

## Perennial Pepperweed (*Lepidium latifolium*) Control Plan 2008 Progress Report

### **Introduction**

The Laguna de Santa Rosa Foundation (Laguna Foundation) is currently implementing the first phase of the Middle Reach Restoration Project (MRRP), a project seeking to restore a nearly contiguous habitat corridor along nearly 8 miles of the Laguna de Santa Rosa. This first phase includes restoration of riparian forest and oak woodland along a 1.8-mile segment of the Laguna's east bank between Highway 12 and Occidental Road. Grassland management for the benefit of endangered Sebastopol meadowfoam is also part of this phase. Landowners along this reach include the City of Sebastopol, Balletto Vineyards, City of Santa Rosa, and County of Sonoma (Figure 1).

A critical component of the project is the control of perennial pepperweed (*Lepidium latifolium*). Pepperweed is a highly invasive non-native species that can rapidly form monocultures over large areas potentially causing declines in biodiversity and changes to natural community structure and soil chemistry. Pepperweed hampers restoration efforts through direct competition with newly establishing plants and potentially creating unfavorable soil conditions. Herbicides are widely considered the most effective strategy for controlling pepperweed.

The City of Sebastopol does not allow the use of herbicides on its lands. However, in February 2007 the Laguna de Santa Rosa Foundation appealed to the city council to allow herbicide use within and directly adjacent to the Phase 1 restoration area (Figure 1). The appeal was guided by a detailed action plan prepared by the Foundation and presented to the council. As this is the upstream extent of the project area the Foundation believed that failure to control pepperweed here would compromise control and restoration efforts in the rest of the project area. After substantial public participation, the council granted an exception to its rule on the condition that the Foundation would also conduct trials using non-chemical control methods. The city provided funds to assist with this activity.

This is a report on the progress of the project through June 2008.





## **Methods**

### *Mapping*

The Laguna Foundation and volunteers mapped 3.11 acres of pepperweed on the Sebastopol property in spring and summer 2006 using GPS technology. Points and polygons were downloaded into a Geographic Information System (GIS) and overlaid on an aerial photo (Figure 2).

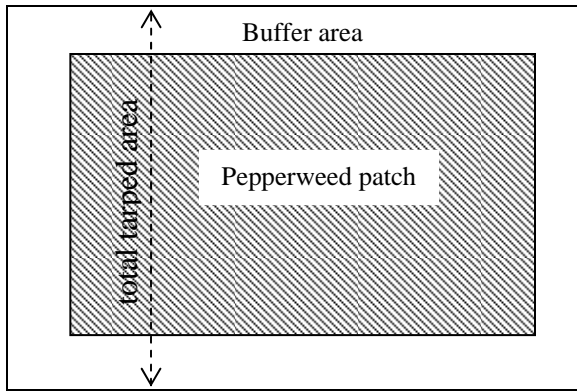
### *Herbicide application*

In spring 2007 approximately 3 acres of pepperweed were treated with the herbicide Telar. Spraying was done by contractor Pacific Open Space, Inc. under the supervision of Laguna Foundation staff May 1-3. No fall herbicide spraying occurred.

The high cost of contracting for herbicide application led the Foundation to send a staff member through the training necessary to obtain an applicator's license. This was completed prior to the spring 2008 control efforts. Although originally scheduled for April, the 2008 spraying was postponed to avoid overlap with the Foundation's docent-led classes on the west side (Wetlands Preserve) and the Foundation's riparian restoration planting on the east side. However, the plants were mowed by Foundation and city staff in April to prevent the pepperweed from flowering and producing seed in this area. Spraying occurred in June. Herbicides used included Telar (active ingredient chlorsulfuron) in areas away from the channel and Rodeo (active ingredient glyphosate) near the channel. This followed the plan submitted to and approved by the Sebastopol City Council in February 2007.

