% of California's riparian forests had been converted to agriculture and other uses (Griggs 1993). Riparian restoration has since become a major focus of many California conservation stakeholders and organizations, including River Partners, a statewide nonprofit founded in 1998. Large-scale projects have now been successfully implemented along major California rivers throughout the state (Wood et al. 2006, McClain et al. 2011, Moore et al. 2011). Practitioners have developed a highly successful formula for riparian restoration that focuses on a combination of cost-effective agronomic practices, sound science, and productive relationships with landowners, public agencies, local governments, irrigation districts, and nonprofit organizations. Riparian restoration projects provide numerous recreational and employment opportunities for people, in addition to enhancing ecosystem services related to wildlife, pollinators, plants, water, and soil.

From a vegetation perspective, early restoration efforts focused primarily on the establishment of overstory forest species (McClain et al. 2011, Moore et al. 2011). Practitioners now recognize the importance of actively restoring riparian understory communities, especially because recent research suggests native understory species are unlikely to naturally colonize restored riparian forests along California rivers. For example, McClain et al. (2011) surveyed riparian restoration sites along the Sacramento River to compare sites in which understory communities were and were not planted during the restoration process. They found that few native understory species recruited naturally into restored sites without direct plantings, and they suggested that active understory restoration would be required at future restoration sites (McClain et al. 2011). More research will be required to determine if native understory species recruit naturally in riparian restoration projects along other California rivers.

Figure 1. Creeping wildrye (*Elymus triticoides*), thrives in the understory of a riparian restoration project at the San Joaquin River National Wildlife Refuge. *Photo: River Partners*

Figure 2. A River Partners' biologist conducts measurements in a patch of gumplant (*Grindelia camporum*) planted in the understory of a riparian restoration project at the San Joaquin River National Wildlife Refuge. *Photo: River Partners*

Riparian Restoration with Native Grassland Species

Riparian restoration often blends modern agricultural and horticultural techniques, restoration ecology, and adaptive management. Biologists will first conduct detailed site surveys of soil, vegetation, hydrology, and land-use history. A restoration plan is then developed to reflect site characteristics, budgetary allocations, and restoration goals. A palette of native overstory shrubs, vines, and trees is carefully selected, based on species' competitive ability, value to wildlife, resilience to flooding, and other criteria. In the Central Valley, trees such as Fremont cottonwood (*Populus fremontii*), box elder (*Acer negundo*), valley oak (*Quercus lobata*), and black willow (*Salix gooddingii*) are often planted, in addition to shrubs like California rose (*Rosa californica*), California blackberry (*Rubus ursinus*), and buttonbush (*Cephalanthus occidentalis*).

Based on similar considerations, a palette of understory species is also developed. For example, common native grasses used in riparian restoration projects in the Central Valley include creeping wildrye (*Elymus triticoides*), blue wildrye (*E. glaucus*), and purple needlegrass (*Stipa pulchra*) (Fig. 1). Some restoration practitioners in the Central Valley also strive to utilize native forbs (Fig. 2), such as gumplant (*Grindelia camporum*), mugwort (*Artemisia douglasiana*), and goldenrod (*Euthamia occidentalis*), in addition to native rushes and sedges, such as Santa Barbara sedge (*Carex barbarae*). Whenever possible, field staff collect seeds and cuttings of both over- and understory species from remnant vegetation on a project site; otherwise, material is gathered from other local sources or purchased from native seed providers.

After development of species palettes, biologists design field layouts that match vegetation to local microsite conditions, habitat for focal wildlife species, hydrologic considerations, and other factors. Site preparation can take many forms, but can include exotic species control, earth work, installation of irrigation, and disking of soil. Trees and shrubs are typically installed in the first year of the project, while understory species are added to overstory gaps via seed drill, plugs, or broadcast seeding in subsequent years after exotic weed control. Different understory species have diverse general planting requirements, which are also influenced by site conditions. Native grasses are often drill-seeded, while forbs and sedges are often established using broadcast seeding or plug planting. After planting, the understory is adaptively managed for at least one additional year through a combination of irrigation, mowing, and herbicide application to control exotic species.

Value of Native Grassland Species in Riparian Restoration

As noted above, native grassland species are now recognized as critical components of riparian restoration projects in California since they enhance the provision of ecosystem services and contribute to restoration success (Golet et al. 2008, Tjarks 2012, Rogner 2013). For example, native understory species enhance the wildlife habitat value of restored riparian plant communities (RHJV 2004, Golet et al. 2008). Native understory species are also critical components of foraging patches for the endangered riparian brush rabbit (*Sylvilagus bachmain riparius*), a frequent target of riparian restoration efforts in the northern San Joaquin Valley. In addition, the endangered Least Bell's Vireo (*Vireo bellii pusillus*) favors riparian habitat with a dense, mugwort-dominated understory (Wood et al. 2006). Following the recommendations of the California Partners in Flight Riparian Bird Conservation Plan (RHJV 2004), River Partners restored such habitat in the San Joaquin River National Wildlife Refuge (SJRNWR) as part of a large-scale riparian restoration project that continues to this day. Happily, Least Bell's Vireos were observed breeding successfully in this habitat at SJRNWR in 2005 and 2006, the first such occurrence in over 60 years.

Native-planted understories may also be more resistant to invasion of problematic riparian weeds such as yellow starthistle (*Centaurea solstitialis*), perennial pepperweed (*Lepidium latifolium*), and black mustard (*Brassica nigra*) (Tjarks 2012). Native grasses, such as creeping wildrye, are highly competitive and can form dense mats that prevent exotic weed establishment. The inclusion of fast-growing native forbs, such as mugwort and gumplant, further contributes to invasion resistance. Monitoring work at the SJRNWR suggests both rapid and sustained replacement of exotic species by mugwort and other native understory species, which grow and spread rapidly in shady conditions beneath overstory vegetation (Tjarks 2012, Fig. 2).

