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Lessons from leafy spurge and yellow starthistle

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● NONCHEMICAL MANAGEMENT OF NOXIOUS WEEDS

LESSONS FROM LEAFY SPURGE AND YELLOW STARHISTLE

Noxious weeds are non-native plants, mostly weeds of rangeland or pasture, that are classified under federal and state law as having negative impacts on agriculture. In many states, counties, and cities, control of noxious weeds is mandated by law.

Leafy spurge and yellow starthistle are examples of noxious weeds that are widespread in the Pacific Northwest. Both species are commonly found in disturbed areas, have characteristics that make them successful weeds, and have been difficult to manage with herbicides. For both of these weeds nonchemical management techniques are successful, including mowing, grazing, burning, mulching, seeding of desirable plants, and introduction of biological control agents.

What can leafy spurge and yellow starthistle teach us about management of noxious weeds in general? Seven important lessons emerge: 1) Noxious weeds have been with us for decades, and there is time to develop successful and sustainable management strategies; 2) A focus on eliminating the causes of weed problems is imperative, so that we create long-term solutions; 3) Biological control is a useful and cost-effective technique; 4) Management techniques need to include tools to reduce seed populations; 5) Encouragement of desirable vegetation is crucial; 6) Proper timing can maximize the effectiveness of nonchemical controls; and 7) Techniques must be appropriate for the treatment site.

BY CAROLINE COX

Many of us have heard the negative rhetoric that is often used in reference to noxious weeds. Their encroachment is reaching "epidemic proportions"¹; they are "alien, exotic, and invading"¹; their spread is "rendering wetlands and habitat unusable by wildlife"¹; and they represent a "catastrophic shift toward weedy vegetation."¹ Most of us have also heard this kind of language used as a justification for herbicide spray programs on hundreds or thousands of acres.

This article presents a different perspective on noxious weeds. Two case studies of noxious weeds, leafy spurge and yellow starthistle, show that nonchemical techniques can successfully manage weeds, and have done so throughout the Northwest. Then, from these two examples, NCAP draws some general conclusions that can be used in evaluating management programs for any noxious weed.



Caroline Cox is JPR's editor.

Leafy Spurge

Leafy spurge (*Euphorbia esula*) is a perennial weed whose milky sap is toxic to cattle, causing skin irritation and digestive problems.² It is widespread on millions of acres in the western United States and Canada,² and estimates of economic losses are over 140 million dollars.³

Spurge is not native to North America; its native range is Eurasian, from Siberia southwest to the Mediterranean and west to northern Europe. It was introduced to North America over a hundred and fifty years ago, most likely as a contaminant in soil used as ballast in ships and in imported seed grains.⁴ The oldest preserved specimen of spurge was collected in Massachusetts in 1827.²

Several physical characteristics make spurge a tenacious weed. It has an extensive root system, and average-sized plants (2 feet tall) can have roots that extend 10 feet into the soil.² These roots crowd out neighboring plants and also store food, enabling the plant to survive unfavorable conditions. In addition, buds on the roots can sprout and produce new shoots,² and a root fragment as small as 2 inches can

WHAT IS A NOXIOUS WEED?

As defined by federal law, noxious weeds are weeds that are "of foreign origin"¹ and "new or not widely prevalent in the United States"¹ when such weeds "can directly or indirectly injure crops, other useful plants, livestock, or poultry or other interests of agriculture."¹ The phrase "interests of agriculture" is defined to also include irrigation, navigation, or fish and wildlife resources.¹

Many states designate weeds as noxious, and both state and local governments commonly have laws that require landowners to control noxious weeds that grow on their property.

7 U.S.C. 61 § 2802.



Aphthona flea beetles on leafy spurge. The beetles have been introduced as biological control agents of leafy spurge and have effectively reduced spurge populations on light well-drained soils.

spurge, the most promising natural enemies are the leafy spurge flea beetles. One beetle, *Aphthona nigricutis*, has given "excellent control"¹⁰ in areas with lighter soils. In Alberta, Canada, leafy spurge was reduced 99 percent five years after release of the beetle.¹⁰ In Manitoba, spurge was reduced 93 percent 7 years after release.¹¹ In Fremont County, Wyoming, over 50,000 square feet of leafy spurge was eliminated in the first four years after release.¹² On a Montana ranch, beetles provided 80 percent control of spurge over an area three miles long and a mile wide in six years.⁹ A related species *Aphthona cyparissiae*, which prefers moister soils, has also been widely distributed. Researchers believe that these flea beetles "should solve the prairie leafy spurge problem on dry, light, open soils."¹¹ What is needed now are similarly effective natural enemies on wetter, heavier soils. Another related flea beetle, *Aphthona czwalinae*, has the potential to meet this need.¹³

