Overview of Extension Non-Crop Weed Research in California

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Over the past few years, increased interest has focused on maintaining and restoring native plant biodiversity in non-crop areas. As a result, weed problems in rangeland, forests, wetlands, and natural habitats, particularly riparian areas and national or state park systems have received more publicity. Among the most important of these weed species in California are yellow starthistle (*Centaurea solstitialis*), giant reed (Arundo donax), salt cedar (*Tamarix* spp.), brooms (*Cytisus* spp. and *Genista* spp.) and most recently perennial pepperweed (*Lepidium latifolium*).

As a non-crop weed specialist, my primary focus is on understanding various biological and ecological aspects of many of these weeds, and to use this to develop effective control strategies. A couple of examples of research projects in which I am currently involved are briefly described below. In addition to these, I have begun research efforts aimed at:

1) controlling perennial pepperweed by determining the best timing for mowing,
2) understanding the phenology of yellow starthistle root development,
3) manipulating the timing of yellow starthistle reproduction to enable desirable vegetation to complete its reproductive cycle prior to employing chemical control options, and
4) investigating the reproductive biology and environmental requirements for germination and establishment of jubata or pampas grass (*Cortaderia jubata*).

Yellow Starthistle

Burning

In collaboration with Marla Hastings (State Park District Resource Ecologist in Sonoma County), I have studied the effect of burning on yellow starthistle populations in the Sugarloaf Ridge State Park (Sonoma County). Two successive burns in July 1993 and 1994 reduced yellow starthistle vegetation cover by 85% relative to unburned controls in May 1995, when the weed was in the rosette stage. Even at maturity (July), yellow starthistle cover was reduced by 70%.

Concomitant with a reduction in yellow starthistle, burning increased total species number, total cover, annual grass cover, and particularly forb cover (Table 1). Perennial grasses, however, decreased in the burned areas, probably as a result of fire damage during the July burn. Using the Shannon-Weiner (Magurran 1988) index to estimate total species diversity, burning significantly increased total plant diversity and species evenness (Table 2). This increase in diversity was most pronounced among broadleaf species. Although the frequency and abundance of some species increased in the unburned areas, the majority of these were nonnative species. In contrast, the majority of species benefiting from the two burn cycles were California native species. Total vegetation cover of native species was 8% in the unburned site, but increased to 17% following the two burns.

Our preliminary results indicate that the use of repeated burning can be an effective, economical, non-herbicidal tool for the management of yellow starthistle in non-crop environments. Periodic burning also appears to be an effective method of increasing native plant biodiversity in California grasslands.

Table 1.

Summary of change in vegetation structure following consecutive burns at Sugarloaf Ridge State Park, CA

Vegetative cover data was obtained by recording the species intersecting a line transect (50 ft) at 1 ft intervals

Vegetation	% change from unburned sites
Yellow starthistle	-85
number of species	+18
total cover	+10
total grass cover	+29
perennial grass cover	–32
annual grass cover	+50
forb cover	+92

Table 2.

Biodiversity and species evenness using the Shannon-Weiner index

Means followed by ± standard deviation

Burn regime	Shannon-Weiner index	Species evenness
No burn	2.10 ± 0.03	0.749 ± 0.007
93/94 burn	2.44 ± 0.01	0.826 ± 0.005

Late Season Herbicide Control

The majority of herbicides registered in California for yellow starthistle control are applied after the plants emergence from the soil. 2,4-D is most economical of these, but it effectively controls the weed only during the early stages of development, when the rosette is a couple of inches across. At later stages of development, both rosette and bolting, 2,4-D does not adequately control yellow starthistle. At these stages, triclopyr is effective at 0.75 lb ai/A (active ingredient/acre). Once the plants have produced flowers, triclopyr is no longer effective. From the early-to mid-flowering stages of yellow starthistle, complete control may be obtained with glyphosate at 1 lb ai/A plus additional 0.25% v/v (volume to volume) surfactant (Kinetic¨ or Silwet¨).

Thus, yellow starthistle can be controlled at all stages of development. For long-term control of yellow starthistle, it is critical to prevent seed development. In many cases, landowners are not aware of the significance of their infestations until later in the season, when plants have bolted or flowered. A late season herbicide option can prevent small patches of yellow starthistle from becoming larger infestation the following year.

Herbicide Effects on Biodiversity in Forestry Practices

Hexazinone has become widely used for vegetation management in conifer site preparation following catastrophic fire. While the long residual soil activity of hexazinone permits conifer (pine) establishment without competition from other herbaceous and woody species, the apparently barren landscapes resulting from herbicide treatment have raised public concern over long-term effect of hexazinone on native plant biodiversity. In collaboration with the Shasta County Farm Advisor, Dan Marcum, I addressed this concern by measuring conifer growth and plant biodiversity in three separate Shasta County fire sites of varying ages (1992, 1985, 1977). At each fire location, hexazinone treatments were compared to untreated areas, both burned and unburned.

Results indicate that hexazinone treatment doubled the stem height and diameter at each burn site (Table 3). More importantly, conifer density was reduced by 71 and 90% when no herbicide was applied in the 1985 and 1977 fires, respectively. The inhibition in conifer survival and growth was correlated with an increase in shrub cover and a reduction in light penetration.

Both line transects and quadrat analysis were used to compare plant biodiversity in hexazinone treated and untreated sites. These values were compared to those of an adjacent unburned mature forest (>50 years old) at each fire site. Line transect data were used to calculate the Shannon-Weiner index of diversity (Table 4). As expected, biodiversity was lowest in the hexazinone treated areas of the 1992 fire (Fountain). However, in the forest burned in 1985 (Tamarack), plant biodiversity in the herbicide treated areas surpassed that of the untreated site. In the oldest Pondosa burn (1977), plant biodiversity was lowest in the untreated area, whereas values for the unburned area and the hexazinone treated site were similar. In all cases, the proportion of native plants did not change with herbicide treament.

Results of this investigation demonstrate that hexazinone site preparation can lead to the economic establishment of a coniferous forest without jeopardizing long-term native plant biodiversity. Despite the initial reduction in biodiversity in hexazinone treated areas, the native plant flora recovered to levels similar to that of an adjacent unburned and untreated forest within 9 years of treatment.

Table 3.

Effect of hexazinone (HEX) treatment on height and diameter of conifers 2, 9, and 14 years after herbicide treatment and planting at 3 sites in Shasta County, CA.

Years since	Height (m)		Stem diameter (cm)	
Site prep	HEX	No HEX	HEX	No HEX
2	0.48*	0.26	1.4	0.6
9	3.57	1.77	9.6	4.8
14	5.41	2.89	14.6	6.1

*all HEX treated sites were significantly different from no HEX sites at 95% confidence level.

Table 4.

Plant biodiversity in hexazinone treated and untreated sites in fire regions of various ages. Years represent time since hexazinone treatment and conifer plantings. Shannon-Weiner index was determined from 50 m line transects intersecting vegetation at 1 m intervals.

Site	Years since treatment	Treatment	Shannon-Weiner index
Adjacent forest (avg. of 3 sites)	None	None	1.73 a*
Fountain Fire	2	Hexazinone	0.36 b
	2	none	0.45 b
Tamarack Fire	9	Hexazinone	1.71 a
	9	none	1.42 a
Pondosa Fire	14	Hexazinone	1.75 a
	14	none	1.12 b

*means followed by different letter are significantly different at 95% confidence level.

Literature Cited

Magurran, A.E. 1988. Ecological Diversity and its Measurement. Princeton University Press, Princeton, New Jersey. 179 p.