A diverse palette of native understory species also benefits pollinators that support plant reproduction and provide critical ecosystem services in California landscapes. For example, gumplant is one of the most commonly planted understory forbs and is very attractive to a range of bee species. Interest in using pollinator-friendly native forbs has also dovetailed with other important restoration topics, such as the identification of plant species that are tolerant of relatively poor site conditions. For example, in partnership with the U.S. Fish and Wildlife Service and other collaborators, River Partners has been testing various pollinator-friendly forb species at the Sacramento River National Wildlife Refuge for use on dry, gravelly sites on which trees and shrubs will not grow (Rogner 2013). These species, which include Fitch's spikeweed (*Centromadia fitchii*), hayfield tarweed (*Hemizonia congesta*), and various buckwheats (*Eriogonum* spp.), flower at different times in the growing season and provide nectar sources for pollinators over much of the year (Rogner 2013).

The inclusion of native understory species in riparian restoration projects has additional benefits related to forage provision and soil fertility. Both native grasses (such as *Stipa pulchra*, George et al. 2013) and native forbs (such as *Trifolium* spp.) can provide high-quality forage for both livestock and wildlife, supporting restoration goals and facilitating the control of exotic species through carefully timed grazing by cattle, sheep, or goats. Leguminous forbs also fix nitrogen and have positive effects on soil fertility.

Inclusion of native grassland species has become an integral part of "state-of-the-art" riparian restoration projects in California. Restoration practitioners are particularly interested in the weed-control benefits of native understory species, their value to wildlife and pollinator species, and their long-term response to flooding and other forms of disturbance. In response, researchers are studying how native grassland species enhance the provision of these ecosystem services in support of current and future restoration projects.

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Herbicides as a Tool for Rescuing the California State Grass, *Stipa pulchra*

by Carl E. Bell,[1] John Ekhoff,[2] and Marti Witter[3]

ABSTRACT: *Stipa pulchra* (purple needlegrass), the California State Grass, was once a dominant plant in coastal and lower elevation grassland, chaparral, and oak savannah habitats in California. Relic populations still exist throughout its original range, but only as a subdominant species in landscapes dominated by weedy grasses and forbs. Restoration of *S. pulchra* has been the subject of research studies for decades, but success has been elusive. We applied herbicides broadcast over all plants in an area to see if some would selectively kill the weeds and do little or no harm to *S. pulchra*. The expected result would be an increase in cover and size of the native grass. Of 15 herbicide treatments applied annually for 3 years, two treatments (a low and a high rate of fluazifop-P-butyl plus triclopyr) consistently increased *S. pulchra* cover and biomass to levels of 4–5 times the untreated control.

CNGA Commentary: Grassland Management Tools and Tradeoffs

CNGA recommends consulting with experts to maximize success and minimize non-target impacts of management tools such as herbicides to control non-native species in grasslands.

Management of non-native species in both natural and highly modified areas is challenging and often characterized by tradeoffs, including the use of different management tools that vary in cost, labor, effectiveness, efficiency, and impacts to non-target species. As no one tool is right for every situation, an analysis based on project goals should be conducted prior to implementing any management action. Available resources, the time required to implement management actions and to maintain the site, and site location and condition will determine the suite of options available to meet the project goals while minimizing impacts to non-target species.

In general, total costs are usually highest for labor-intensive methods like manual control or spot treatment with herbicides, which minimize impacts to non-target species. Methods for treating larger areas with minimal human oversight, such as grazing, are generally the least expensive if a project exceeds a minimum size. Other methods like mowing, disking, prescribed fire, and broad-scale application of herbicides, are generally intermediate in cost and can be implemented in such a manner to reduce, but never eliminate, impacts to non-target species. Research on herbicides and their effectiveness as a management tool provides critical information to improve successful implementation of this technology and lessens the potential for unintended negative environmental consequences.

— CNGA Board of Directors

Introduction

Stipa pulchra (purple needlegrass) is a native perennial bunchgrass of lower elevation (circa < 1200 meter (m)) grassland, chaparral, and oak savannah habitats in California (Hickman 1993). Beetle (1947) mapped a continuous distribution of *S. pulchra* throughout the Coast Ranges into the Central Valley of northern California. *S. pulchra* is still present in much of its original range, but these landscapes are now dominated by weeds, especially *Bromus* spp., *Erodium* spp., and *Avena fatua* L. (White 1967, Bartolome 1981, Heady 1988). The cause of the displacement of *S. pulchra* with weeds following European settlement of California is thought to be from a combination of intensive livestock grazing, changes in fire regimes, rodent activity, agriculture, and the highly competitive nature of the weedy species (Stromberg and Griffen 1996, Dyer and Rice 1997, White and Holt 2005).

Research on methods to shift the dominance in grassland from weeds back to *S. pulchra* has included fire and livestock grazing (Menke 1992, Dyer and Rice 1997, Gillespie and Allen 2004), clearing and planting (Angelo 2005) and mowing (Starr Ranch 2011). All of these methods have had some successes, but few seem to be in widespread usage in southern California. Except for grazing, these restoration methods are typically initiated in the late spring or summer after the end of the winter/spring rainy season. Prescribed fire requires fuel; invasive plants have to be allowed to grow and be in senescence so they will burn (Kyser et al. 2008). Mowing or clearing using large equipment can only be done during dry spells when the soil is not wet from winter rains. Grazing may be initiated in the early winter, but requires forage, which means that the weeds have to be allowed to grow moderately throughout the season to produce sufficient biomass for livestock (Menke 1992). The result is that the weeds still dominate the ecosystem early in the rainy season and have used much of the limited annual precipitation. So even after weeds are controlled, *S. pulchra* is not able to thrive as well as it might if it had more soil moisture in late spring and summer.

A basic concept of weed ecology is that competition between desirable and weedy plants begins when plant growth starts and that the longer the weedy plants are allowed to compete, the greater their negative interference on the desirable vegetation (Lanini et al. 2002, Radosevich et al. 2007). Several authors have described the near impossibility of establishing *S. pulchra* in the face of interference from weeds (Bartolome 1981, Nelson and Allen 1993, Dyer et al. 1996). Dyer and Rice (1997) showed a strong negative correlation between weed competition and *S. pulchra* growth and survival. Lulow et al. (2007) had success with *S. pulchra* when weeds were controlled before planting.

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Our hypothesis is that weed control early in the winter rainy season would benefit an existing *S. pulchra* population by removing competition and making water available to the native grass instead of the exotic flora. We believed, as others have shown (Barnes 2007, Nyamai et al. 2011), that there are post-emergence (e.g., foliar-applied) herbicides that would selectively kill the weeds without doing significant damage to *S. pulchra*. We also believe that herbicides can be used as part of an adaptive weed management approach that uses all available tools.

