The Cost and Effectiveness of **Small-Scale Fennel Control Methods**

Abstract:

This study examines which of three methods will work most effectively at killing fennel (Foeniculum vulgare) in a small-scale infestation while costing the least in two sites in Salinas. The methods are: digging out individual plants with a shovel, chopping the plants repeatedly during the summer with a machete, or chopping the plants and immediately spraying the stumps with an application of the herbicide Rodeo. I discovered that the most effective method was digging each plant individually with chopping and spraying a close second. The chopping repeatedly method was not effective at all with a mortality rate very similar to my control group of plants which received no treatment. I also found that the least expensive method was chopping and spraying with chopping repeatedly a close second. Digging the individual plants was the most time consuming and therefore most expensive.



Map of Monterey County, CA. The inset shows an aerial photo and map of Salinas. Approximate site locations are marked by red dots.

Introduction:

The purpose of this project is to determine which of the control methods available work most effectively at killing fennel (*Foeniculum vulgare*) in two sites in Salinas (Natividad Creek Park and Upper Carr Lake) with the greatest frequency of success and lowest monetary and labor cost. The recommended method for light infestations, such as the ones in my two sites, is to dig out individual plants. However, in heavy clay soils, such as those in both of my sites, the method of digging up each individual plant can be very time consuming. Several studies on the control of invasive fennel have been done on Santa Cruz Island, California, where the fennel removal practices have been on a large scale and have included controlled burns and the aerial application of herbicides, neither of which is appropriate for small scale infestations in public parks within city limits. Herbicides that have been determined to be effective are amine and ester formulations of triclopyr, Garlon 3A and Garlon4, and glyphosate as Roundup.

My question is: Which treatment methods are most effective at killing fennel while having the least monetary and labor cost?

Photographs:

The pictures here show the results of each of the 4 different treatment methods used.



Abigail Gwinn CSU, Monterey Bay - Division of Science and Environmental Policy and Return of the Natives Restoration Education Project at the Watershed Institute abigail_gwinn@csumb.edu

Methods:

I randomly selected a total of 100 fennel plants in two sites in Salinas, CA: Natividad Creek Park and Upper Carr Lake. There were 50 plants per site and all 100 plants were randomly assigned to four different treatment methods. There were 25 plants per method. Treatment methods began on July 10th, 2006. The methods were:

- Control: These plants received no treatment other than to remove any flower heads that were produced during the season to prevent them from spreading
- <u>Chop Repeatedly</u>: These plants were chopped with a machete to 20cm or less above the ground. They were then revisited every two weeks to chop any new arowth
- Chop and Spray: These plants were chopped with a machete to 20cm or less and then immediately sprayed with the herbicide Rodeo, which is glyphosate (Roundup) kwithout a surfactant. This was the only treatment method that had two people working together on the same plant.
- <u>Dig</u>: These plants were dug up with a shovel with the intent to remove as much of the root as possible.

The time spent on each plant for all methods except the control was recorded to factor in the cost of labor. The cost of labor was assumed to be \$10 per hour per person for this study. The amount of herbicide used was also recorded.

The treatments were stopped on September 4th, 2006 which included a final round of chopping and an assessment of all of the plants. The plants were visually evaluated and placed into one of three categories:

- Dead: These plants showed no new growth and were often brown and shriveled. • Stressed: These plants were obviously unhealthy and often had yellowed,
- drooping leaves.
- <u>Alive</u>: These plants were green or showed signs of new growth.

Results:

Effectiveness at Killing Fennel:

- The most successful method was digging the individual plants with 100% mortality. Chop and spray was a close second with 96% mortality (Figure 1).
- The chopping repeatedly method was completely ineffective (Figure 1).

Cost per Method:

- The most expensive method was digging with an average of \$3.49/plant (Figure 2, Table 1).
- The least expensive was to chop and spray with an average labor cost of \$0.16/plant, assuming a pay rate of \$10/hour for two people. This does not include the cost of Rodeo used. Chopping repeatedly was also inexpensive (Figure 2, Table 1).

Discussion:

My results show that chopping and spraying each plant with herbicide was the most effective and least expensive method. However, it didn't take into account the cost of the Rodeo used. I used about 10ml mixed with water and no surfactant in a standard. 1-liter spray bottle and still had about half of the mixture left after treating all 25 plants with that method. The Rodeo I used was already available and so the herbicide did not need to be purchased. Rodeo sells for about \$50.00 - \$60.00 per gallon.

Though Roundup is a more common glyphosate formulation than Rodeo, I chose Rodeo because my research shows that it may be safer to use in riparian areas, and is the better choice when one is seeking to reduce the impact upon the aquatic zone. Several studies have shown that it is the surfactant associated with Roundup and often added to Rodeo that seems to be lethal to amphibians. All of my herbicide applications took place upland of the nearby waterways and without the use of any surfactant

Digging was the most effective at killing the fennel plants but it was extremely time consumptive with each plant averaging about 20 minutes to dig out and one notable plant taking over an hour -- 68 minutes -- to dig out. It is possible that this time may be reduced by using a different tool, such as a pulaski or mattock instead of a shovel, however only the shovel was used in this study.

Conclusion:

- If herbicide application is not an issue then chopping and spraying each fennel plant with Rodeo is the best treatment method.
- If soils are soft and the infestation is small (and/or herbicide application is not appropriate), digging up each individual fennel plant is the best treatment method.



Survivorship of Fennel Plants



Figure 1:

The cumulative percent of fennel survivorship in each of the four treatment methods. * Two of the plants listed as dead in the chop repeatedly method were missing during the assessment.



Figure 2

The average cost of labor for each method (not counting the control), assuming a pay rate of \$10.00 per hour.

~ Includes cost to chop 5 times (every 2 weeks from July 10th to September 4th). * Does not include cost of Rodeo. Includes cost of 2 people per plant. ^ Assuming \$10/hour using a shovel. Time may be different with other digging tools.

Table 1:

The average cost of each method per plant, as well as the range of cost. (Note the maximum cost for digging). Each method involved 25 plants.

	Chop Repeatedly	Chop and Spray	Dig
Average Cost	\$0.22	\$0.16	\$3.49
Minimum Cost	\$0.06	\$0.06	\$0.36
Maximum Cost	\$0.77	\$0.31	\$11.33

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