### *Tarping*

The Laguna Foundation purchased a single roll (17,000 square feet) of Hercushield<sup>®</sup> 2400, a heavy duty (12 mil) pond liner. Hercushield<sup>®</sup> 2400 is promoted as being UV and puncture resistant (<http://www.in-lineplastics.com/Hercushield2400.pdf>). Rolls weigh 750 lbs and are difficult to maneuver in the field. In June 2007, following earlier vegetation monitoring (see next section), six tarps were installed. Prior to installation all vegetation was mowed using a Billygoat Outback<sup>®</sup> brush cutter, which mows to a height of about 3 inches. Because the tarp roll is only 12 feet in width, larger patches required 2 or more strips. The area invaded by pepperweed was buffered on all sides by roughly 1 m to minimize the risk of the plant growing around the edges of the tarp. Tarps were fastened with 11-gauge 9" irrigation staples. Over 15,000 sq. ft of tarp were installed.



Selected perennial pepperweed patches were monitored, cleared of vegetation, including at least a one meter buffer on all sides of pepperweed patch, and then covered with a heavy duty tarp. Tarps were secured with irrigation staples and sandbags.

For a variety of reasons tarps proved very difficult to maintain. Because they are black and absorb solar radiation the tarps heat dramatically during the day causing expansion.<sup>1</sup> If the tarp is installed and stapled while expanded, the staples can be forced out of the ground as it contracts during cooler hours. Similarly, if installed while contracted the staples can pop out when expansion occurs. This was a frequent occurrence. To compound the problem, when the staples pop out the tarp can be undermined by wind gusts which can lift the tarp causing more staples to pop out or causing the tarps to rip around the area of the staples. Small holes enable light penetration and subsequent plant growth (Figure 3). To address the problem sandbags were placed on top of the tarps, which was successful except on the largest tarps which continued to be problematic and required ongoing maintenance.



A pepperweed plant takes advantage of a small hole in the tarp.

During the 2007-2008 winter flood events new problems emerged with water undermining the four tarps located low in the floodplain. By mid-February these were rolled and secured thereby exposing the sites to sunlight. Ultimately the Laguna Foundation staff decided to abandon these four tarp sites rather than reestablish them.

In June 2008 three new tarps were installed higher in the floodplain making a total of 5 tarp sites (Figure 2). Instead of mowing the sites first, they were weed whacked to

<sup>1</sup> The underside of the tarps is white. Future investigations should compare white vs. black tarping effectiveness.

ground level to avoid puncture damage from stout stems. All trimmed vegetation was raked out of the patch and piled on the perimeter of the newly installed tarps. One of the existing tarps had to be enlarged because insufficient buffering allowed pepperweed to grow out from under it. These stems were weed whacked and covered by additional tarp.



Weed whackers were used instead of mowers to clear vegetation from new tarp sites. The mower was unable to get close enough to the ground and remaining stems could puncture the tarp.



Insufficient buffer areas can allow pepperweed rhizomes to spread outside of the tarped area and produce copious stems.

### *Monitoring*

In order to compare the efficacy of tarp to herbicide treatments for controlling pepperweed, Foundation staff are monitoring 0.25m<sup>2</sup> quadrats within 5 herbicide treated patches (n=19 quadrats) and 5 tarp treated patches (n=21 quadrats). Actively monitored patch sizes range from 36m<sup>2</sup> to 170m<sup>2</sup> (Table 1). Smaller tarp sizes are vastly easier to maintain. The total tarped area is 650m<sup>2</sup> (6994 sq. ft).

Initial monitoring occurred before herbicide and tarp treatments. Herbicide plots are monitored every year. Tarp plots will not be monitored again until the study is complete, no earlier than 2011. Although control plots are necessary for proper scientific evaluation, the threat posed by leaving pepperweed patches unattended was considered harmful.

Patch sizes were determined by multiplying the distance of the longest and widest sections of the pepperweed patch. A transect was then established through the long axis of the patch. One percent of the each patch was sampled using 0.25m<sup>2</sup> quadrats. Pepperweed density was determined by counting the number of stems in each quadrat. Absolute cover of pepperweed and other species was determined by ocular estimates of percent cover within each quadrat.