Selective has several meanings. In weed control in natural areas, it often means applications targeted to just the weeds while carefully avoiding the native vegetation. In agriculture, *selective* typically refers to an herbicide capable of being broadcast-applied (over all of the foliage in an area) and that will kill weeds without injury to the crop (Agamalian and Ashton 2002). We use *selective* in the latter sense. This type of selectivity can be physiological: some plants are completely or partially tolerant of the herbicide; others are not (Bell et al. 2008). It can be a rate response (a rate is the amount of herbicide per area, not the concentration in a spray mix). A low rate of an herbicide kills some plants but is less than sufficient to kill others. This can be due to differences between plant species in relative susceptibility or phenological stage. It can also be application or timing factors; some plants may be tolerant when they are in a dormant state or during certain environmental periods or seasons. Seasonal differences in phloem transport (acropetal versus basipetal) in perennial species affect the lethality of herbicides that must reach the root or rhizomes to be effective (Bell 2011).

We chose herbicides for this study based upon their selective properties when broadcast-applied. A broadcast herbicide application takes far less time than a targeted spray, saving money and other resources (C.E. Bell, C.A. Wilen, and M.E. McGiffen unpublished data). Developing uses of selective herbicides that are safe and effective for passive restoration of natural lands should be of interest to land managers. Herbicides tested in these experiments were those that were expected to have desirable selective characteristics (Table 1). Herbicide labels from manufacturers provide substantial information on weeds controlled. They do not usually list nonsusceptible species, or provide much information on effects to native plants such as *S. pulchra*. This research has two main objectives. One is to evaluate these herbicides

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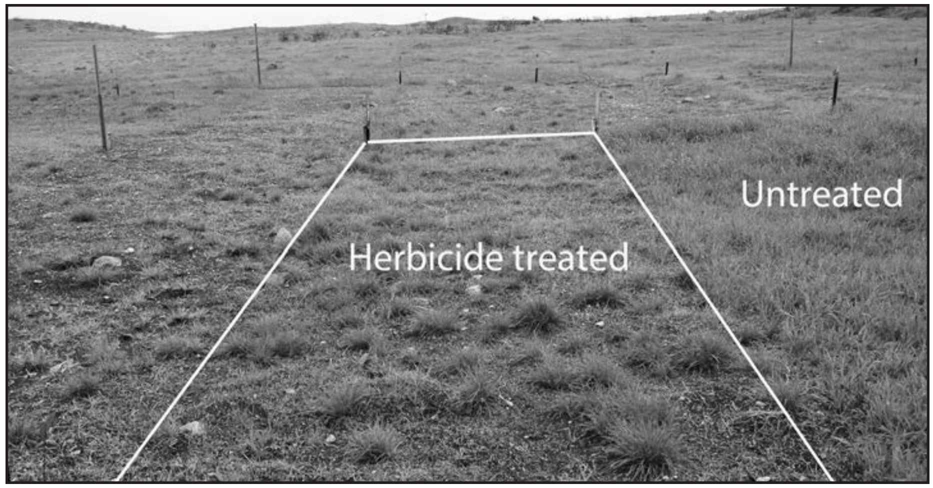

The herbicide-treated plot in the center of the photo has a healthy population of robust *S. pulchra* plants. The untreated plot on the right has a dense cover of non-native invasive grasses. *Photo: Carl Bell*

Table 1: Herbicides used in these experiments, weeds controlled, and factors that might confer selectivity favorable to *S. pulchra*.

HERBICIDE(S) AND RATES (g/ha = grams active ingredient per hectare)
- *WEEDS CONTROLLED*

SELECTIVITY

fluazifop-p-butyl[1] (Fusilade),105, 210 & 315 g/ha; **clethodim**[2] (Envoy) 75 & 150 g/ha
- *Poaceae only, with some exceptions, such as* Erodium cicutarium

1. Not all Poaceae are equally susceptible, and species susceptibility is not predictable. Therefore these herbicides have to be tested on each species, and results are not likely to be the same between herbicides and species. *S. pulchra* may be completely tolerant to one or both of these herbicides.
2. Annual grass species are typically killed at lower rates than are perennial species. Therefore a low rate may be toxic to weedy annuals and safe to *S. pulchra*.

Glyphosate[3] (Roundup, other generic products), 420 & 840 g/ha
- *All plant species*

1. The degree of weed control is influenced by several factors, such as rate, season of application, and developmental stage of plants.
2. Annual grasses are killed at much lower rates than perennial grasses.
3. Perennial plants are most susceptible when phloem transport is basipetal and less susceptible when phloem transport is acropetal.
4. Previous research has suggested some tolerance of *S. pulchra* to glyphosate (Bell et al. 2008).

Triclopyr[4] (Garlon) 1,120 g/ha; aminopyralid[5] (Milestone) 208 g/ha
- *Dicotyledonae*

1. Little to no potential to injure or kill Poaceae.
2. Susceptibility of other plant species not completely known, in particular non-grass monocots.

Imazapic[6] (Plateau) 35 & 70 g/ha
- *Broad spectrum of grasses and forbs*

Being tested extensively as a selective herbicide for restoration of native grassland in the Great Basin, Plains, and Midwest regions of the U.S., but is unknown with regard to application on *S. pulchra*.

Rimsulfuron[7] (Matrix) 35 & 70 g/ha
- *Broad spectrum of grasses and forbs*

Being recommended for native grassland restoration, but it is unknown with regard to application on *S. pulchra.*

All websites accessed 10/18/11. [1] Fluazifop-P-Butyl (Fusilade, Syngenta Co. **www.syngentacropprotection.com/labels/default.aspx**) [2] Clethodim (Envoy, Valent Co. **www.valent.com/Data/Labels/2007-ENVP-0001%20-%20Envoy%20Plus%20-%201612-B.pdf**) [3] Glyphosate (Roundup Pro, Monsanto Co**. www.cdms.net/LDat/ld07A016.pdf**) [4] Triclopyr (Garlon 4, Dow AgroSciences. **www.cdms.net/LDat/ ld0B0013.pdf**) [5] Aminopyralid (Milestone, Dow AgroSciences Co. **www.cdms.net/LDat/ld0B0013.pdf**) [6] Imazapic (Plateau, BASF Corp. **www.cdms.net/LDat/ld2LP015.pdf**) [7] Rimsulfuron (Matrix, DuPont Crop Protection. **www2.dupont.com/Production_Agriculture/en_US/label_msds_info/labels/R1076.pdf**) for their direct effect on *S. pulchra*. The other is to assess the interaction of weed control and impacts on growth, development, and changes in cover of *S. pulchra* under typical field conditions.