Another nonchemical tool that has successfully managed spurge is grazing by sheep and goats. Unlike cattle and horses, sheep and goats like spurge, particularly after they become accustomed to the weed. On experimental plots in Canada, 5 years of sheep grazing reduced the amount of spurge 93 percent. Successful grazing of spurge requires starting early in the season because sheep prefer small spurge plants.¹⁴ Sheep grazing of spurge provides income for ranchers because they can lease their range to sheep producers.⁹

Grazing by angora goats is also a successful management tool. In North Dakota, 3 years of grazing by angora goats resulted in a decrease in leafy spurge biomass of 44 percent, and an increase in grass biomass of 57 percent.¹⁵ Angora goats have also been used on infested range in Oregon and Idaho.^{7,16} These projects are new, with only one season of grazing, but results so far are promising.⁸ Seed production was completely eliminated in the Oregon project.¹⁷

Along roadsides, planting of competitive grasses, including the native grass little bluestem, has successfully reduced spurge abundance. In an experiment

produce a mature plant in one season.² Spurge seeds grow inside a capsule that bursts when the seed is ripe, dispersing seeds up to 15 feet.⁵ The seeds can live for up to 7 years in the soil,⁵ so that germination of new seedlings can occur long after visible plants are gone.

Leafy spurge is primarily, although not exclusively, found in disturbed areas. A study of a native prairie found that 95 percent of the spurge plants were associated with soil disturbances. Seedling establishment was 45 times greater on bare soil than in undisturbed vegetation.⁶

Chemical control of spurge has been problematic. Herbicides that kill leafy spurge also kill desirable plants. Also, herbicide costs can easily exceed the value of the land on which they are used. The U.S. Department of Agriculture has estimated that the costs of spraying outweigh the benefits by as much as 10 to 1.⁵

In addition, spurge is hard to kill with herbicides because the plant is able to block movement of the chemicals to the root system, allowing the roots to survive herbicide treatment.⁵ For example, Rich Sacchi, a rancher in south-central Oregon, spent four years and over 100,000 dol-

lars trying to control spurge on a 700 acre ranch⁷ that had been overgrazed by its previous owners.⁸ His evaluation of the efficacy of the herbicides? "The chemicals were a joke."⁷ In central Montana, rancher Tom Elliot spent two seasons and over 25,000 dollars trying to control spurge with chemicals. The result? "You would have thought we put fertilizer on the stuff,"⁹ he reported.

The picture painted here is clearly one of a difficult weed. Yet, nonchemical techniques for managing leafy spurge are both available and effective.

One management tool is biological control, the importation and distribution of the weed's natural enemies. In spurge's native areas it is of little or no economic significance.² According to USDA, "insects and diseases in the Old World have put such stress on spurge that it remains an insignificant component of the landscape."⁵ The insects and diseases were not introduced to North America along with the weed.⁵ Biological control involves bringing these natural enemies to North American spurge infestations.

Although a number of different insects have been introduced to manage leafy

funded by the Minnesota Department of Transportation, spurge declined 67 percent two years after grass seeding.¹⁸

Yellow Starthistle

Yellow starthistle (*Centaurea solstitialis*) is an annual weed, one that completes its life cycle in a single growing season. Seeds germinate anytime between October and June, depending on when rain occurs.¹⁹ The plant then grows as a rosette with a robust tap root that can reach a depth of 6 feet by early summer. In May or June, the plant bolts, then flowers, and sets seed.²⁰



The weevil *Eustenopus villosus* has been introduced in the Pacific Northwest to reduce yellow starthistle populations.

Starthistle is toxic to horses and causes a fatal nervous system disease.²⁰ Mature plants are unpalatable to cattle because of their spiny flower heads.²¹

Starthistle is widespread throughout the Pacific Northwest. It occupies 10 million acres in California,¹⁹ 980,000 acres in Oregon, 200,000 acres in Idaho, and 130,000 acres in Washington.²¹

Like spurge, yellow starthistle is not native to North America. It was introduced into California over a hundred

years ago as a contaminant in alfalfa seed brought to California from Spain and Chile. The oldest preserved specimens were collected in 1897. Efforts to control this weed were begun in 1917.²²