Table 1. Active and abandoned pepperweed monitoring sites in the Meadowlark Field.

<b>ID</b>	<b>Treatment</b>	<b>size (m2)</b>	<b>Status</b>
P1-T	Tarp	120	active
P2-T	Tarp	30	abandoned
P3-T	Tarp	208	abandoned
P4-T	Tarp	64	abandoned
P05-H	Herbicide	104	active
P6-T	Tarp	70	active
P7-H	Herbicide	170	active
P8-H	Herbicide	63	active
P9-H	Herbicide	36	active
P10-H	Herbicide	81	active
P11-H	Herbicide	836	abandoned
P12-T	Tarp	574	abandoned
P13-T	Tarp	78	active
P14-T	Tarp	80.5	active
P15-T	Tarp	150	active

## Results

Following one year of herbicide treatment the density of pepperweed decreased from 20 to 0.04 stems/m<sup>2</sup> in herbicide treated patches (Figure 3) and cover decreased by 79% (Figure 4). The cover of non-pepperweed dicots increased 35% but nearly every dicot present before and after treatments were non-native species, some of which are highly invasive. Monocot cover decreased by 83%. The cover of thatch, bare ground and moss increased over 100%. No data will be presented for tarped plots until the tarps are removed.

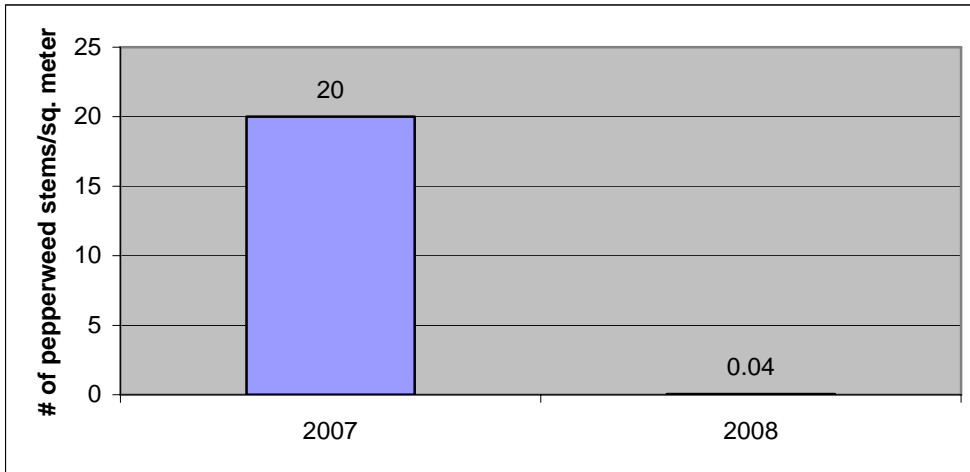


Figure 3. Change in density of perennial pepperweed following one year of herbicide application in the Meadowlark Field, Sebastopol, CA (n = 19).