Materials and Methods

Two experiments, each replicated twice in time, were conducted to test our hypothesis. The first was conducted at a weed-free *S. pulchra* seed nursery located in the Cheeseboro Canyon area of the U.S. National Park Service Santa Monica Mountains National Recreational Area (hereafter SMM), about 2.7 kilometers (km) NNE of the city of Agoura, California (34° 9.77N, 118° 43.26W, elevation 343 m). The lack of weeds allowed an assessment of the impact of the herbicide treatments without the confounding effects of weed competition. The other experiment was conducted at the California Department of Fish and Wildlife Rancho Jamul Ecological Reserve (RJER) located about 7 km SSE of the town of Jamul in San Diego County, California. This location had a natural, but sparse population of *S. pulchra* in an area dominated by weedy Mediterranean annuals, especially *Bromus diandrus*, *A. fatua,* and *Erodium cicutarium*. Both of these sites were former livestock ranches for more than 150 years, but are now publicly owned nature preserves.

Research at SMM was conducted in 2007 and 2009. Individual 12 x 12 m nursery plots with relatively uniform populations of *S. pulchra* were used as blocks in a randomized complete block design. Soil type was a Cumulic Haploxeroll alluvial sandy loam about 0.5 m deep over clay (USDA 1973). There were four replications in 2007 and three in 2009. Nursery plots used in 2007 were not used again in 2009. Precipitation in 2007 was 173 millimeters (mm) and in 2009 was 283 mm. Treatment plot size was 1 x 11 m. *S. pulchra* plants on the day of treatment in both years measured about 20–25 centimeters (cm) tall. Herbicide treatments included: fluazifop-P-butyl (hereafter fluazifop) at 105 and 210 grams (g) of active ingredient per hectare (g/ha) in 2007 and 210 and 315 g/ha in 2009; clethodim at 75 and 150 g/ha; glyphosate at 420 and 840 g/ha; and triclopyr at 1,120 g/ha. These rates are all within normal usage and manufacturer's label recommendations. An untreated plot was included in each replication as a control. Herbicide applications were made on 22 January 2007 and 26 February 2009. Herbicide applications were made with a hand-held CO_2 pressured (138 kilopascal (kPa)) small plot sprayer with a single 8006vs flat fan nozzle at a spray volume of 320 liters/hectare (l/ha).

Herbicide impact on *S. pulchra* was estimated by biomass (green weight) and diameter of the basal area of treated plants. These data were collected on 23 May 2007 and 9 June 2009, about 4 months after treatment. Biomass data was the sum of two 0.5 x 1 m quadrats from each plot, clipped 3 cm from the ground. Basal diameters consisted of taking two measurements at right angles of the basal area of 15 individual plants. For analysis, we used the overall means of the two measurements. Visual evaluation of herbicide injury (0–100 scale where 0 = no injury, 100 = dead plants) to *S. pulchra* was also made 4 months after treatment.

At RJER, experiments were situated in a hilly location at 296 m elevation, about 2.25 km SSW of the reserve headquarters near California State Highway 94. Both sites had burned in fall wildfires in 2003 and 2007. The first site, hereafter RJER-1, was initiated before the 2007 fire event, and the second site, hereafter RJER-2, about 600 m distant after the second wildfire. RJER-1 (32° 39.722N, 116° 51.672W, elevation 265 m) had a Bosanko stony clay soil about 1 m deep on a slight (<2%) west-facing slope (USDA 1973). RJER-2 (32° table 39.949N, 116° 51.397W, elevation 293 m) had a Friant rocky fine sandy loam soil about 0.3 m deep over rock on a 5-10% north-east facing slope (USDA 1973). Experimental design was a randomized complete block design with four replications. Blocks were placed to maximize homogeneity of the *S. pulchra* populations within blocks. Treatment plots were 3 x 10 m, with an untreated control plots in each block. Herbicide treatments were repeated annually for 3 years, after weeds had germinated following winter rains. Precipitation varied annually, ranging from a low of 98 mm in 2007 to a high of 269 mm in 2010. Herbicide treatments at the RJER-1 site were made on 9 February 2007 (Year 1), 28 December 2007 (Year 2), and 19 January 2009 (Year 3). At RJER-2, applications were made on 18 January 2008 (Year 1), 28 January 2009 (Year 2), and 2 February 2010 (Year 3). *S. pulchra* cover was not measured per plot prior to herbicide treatment, but was estimated to vary between 2–10% across both sites.

Herbicide treatments were fluazifop at 210 and 315 g/ha, clethodim at 75 and 150 g/ha, glyphosate at 420 and 840 g/ha, fluazifop plus triclopyr at 210 plus 1120 g/ha and 315 plus 1120 g/ha, aminopyralid at 208 g/ha, fluazifop plus aminopyralid at 210 plus 208 g/ha and 315 plus 208 g/ha, clethodim plus aminopyralid at 75 plus 208 g/ha and 150 plus 208 g/ha, imazapic at 35 and 70 g/ha (only at RJER-1), and rimsulfuron at 35 and 70 g/ha (only at RJER-2). All herbicides were applied with a hand-held CO_2 pressured small plot sprayer through a boom that covered a swath of 1.5 m. Herbicide application spray volume for each site and year was calibrated separately, averaging 420 l/ha.

S. pulchra plants in Year 1 on the day of treatment at RJER-1 were mature, with spring shoots about 20–30 cm tall. In Year 2, because of the fall 2007 wildfire, *S. pulchra* shoots were much smaller, about 5–10 cm and emerging from burnt crowns. By Year 3, *S. pulchra* plants had recovered and were from 20–40 cm tall. In the RJER-2 site on the day of treatment in all three years, the spring growth was about 15 cm tall. While both sites were initially dominated by *B. diandrus, A. fatua,* and *E. cicutarium*, control of these weeds with herbicides increased the cover of other weeds such as *Brassica nigra* and *Centaurea melitensis*. Native forbs and geophytes were scattered throughout both experiments, but not in sufficient numbers or consistency to be measured.