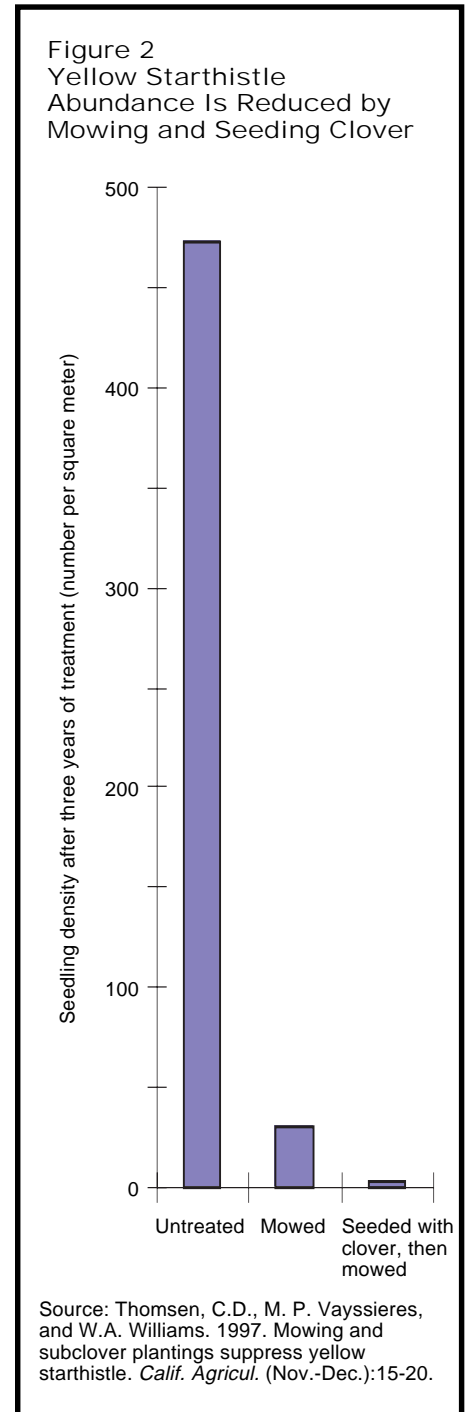
Three attributes of yellow starthistle make it a successful weed. First, its long tap root allows it to use water deep in the soil and gives the plants a high tolerance for drought. Second, patches of seedlings are often dense, and block sunlight from reaching the soil surface. This suppresses the growth of other species.¹⁹ Finally, starthistle plants produce an extraordinary amount of seed. Each plant produces between 700 and 10,000 seeds;²⁰ an acre of starthistle will produce between 50 and 200 million seeds.¹⁹ While most seeds are short-lived, some persist in the soil for up to 10 years.²³

Starthistle thrives in areas where other vegetation has been disturbed by fire, construction, or overgrazing. For example, in an experiment at Washington State University, artificial cattle grazing (clipping that simulates grazing) reduced the ability of four perennial grasses to resist invasion by yellow starthistle.²⁴

Management of yellow starthistle with herbicides "is not ideal and often results in failure,"²⁵ according to a researcher from the University of California at Davis's Weed Science Program. Many herbicides that control starthistle also injure desirable grasses. Several combinations of herbicides provide only moderate control. Often multiple applications are required because seed germination occurs over a long period.²¹ Resistance to multiple herbicides has been documented in yellow starthistle populations that have been frequently treated with herbicides.²⁶

Overall, yellow starthistle is clearly a weed that is difficult to manage. Yet, as with leafy spurge, nonchemical techniques for managing this weed are both available and effective.

One successful nonchemical technique for managing starthistle is grazing by sheep or goats. To be successful, grazing must occur during bolting, and then be continued to remove any regrowth. If plants are only grazed when they are ro-



In field experiments, mowing of yellow starthistle combined with seeding of clover reduced yellow starthistle populations by over 99 percent.

settes, starthistle thrives. With appropriate timing, however, grazing is highly effective. In one set of experiments in California, grazing reduced the number of flower heads up to 90 percent.²⁷

Mowing is also an effective nonchemical tool. Again, timing is crucial. Early mowings can increase starthistle density, probably because it suppresses competing vegetation. However, mowing when plants had just started to bloom reduced subsequent flower head density between 63 and 86 percent. Seedling density the following fall was reduced between 73 and 89 percent.²⁷

When a second mowing removed regrowth, starthistle densities were reduced even further. Density of flower heads was reduced up to 97 percent, while densities of seedlings the following fall was reduced up to 98 percent.²⁷ When these treatments were repeated for three years, the results were especially striking: seedling numbers decreased by 99.5 percent, and seedlings were 20 times more abundant on plots that were only mowed once.²⁸

Seeding of competitive vegetation combined with mowing has been particularly successful. Researchers at the University of California at Davis showed that seeding of clover, followed by three years of mowing, reduced flower head production to zero and reduced fall seedling densities by over 99 percent. It was crucial to select a clover variety that competed strongly with starthistle and was well adapted to the site.²⁸ Also, planting of an aggressive competitor (vetch) has been successful without mowing.²⁰