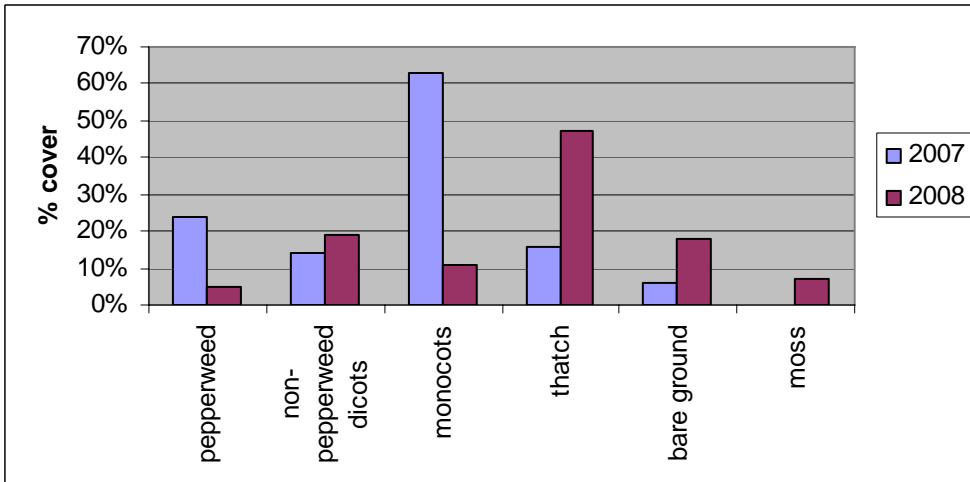


Figure 4. Change in ground cover following one year of herbicide application in the Meadowlark Field, Sebastopol, CA (n = 19).

## Discussion

Drawing conclusions from one year of data is not advisable because the plots will continue to change with subsequent herbicide applications in 2008 and 2009. Dramatic reduction in target weeds after the first year is common, but the more important measures are how long the condition persists and what fills the unoccupied niche. For example, in one of the plots the pepperweed cover dropped from 22% to 0% cover over the one year period but on close inspection we found live pepperweed rhizomes at and just below the surface. Pepperweed plants have extensive belowground biomass and persistence is required to kill the root system no matter what method is used. This is particularly significant for the tarping efforts as it suggests that large patches will require the tarps to be left in place for long durations. While this is not surprising, tarp maintenance is highly labor intensive and expensive and tarping of large areas may not be practical (Table 2).

The increase in non-pepperweed dicots and the decrease in monocots are unexpected because the herbicide used was broadleaf specific and should favor monocots. The increase in dicots may not be statistically significant, however, but the data will not be thoroughly evaluated until the entire project is complete.

### **Restoration**

In April 2008 the Laguna Foundation began active restoration in the northern half of the Meadowlark Field in areas without pepperweed (Figure 1). Approximately 11.5 acres of riparian and oak woodland vegetation were planted with native and site appropriate trees and shrubs (~1,500 trees). An extensive irrigation system was installed using reclaimed water from the City of Santa Rosa's Sub regional Wastewater Treatment Facility. Additional shrub planting will occur in fall 2008. Grass and sedge planting will begin in herbicide application plots in winter 2008 or 2009 depending on regrowth of pepperweed.

Table 2. Detailed tacking of activities and labor requirments for pepperweed control from July 1, 2007-June 30, 2008.

<b>Work accomplished</b>	<b>date</b>	<b>Responsible entity</b>	<b># of individuals assigned to task</b>	<b>Total hours</b>
Maintain tarps	July 2007-March 2008	Laguna Foundation	variable	35
Coordination and preparation	April-June, 2008	Laguna Foundation)	1	7
mowing	April 15-16, 2008	Laguna Foundation staff	1	8
Monitoring spray plots and identifying and monitoring new tarp plots	April 18, 2008	Laguna Foundation staff	2	8
Mowing and tarping	June 3, 2008	Laguna Foundation staff	4	32
Herbicide application	June 11-12, 2008	Laguna Foundation staff	2	20
Herbicide application	June 16 and 18, 2008	Laguna Foundation staff	2	18
Data entry, analysis and reporting	June 1-20, 2008	Laguna Foundation staff	1	14
			<b>Subtotal Laguna Foundation hours</b>	<b>142</b>
Monitoring spray plots and identifying and monitoring new tarp plots	April 18, 2008	Consulting botanist	1	4
			<b>Subtotal consultant hours</b>	<b>4</b>
mowing	April 15-16, 2008	Sebastopol staff	2	16
Herbicide application	June 11-12, 2008	Sebastopol staff	2	20
			<b>Subtotal Sebastopol staff hours</b>	<b>36</b>
			<b>Total hours spent July 2007-June 2008</b>	<b>182</b>