Experiments were evaluated visually (0–100 scale; 0 = no control or injury, 100 = all plants dead) at frequent intervals for weed control by species and herbicide injury to *S. pulchra* and other natives. These data are not shown, but general comments are included in the Results and Discussion sections. Cover of *S. pulchra* and weeds were visually estimated. Five representative *S. pulchra* plants were sampled annually in summer for biomass (green weight) and diameter of the basal area per plot. Each sample included the green biomass of plants clipped 3 cm from the ground and basal diameter of the crown measured twice at right angles. For analysis, we used the mean value of the five plants for each measure.

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NOTES FROM THE FIELD:

CNGA's First Conservation Photography Workshop

by Diane Crumley, ddcrumley@sbcglobal.net

CNGA thanks Bay Area photographers/ecologists Jim Coleman and Lech Naumovich for their collaborative efforts this summer in preparation for our first photography workshop on August 24. Designed with an eye toward participants' future presentations and documentation of ecological projects, the first offering of this workshop was a success!

A wonderfully diverse group of native grassland enthusiasts attended the intensive, hands-on course, including landscape designers, architects, ranchers, resource managers, and scientists. The classroom portion covered tips on lighting, composition, content, and post-processing. The field portion at Miller Knox Regional Shoreline Park, near Richmond, provided opportunities to practice these techniques, focusing on both the macro and landscape photography.

For a more in-depth description of the workshop from an instructor's perspective, link to Lech Naumovich's blog post at: **lechphoto.com/2013/08/30/conservation-photography-workshop-a-day-in-review**

CNGA looks forward to offering future Conservation Photography workshops. Watch for announcements on our website at **www.CNGA.org**, on Facebook at **www.facebook.com/CAnativegrassland**, and in our quarterly issues of *Grasslands*.

Above: John Tait captured both the macro and landscape levels with solitary *Scabiosa altropurpurea* in the foreground and scrub–grassland interface in the background. *Photo: John Tait*

Below: Attendee Stefan Lorenzato capturing a landscape-level image of the scrub–grassland interface at Miller Knox Regional Shoreline Park, Richmond. *Photo: Judith Elaine Bush*

Herbicides *continued*

Quantitative data were fit to a factorial ANOVA model with treatment, year, site, treatment by year, treatment by site, site by year, and treatment by year by site as dependent variables. Single variables were analyzed using one-way ANOVA; means were separated using Tukey-Kramer Highly Significant Difference tests (P=0.05) (JMP 10.0, 2013). Because of a lack of homogeneity of variance at RJER, data were log transformed for analysis; results are shown as back-transformed data.

Results

Santa Monica Mountains National Recreational Area

S. pulchra biomass and basal diameters were sampled about 4 months after herbicide application at this location (Table 2). There were no qualitative or quantitative differences between treatments and the untreated control in either experiment.

Rancho Jamul Ecological Reserve

Visual Evaluations: The untreated control plots were dominated by weedy grasses all three years at both sites. Aminopyralid did not control grasses, so these plots were dominated by weedy grasses and looked similar to the untreated control.

Fluazifop and clethodim treatments controlled weedy grasses over 90% at both sites in Year 1. In Years 2 and 3, weedy forbs, principally *E. cicutarium*, *B. nigra,* and *C. melitensis* dominated these treatments. *Festuca myuros*, a weedy grass species was also increasing; it is reported to be completely tolerant of these herbicides (Brewster and Spinney 1989). There was no visible effect on the native geophytes or forbs. *S. pulchra* decreased annually in size and cover in clethodim plots.

Glyphosate controlled all of the weeds present in treated plots, but there was some subsequent germination of weeds from precipitation that occurred after the annual herbicide application. Injury to *S. pulchra* was inconsistent but was less apparent at the lower rate treatments and at the RJER-2 site. There were no visible effects on the native geophytes.

Fluazifop plus triclopyr was consistently the best treatment for control of all of the weedy species and did not appear to damage *S. pulchra*. As in the fluazifop treatments, there was an increase in *F. myuros* cover in these plots. Brown and Rice (2000) found *F. myuros* to be very competitive against *S. pulchra* seedlings, but we did not observe much impact on the growth and development of existing *S. pulchra* plants. There was severe injury to native geophytes in these plots, showing typical epinasty and twisting common with an auxinic acid herbicide like triclopyr or aminopyralid (DiTomaso 2002).

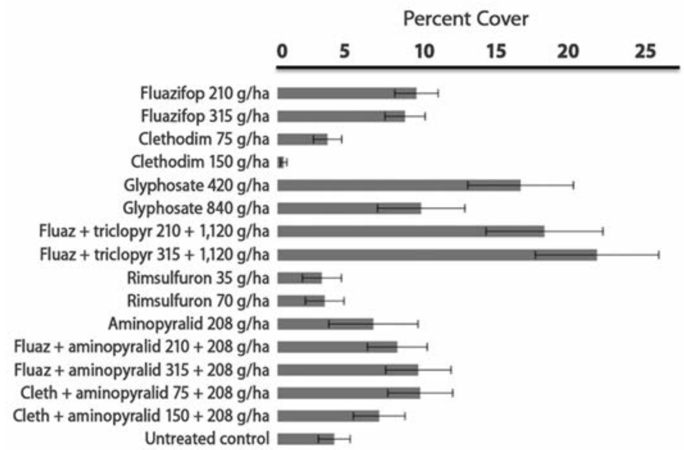

Figure 1: Percent cover of *S. pulchra* as affected by herbicide treatment (from back-transformed log data, ± 1 SEM, n = 24), Rancho Jamul Ecological Reserve

Fluazifop plus aminopyralid and clethodim plus aminopyralid treatments controlled weedy grasses, but weedy forb control, especially *B. nigra* and *E. cicutarium,* was less than satisfactory, ranging from 30–70%. Auxinic acid symptoms on native geophytes were evident and appeared to be worse than those from triclopyr. *S. pulchra* seemed to be thriving better in the clethodim plus aminopyralid plots than in the clethodim plots, perhaps due to an antagonistic effect of aminopyralid on clethodim that reduced the toxicity of clethodim on *S. pulchra* (Barnwell and Cobb 1994).