Burning is useful, especially where fire has historically been frequent. At California's Sugarloaf Ridge State Park, carefully timed burns have "nearly eliminated" starthistle. A single burn reduced the number of seeds by 74 percent, and the number of new seedlings by 81 percent. Three years of burns reduced both seed and seedling numbers over 99 percent. Declines in starthistle were accompanied by increases in the abundance and diversity of native species.²⁹

Because yellow starthistle is an introduced weed, biological control is also a promising management tool. Potential biological control agents include seed head weevils, seed flies, and seed head gall flies. The one that has the most potential is probably the weevil *Eustenopus*

villosus. *Eustenopus* has more impact on starthistle than the other insects because both larvae and adults feed on developing flower heads.³⁰ Near Myrtle Creek, Oregon, densities of yellow starthistle were "greatly reduced"³¹ following introduction of the weevil, combined with a reduction of cattle grazing and increases in competition from perennial grasses.³¹

On small sites, other nonchemical techniques can be useful. Straw mulch provides good control of starthistle, with a 3.5 inch mulch yielding 98 percent con-

" Attempts to control weeds without addressing the causes of the invasion are doomed because they treat symptoms rather than causes."

-- R.J. Hobbs and S.E. Humphries

trol.³² Hand-weeding, and hoeing are also useful tools. They are most successful early in the season before the plant has had a chance to develop a large taproot. Another small-scale management technique involves depleting the soil's seed bank with repeated irrigation and cultivation. Irrigation causes seedlings to germinate, and then they can be removed by disking the area.²⁰

Lessons Learned

What can we learn about management of noxious weeds in general from looking at these examples, leafy spurge and yellow starthistle? Seven important lessons emerge:

1. Don't Panic

There's no need to rush to treat nox-

ious weeds. Like leafy spurge and yellow starthistle, many noxious weeds were introduced into North America over a hundred years ago and have been here since. Although infestations are often portrayed as crises, there is always time to develop successful, sustainable strategies.

The only time quick action is mandatory is when a small population of a newly introduced weed is found. In this situation simply pulling the undesirable plants is the appropriate response.

2. Identify and Eliminate the Causes of Weed Problems

Like leafy spurge and yellow starthistle, most noxious weeds thrive in disturbed areas. For example, roadsides and heavily grazed rangeland are often sites of noxious weeds. Weed management needs to focus on how to manage these disturbed areas so they are less open to weeds. As two researchers from the Commonwealth Scientific and Industrial Research Organization have written, "attempts to control weeds without addressing the causes of the invasion are doomed because they treat symptoms rather than causes. The changes ... that allow the initiation or intensification of weed invasion have to be addressed before effective weed control can be achieved."³³ Unless the causes of disturbances are identified and eliminated, noxious weed management is like running on a treadmill; there is lots of action but little permanent progress.

3. Promote Biological Control

Most noxious weeds are not native to the area in which they are a problem. Either accidentally or intentionally, they have been introduced from around the globe. Most noxious weeds have been introduced without the insects and diseases that regulate their abundance in their native range, so they are good candidates for biological control. Biological control is not a silver bullet. It can take years for populations of a biological control agent to build up enough to impact weed populations. Also, biological control needs to be done carefully, to avoid irreversibly introducing an insect or disease that im-

pacts native or crop plants.^{34,35} But, with these caveats, biological control offers “environmentally safe, energy self-sufficient, cost-effective, and self-sustaining”³⁶ management strategies for noxious weeds.

4. Find Effective Ways to Reduce Seed Numbers

Weed seeds are future weed populations. Reducing the number of seeds in the soil, or the number of plant parts capable of vegetative reproduction, is essential. Even though seeds and root buds are often invisible, they hold the key to long-term successful management.

5. Encourage Desirable Vegetation

Sustainable weed management requires not just a reduction of weed populations, but also the encouragement of desirable vegetation, the vegetation we'd like to see replace the weed. Unless both issues are addressed, a weed management program is incomplete and will probably lead to repeat weed problems.

6. Experiment With Timing to Improve Success

The success of many nonchemical management techniques changes dramatically depending on the life stage of the weed at the time the technique is used. For example, mowing of yellow starthistle increases its abundance if the mowing is done early in the season, but effectively reduces seed and subsequent seedling populations if done later in the season. It's crucial to determine these effective management “windows.”

7. Use Site-appropriate Techniques

No one nonchemical technique will be appropriate everywhere. For example, sheep grazing is usually unacceptable on a nature preserve, but may be appropriate to manage weeds on a cattle ranch. All techniques should be compatible with larger management goals.

Conclusion

Noxious weed control does not have

to mean widespread use of toxic chemicals. Alternative techniques can successfully reduce weed populations and encourage vegetation whose presence is desirable, thus reducing or eliminating the need for repeated treatment. Implementing nonchemical strategies and reducing the herbicide dependence of noxious weed programs provides long-term and cost-effective weed management. ✦

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