Phalaris aquatica Control at a Remnant Coastal Terrace Prairie in Richmond, CA

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The Watershed Project restoration stewardship program University of California, Berkeley's Richmond Field Station in Richmond, California

Abstract

The Richmond Field Station supports one of the last remnants of coastal terrace prairie within the surrounding San Francisco Bay Area. This prairie contains remarkable diversity, and over 80% native plant cover in the grassland's core.

Surrounding the intact prairie, however, invasive *Phalaris aquatica* dominates, and pioneer populations have begun to gain foothold in the core section. In order to preserve this biodiversity, and to inform restoration efforts on similar sites, plots were established to test different control and eradication techniques. *P. aquatica* patches are prioritized for removal based on their proximity to areas that support the highest species richness. Control methods include hand-removal, herbicide application, mowing, brushcutting, and recycled carpet cover. Preliminary monitoring indicates that the treatment results vary widely. This experiment aims to develop an effective and adaptive approach for restoration in an environment of limited resources.

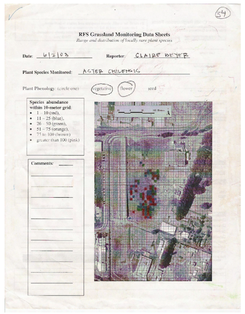
The Problem

Phalaris aquatica is an introduced perennial grass from the Mediterranean that has become a widespread invasive plant throughout most of California. Ironically, most scientific literature concerning *P. aquatica* regards it as a desirable plant for cattle forage, and little information is found about how to eradicate it. This species has become well established in the remnant coastal terrace prairie found at the Richmond Field Station, with patches of greater than 80 – 90% cover surrounding the eastern, southern and northern boundaries of the prairie. Pioneer patches are currently establishing within the core prairie habitat and threaten to reduce the grassland's unique biological diversity. Successful *P. aquatica* control will ensure protection of this resource and identify possible control techniques for other coastal terrace prairies threatened by *P. aquatica.*

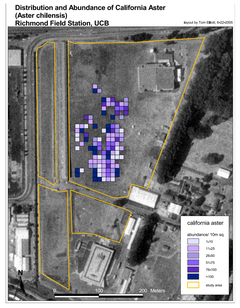
Phalaris aquatica can be found in dense patches in grasslands and wetlands throughout California.

Mapping & Prioritizing Treatment Areas

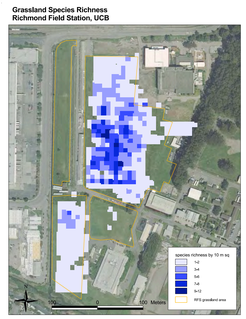
A control strategy has been established by prioritizing patches of *P. aquatica* based on their proximity to regions of the grassland supporting the highest diversity and richness of native species. In 2002, the Watershed Project collected distribution and abundance data for 40 locally significant native plant species and other indicator native plant species throughout this prairie. The population of *P. aquatica* was also mapped using GPS. By overlaying a composite map illustrating areas rich in important native plants with the distribution of *P. aquatica*, *P. aquatica* patches were prioritized for control. Priority was given to isolated pioneer patches of *P. aquatica* in areas of high native species richness and density, and to leading edges of *P. aquatica* surrounding the core remnant grassland. This analysis also identifies which patches of *P. aquatica* fragment the richest areas of native grassland and should be removed to reconnect smaller, isolated native areas to the core native prairie.



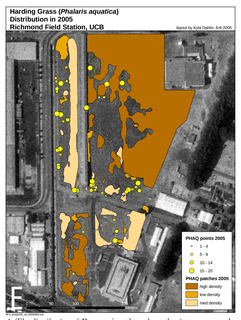
1. A monitoring data sheet is created for each species to record the population's extent and abundance.



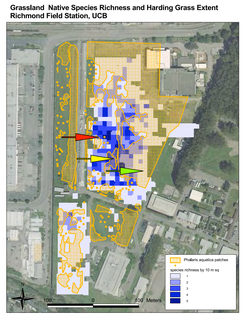
2. A GIS shapefile is created for each species.