Imazapic treatments killed all of the existing *S. pulchra* and the majority of the weedy species the first year of treatment at RJER-1. This treatment was dropped from the experiment and rimsulfuron substituted at RJER-2. *S. pulchra* survived the first year rimsulfuron treatment, so the treatment was continued for 3 years. By Year 3, however, *S. pulchra* plants were severely stunted by the cumulative application of rimsulfuron. Rimsulfuron controlled most of the weedy grasses and forbs.

Quantitative Evaluations: The factorial ANOVA did not detect any significant interactions of treatment, site, or year, so data are combined for each dependent variable at RJER (Cover, Fig. 1; Biomass, Fig. 2; Basal Diameter, Fig. 3). Herbicide treatments affected *S. pulchra* cover ($F = 7.81$, $P < 0.0001$). Cover was increased 4- or 5-fold ($P = 0.05$) by the two fluazifop plus triclopyr treatments (17.5±3.9% for the lower rate and 20.9±3.9% for the higher rate compared with 3.8±1.1 % for the untreated control) (Fig. 1). In the clethodim and rimsulfuron treatments, cover was reduced to 0.4± 0.3 and 3.1±1.2%, respectively. Herbicide treatment had a similar effect on *S. pulchra* biomass ($F = 13.18$, $P < 0.0001$). Again, fluazifop plus triclopyr increased biomass of *S. pulchra* ($P = 0.05$) compared with the untreated control (Fig. 2). *S. pulchra* in the low rate treatment was 28.8±5.9 g per plant and 31.2±6.2 g per

Table 2: Herbicide treatment effects on *S. pulchra* biomass and basal diameter at Santa Monica Mountains National Recreational Area experiments (mean of 4 replications in 2007, 3 replications in 2009±1 SEM). There were no significant differences (P > 0.05) between treatments.

HERBICIDE TREATMENT	RATE g/ha	BIOMASS g/m² 2007	BIOMASS g/m² 2009	BASAL DIAMETER mm 2007	BASAL DIAMETER mm 2009
Fluazifop-p-butyl	105	462.5±15.5		62.9±2.7	
Fluazifop-p-butyl	210	387.5±.5.4	406.6±14.2	56.3±1.1	65.8±0.9
Fluazifop-p-butyl	315		373.3±44.9		61.1±3.4
clethodim	75	525.0±93.0	430.0±55.9	58.9±2.6	69.1±0.8
clethodim	150	325.0±42.3	300.0±30.8	54.6±3.0	64.2±3.1
glyphosate	420	345.0±33.1	346.6±59.8	63.1±1.8	62.0±2.2
glyphosate	840	362.5±38.5	296.6±12.1	54.4±1.9	61.4±1.2
triclopyr	1,120	417.5±45.1	316.6±44.6	59.3±1.0	63.9±3.9
Untreated control		487.5±28.4	433.3±50.5	54.6±0.5	62.3±3.4

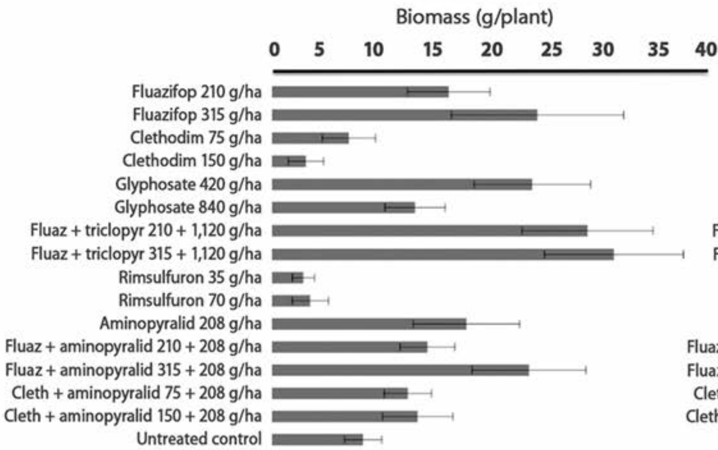

Figure 2: Biomass (g/plant) of *S. pulchra* as affected by herbicide treatment (back-transformed log data, ± 1 SEM, n = 24), Rancho Jamul Ecological Reserve

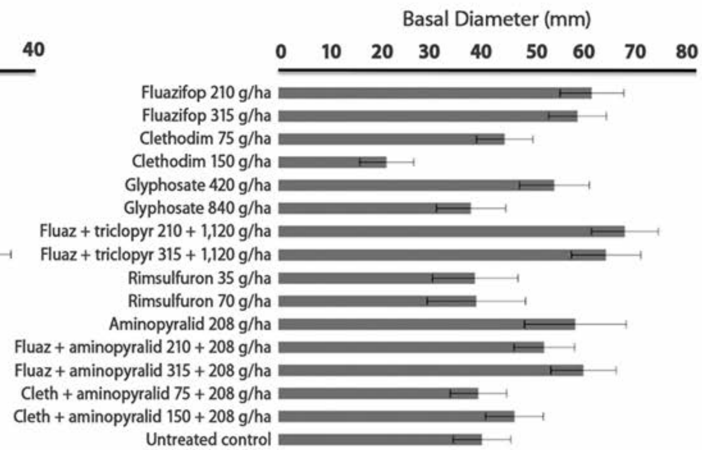

Figure 3: Basal diameter (mm) of *S. pulchra* as affected by herbicide treatment back-transformed log data, ± 1 SEM, n = 24), Rancho Jamul Ecological Reserve

plant in the higher rate treatment, compared with 8.4±1.7 g in the untreated control. The mean value for *S. pulchra* plants in the high rate clethodim treatment was 3.2±1.5 grams per plant. Although basal diameter of plants was affected similarly by treatment (F = 5.40, P <0.0001), the differences between treatments were not as high as in the other variables (Fig. 3).

Discussion

Experiments designed to evaluate the selective use of herbicides generate data on weed control efficacy and injury to desirable vegetation (Barnes 2004, 2007). In these experiments, an herbicide treatment that successfully controlled exotic grasses and forbs should have increased *S. pulchra* cover and growth by reducing competition, as was the case with fluazifop plus triclopyr. These two herbicides combine one that controls grasses with one that controls exotic forbs, and neither herbicide caused significant injury to *S. pulchra* in these experiments. A combination of fluazifop or clethodim plus aminopyralid was also effective, but not as good as fluazifop plus triclopyr because aminopyralid did not control the range of exotic forbs as well as triclopyr did.

If the herbicide kills weeds but also caused injury to *S. pulchra*, (i.e., clethodim, rimsulfuron, and imazapic) in the RJER experiments, the plant will not be able to take advantage of the reduced competition. The severity and duration of plant injury will vary depending upon factors such as age, size, and metabolic processes. Clethodim, for example, did not injure *S. pulchra* in the SMM experiments. Older, larger plants at SMM were evidently able to tolerate the herbicide dosage better than the small plants at RJER (Agamalian and Ashton 2002).

Glyphosate is a nonselective herbicide, which suggests that it kills every plant with which it comes in contact. In practice, however, its toxicity varies because of plant age, size, and woodiness; weather, climate, and season; rate of application; and several other factors. Glyphosate moves in plants with sugars in phloem tissues, and it is most effective when it damages root systems. Sugar transport is generally down into root systems in perennial plants during summer and fall. In early spring, however, sugar moves upward in perennial grasses to support growth of new leaves. We utilized this seasonal change in phloem movement to explore selectivity of glyphosate on *S. pulchra*. By using relatively low rates of glyphosate applied in early spring, we hoped the herbicide would move upward and not be too injurious to the perennial grass *S. pulchra*, but would still be lethal to small annual grasses. Weed control was good with glyphosate, but we had mixed results with regard to injury. Mature plants at SMM appeared tolerant of glyphosate. The lower-rate glyphosate treatment was less damaging at RJER-2 than it was at RJER-1 (data not shown). We do not know the precise reasons for this difference, but we suspect a combination of microclimate and *S. pulchra* phloem transport. *S. pulchra* injury from glyphosate was significant enough, however, for us to conclude that this would not be a recommended option to use for passive restoration purposes.

Another complicating factor when testing for herbicide selectivity is changes in the weed flora over time because of herbicide treatment (White and Holt 2005). The weed seed bank in preserved lands in California that have been grazed or farmed for 1–2 centuries is robust and typically dominated by annual grasses (White 1967, Heady 1988). Weedy forbs are less abundant, except when the dominant grasses do not germinate well or are removed. The fluazifop and clethodim treatments controlled exotic grasses well in Year 1. However, weedy forbs became the dominant cover in these treatments in subsequent years, depriving *S. pulchra* of a chance to thrive.

A 4- to 5-fold increase in cover and biomass, averaged over 2 sites and 3 years suggests a useful role for one specific combination of herbicides in passive restoration of *S. pulchra* populations. This same result has been shown in other regions of the United States (Barnes 2004, 2007; Nyamai et al. 2011). These increases are much better than some results obtained by other methods discussed in the introduction, such as grazing or burning (Menke 1992, Dyer and Rice 1997). Herbicides offer the ability to remove competitive exotic weeds early in the rainy season in California before other methods can typically be utilized.

Herbicide use must incorporate many factors, such as weed species shifts, resistant weed species, damage to non-target plants, weed physiology or phenology, and the interaction with alternative weed control methods. Applying the same herbicide treatment repeatedly in one location will likely have some undesirable consequences (i.e., fluazifop increasing *F. myuros* populations or glyphosate damaging desirable plants one year but not the next). Others (Blumenthal et

continued next page

Herbicides *continued*

al. 2003; Barnes 2004, 2007) have demonstrated good results when herbicide follows prescribed fire. In natural areas, herbicides can be a valuable part of adaptive weed management that uses all available tools.

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SPECIES SPOTLIGHT: **White-tailed Kite (*Elanus leucurus*)**

by Hillary White, Wildlife & Restoration Ecologist, H.T. Harvey & Associates, Sacramento, CA. hwhite@harveyecology.com

The White-tailed Kite (*Elanus leucurus)*, formerly known as the Black-shouldered Kite, is commonly seen hovering as it hunts for prey in low elevation areas such as open grasslands, savannas, emergent wetlands, oak woodlands, and certain types of agricultural areas (Grinnell and Miller 1944, Dunk 1995). As White-tailed Kites search for food, they soar, glide, and hover up to 80 feet above the ground, then dive straight down to capture their prey (Warner and Rudd 1975). In the early 1900s, this medium-sized raptor was threatened with extinction in North America, but the California population continues to show signs of recovery in large part due to its designation as a state "fully protected" species, enhanced conservation efforts, and increased agricultural irrigation that provides habitat for its favored prey, the meadow vole (*Microtus californicus*). California is currently considered the breeding range stronghold for this species, occupying nearly all areas along the coast up to the western Sierra Nevada foothills and southeast deserts (Small 1994, Dunk 1995).

White-tailed Kite (*Elanus leucurus*). *Photo: Hillary White*

The White-tailed Kite typically nests in dense-canopied trees that are situated in close proximity to suitable foraging habitats, especially ungrazed grasslands or alfalfa fields adjacent to riparian habitats that support voles and other small mammals. Because the White-tailed Kite is a non-migratory resident in California, this matrix of riparian corridors and open lands is important to the species throughout the year. They have also been known to form communal night roosts in these wooded habitats.

The primary factors that regulate the White-tailed Kite population are prey availability and suitable nesting areas situated near their foraging grounds (Dunk and Cooper 1994). Lightly grazed or ungrazed fields generally support larger prey populations and appear to be preferred by White-tailed Kites (Johnson and Horn 2008, Pandolfino et al. 2011). The conversion of natural grasslands or compatible agricultural land cover types to development will decrease prey availability. However, wildlife-friendly agricultural practices, such as maintaining areas for prey refugia and encouraging beneficial crops (e.g., alfalfa) and conserving grasslands may provide an adequate source of food for the White-tailed Kite. As demonstrated by a study on California Department of Fish and Wildlife lands where grazing pressure was removed, the management of grasslands to maintain ungrazed areas would benefit prey populations and may consequently increase raptor density (Dunk 1992). Increasing nesting habitat by planting windrows and hedgerows consisting of suitable tree species on field margins could provide nesting habitat, which can otherwise be limited in agricultural landscapes. Encouraging these regional conservation practices can be an effective tool to manage and sustain White-tailed Kite populations in California.