3. A GIS analysis of the 40 species monitored illustrates which grassland areas support the greatest richness of rare and otherwise significant native species.



4. The distribution of P. aquatica *throughout the site was mapped using GPS*



5. A second GIS analysis of significant native plant richness and the distribution of P. aquatica *was used to determine which populations of* P. aquatica *should be prioritized for removal. The red arrow illustrates a population of* P. aquatica *given high priority for removal. It exists in an area rich in significant native plant species, and yet its small size makes it relatively easy to remove. The yellow arrow points to a lower-priority area with moderate native species richness, and with a larger, more difficult to remove, population of* P. aquatica, *where control techniques may be more feasible. The green arrow points to an area lowest in priority for restoration.*

Experimental Treatments

Seven plots were established throughout the grassland in areas with greater than 70% cover of *P. aquatica* to test different control methods. The total area covered by these plots is 1200 sq. m. (0.30 acres).

Hand Removal

In four of these plots *P. aquatica* was removed with hand tools. The plots were planted with nursery container stock at a density of approximately 1.8 foot centers. Bare ground was then covered with 6 to 12 inches of weed-free rice straw mulch.

Herbicide Treatment

Two of the plots were treated with one application of a 1.5% solution of Glyphosphate in May 2005. Initial dieback of *P. aquatica* was over 95%. (Interestingly, some of the native *Danthonia californica* and *Juncus phaeocephalus* survived herbicide treatment.) Following the season's first rains, staff monitored both plots for the presence of resprouts and seedlings. The average resprout density was 0.21 and 0.01 plants/sq. m. for each plot respectively. The plots were then planted with container stock at a density of approximately 1.8-foot centers. The herbicide plots were not covered with rice straw because the dead *P. aquatica* created a layer of thatch throughout the plot. Following planting, both plots required follow-up hand-removal treatment.

Recycled Carpet Cover

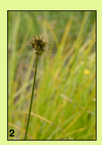
One *P. aquatica* plot was covered with recycled carpet to determine whether the *P. aquatica* seedbank can be depleted with thick cover. Sixteen months after initial covering, soil from this plot was placed into two nursery flats, each 1 ft. sq. Initial germination tests show an average of two *P. aquatica* seedlings emerged per flat. The carpet will be removed in May 2006 to allow a flush of seedlings to germinate, and will then be re-covered when seedlings reach 4-6 inches in height. This process will be repeated for two more years.

Mowing and Brushcutting

Some grassland experts (personal conversations) suggest that a repeated low cutting (< 3 inches) of the grass significantly weakens *P. aquatica*. In addition, mowing can be timed to prohibit populations of *P. aquatica* to spread by seed or vegetatively by tillers or shoots. Three years of mowing large swaths of the grassland, twice per season, have been completed. Beginning in June 2006, *P. aquatica* will be re-surveyed using GPS to determine whether the leading edge of *P. aquatica* has been contained, and whether the mowing treatment may have had an effect. Additionally, stakes will be used to demarcate key leading edge areas.

Locally Significant Plant Species

Based on Rare, Unusual and Significant Plants of Alameda and Contra Costa Counties, 7th edition, March 2004, by Dianne Lake



species	Status	rare at	RFS*	Surveyed at RFS in 2002
1. Carex densa	Ua2	-		x
2. Carex subbracteata	Ub	-		x
3. Centunculus minimus	Ua1	x		x
4. Ciendia quadrangularis	Ub	x		x
5. Elymus trachycaulus	Ub	x		x
6. Elymus x hansenii	Ua2	x		x
7. Eryngium armatum	Ua2	-		x
8. Hordeum jubatum	Ua2	-		x
9. Juncus phaeocephalus var. phaeocephalus	Ub	-		x
10. Rumex salicifolius var. salicifolius	Ub	x		x
11. Spiranthes romanzoffiana	Ua1	x		x
12. Stachys ajugoides var. ajugoides	Ua2	x		x

*Ua** A species given special status by state or federal agencies or by state level of CNPS. Protected by CEQA
Ua1 Species known in 2 or less botanical regions in the counties
Ua1x Species believed to be extirpated
Ua2 Species currently known from 3 - 5 regions in the two counties, or meeting other important criteria
Ub A High- Priority Watch List: Species currently known from 6 - 9 regions in the two counties, or meeting other important criteria
Uc A second priority watch list: species known from 10 or more regions in the two counties, but potentially threatened if certain conditions persist.
* Populations of less than 500 individuals.