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CNGA's Bunchgrass Circle

As a nonprofit organization, CNGA depends on the generous support of our Corporate and Associate members. Through their donations, these farmers, ranchers, companies, and agencies advocate for the preservation and stewardship of our state's native grasses and the mission of CNGA. If you are interested in regular giving at a higher level — either as an individual, agency, or company—please contact Administrative Director Rebecca Green at 530.297.0500 or admin@cnga.org. *Your support is deeply appreciated.*

Corporate Members

Muhlenbergia rigens ($1,000/yr)

Hedgerow Farms
S & S Seeds

Stipa pulchra ($500/yr)

Delta Bluegrass Company
Pacific Coast Seed

Poa secunda ($250/yr)

Dow AgroSciences
Hanford Applied Restoration & Conservation
Restoration Resources
Sun City Lincoln Hills Community Association

Associate Members ($125/yr)

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Carducci Associates Inc
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2014 CNGA Workshop Schedule Is Shaping Up!

Front cover: Meadow in the eastern Sierra Nevada near Twin Lakes and Bridgeport. *Photo: Cathy Little, 2011*

Back cover: Native *Stipa* near Highland Lake, Headwaters of the Stanislaus River. *Photo: Sara Sweet, 2008*

Fall is here, a time for planting and *renewal*…

Help us get a headstart on 2014…Renew your membership early!

This year,CNGA is changing to an end-of-year renewal cycle. Check your mailing label on the back cover to see if you need to renew now. Soon, all memberships will be renewing each year on December 31.

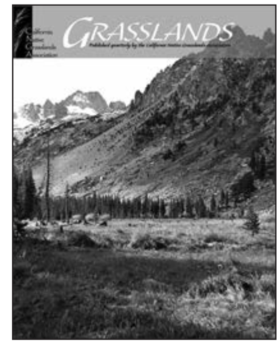
- ❊ For "extra giving," you can renew as a Sustaining Member for $60/year.
- ❊ Save $10 by joining both CNGA and SERCAL as a Joint Member.

Above: Western burrowing owl. *Photo:* *Heather Artis, Borrowing Owl Conservation Network*

Right: 2013 CNGA Field Day at Hedgerow Farms. *Photo: Phil Hogan, USDA-NRCS*

Your membership directly supports CNGA workshops and educational projects, conservation and advocacy efforts, and the publication of *Grasslands*.

Thank you!



2014 Renewal Application *or renew online at www.cnga.org*

CNGA members have voting status, and receive the quarterly *Grasslands* publication, discounts at workshops, and monthly email news.

- - - - *Detach and mail this form with check made out to CNGA. Send to CNGA, P.O. Box 72405, Davis, CA 95617* - - - -

Individual Membership

- ❒ **REGULAR:** $45/year
- ❒ **SUSTAINING:** $60/year
- ❒ **JOINT CNGA+SERCAL:** $80/year (save $10)
- ❒ **STUDENT:** $30/year *Please send photocopy of current ID.*
- ❒ **RETIRED:** $30/year
- ❒ **LIFE:** (one-time payment) $500

Corporate Membership and Benefits

All employees of a corporate member receive member pricing when registering for CNGA events. All membership benefits are good for 2014 (see p. 2). All copies of *Grasslands* will be sent to the main contact at the organization.

Name ____________________

Title ____________________

Organization ____________________

Street ____________________

City ____________________

State____________________ Zip ____________

Phone ____________________

Fax ____________________

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	Membership Level	Annual Cost	Online (color) Ads w/link to member website[1]	*Grasslands* (b&w) Ads currently 4 issues per year	Employee Memberships[2]	*Grasslands* Subscriptions[3]
❒	*Muhlenbergia rigens*	$1,000	Half page (570 x 330 pixels) at top of CNGA sponsor page	Half page (7.625 x 4.375) 300 dpi jpeg, tif or pdf file	6	4
❒	*Stipa pulchra*	$500	Quarter page (256 x 296 pixels) below *Muhlenbergia* listings	Quarter page (3.75 x 4.375) 300 dpi jpeg, tif or pdf file	5	3
❒	*Poa secunda*	$250	Bus.-card size (129 x 200 pixels) below *Stipa* listings	Bus.-card size (3.5 x 2.25) below *Stipa* listings	4	2
❒	*Associate/Agency*	$125	Text listing below *Poa* sponsors for 1 calendar year	Text listing published in *Grasslands* for 1 calendar year	3	1

[1]*If there is more than one Corporate member per level, the members will be listed alphabetically.* [2]*Employee memberships include all the benefits of a personal membership, the organization determines the recipients of* Grasslands *subscriptions.* [3]*Company may opt for fewer subscriptions.*

Howard Ranch, March 2009. *Photo: Sara Sweet*

Take a Look! 2014 CNGA Workshop Schedule Is Shaping Up

Dates and some locations are not yet firm; CNGA will notify members by email and Grass-blast as soon as registration is open. You can also watch our website at **www.CNGA.org** for more information.

Spring

March 14: Grassland Monitoring Methods and Techniques

Teaches the fundamentals of monitoring grassland vegetation and wildlife. | ***Instructors:*** *Chad Aakre, Andrew Rayburn, Hillary White, and others* | ***Location:*** *Yolo County* | *Fees: $130 Member / $150 Non-member / $80 student*

April: Seventh Annual CNGA Field Day at Hedgerow Farms

Offers day-long learning about all things native at Hedgerow Farms. | ***Instructors:*** *Hedgerow Farms Founder John Anderson, Bryan Young, Chris Rose, JP Marié, and others* | ***Location:*** *Hedgerow Farms, Winters*

May: New! Native Grasses in the Built Environment

Highlights how California native plants can be used in urban and residential environments. | ***Instructors:*** *Andrew Fulks, Ingrid Morken, and JP Marié* | ***Location:*** *UC Davis*

May 13–15: SERCAL Annual Conference, *Santa Rosa*

CNGA will host the session "Upland Habitat Restoration and Management"

June: Introduction to Grass Taxonomy and Identification

Presents the basics of identifying grasses using the new *Jepson Manual*, in addition to focusing on the identifying characteristics of common native and non-native grass species. | *Instructors: Michelle Cooper and Jon O'Brien* | ***Location:*** *to be announced*

To Be Scheduled: Improving Land Health and Profitability — A Workshop for Ranchers

Instructor: *Richard King* | ***Location:*** *to be announced*