Preliminary Results

Hand-removal more effective than herbicide

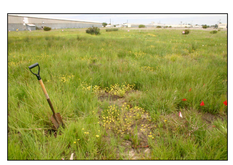
One herbicide and all hand-treatment plots, which initially had greater than 70% cover of *P. aquatica*, have 85% or greater native plant cover as of April 2006, 12 – 18 months after initial treatment. As of this date, the remaining herbicide plot has over 50% native plant cover. Preliminary observations and data indicate that hand-removal was more effective than herbicide. High amounts of soil disturbance and removal of the top layer of soil that accompanied hand-removal may have significantly decreased the seedbank. Furthermore, by removing entire root systems, hand-removal makes vegetative resprouts less common. The reduction of 2 – 3 inches of soil during plant removal also resulted in a surface expression of the water table, expanding the site's seasonally wet areas. This favored hydrophilic native species such as *Juncus phaeocephalus, Carex subbracteata, Carex densa,* and *Eleocharis macrostachya*, which re-established independently in these plots.

Because herbicide treatment was completed less than a year ago, its effectiveness has yet to be fully determined, and cannot yet be compared to hand-removal treatment. Initial monitoring and observation suggest that a single treatment of herbicide is less effective than hand-removal. While *P. aquatica* showed a high initial die-off following the May 2005 herbicide application, monitoring data from January 2006 indicates increasing numbers of resprouts, from 0.32 to 0.94 *P. aquatica* plants/sq. m. However, while hand-removal has been highly effective, it is also costly and labor intensive. Approximately half an hour per sq. m. was spent on the initial phase of *P. aquatica* removal by hand.

Thick applications of mulch reduced resprouts and seedlings

Initial observations indicate that the application of mulch (weed-free rice straw) post hand-removal treatment is a highly effective means of suppressing *P. aquatica* resprouts and seedling emergence. All hand-removal plots were covered with approximately 6 inches of mulch following planting. One plot received two layers of mulch totaling approximately 12 inches, and reemergence of *P. aquatica* in this plot was significantly reduced. As a result, follow-up hand-removal for resprouts in this plot required approximately 11 minutes/sq. m., approximately half the time required in comparison to other plots. Further monitoring is underway to quantify the effect of mulch on *P. aquatica* reemergence following hand-removal and herbicide treatment

Plot 4B following herbicide application and before revegetation.



Plot 1A, one year after hand removal and revegetation.

Hand removal of P. aquatica expanded seasonally wet areas allowing for natural re-establishment of native rushes and sedges.

Future Actions

While herbicide initially appeared to be an effective treatment, high numbers of seedling emergence following treatment require intensive follow-up hand-removal and may nullify this treatment's initial low cost. Future test plots will be treated with two applications of herbicide to determine whether herbicide can be used more effectively to decrease the follow-up hand-removal needed, and therefore allow for larger scale control and restoration.

While brushcutting and mowing have been used to prevent *P. aquatica* from further spreading in the grassland, no quantifiable data has been collected to measure the efficacy of this treatment. Seed has been collected from *P. aquatica* in various states of development for germination tests that will inform future mowing regimes. If funding and resources allow, further plots could be established to test effectiveness of mowing.

The distribution of *P. aquatica* throughout the site will be mapped yearly using GPS to monitor changes in the population and the effects of control methods. Several literature reviews have revealed little information regarding the management of *P. aquatica* as an invasive plant. We hope to build on the experience and information collected in this project to make possible more informed management actions on our project and others. Additional information and anecdotes regarding *P. aquatica* appreciated. Please contact Monica Stafford at monicaamelia@yahoo.com.

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the watershed project