

Seed Ball Experiment - Final Report

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January 13, 2011

Introduction

The Puente Hills Landfill Native Habitat Preservation Authority's (Habitat Authority) Resource Management Plan (RMP), adopted in 2007, outlines methods for habitat management and restoration throughout the Puente Hills Preserve. The RMP recommends conducting "pilot restoration experiments utilizing different techniques to determine the most cost-effective methods" for habitat restoration¹. The RMP also notes that while Broadcast Seeding is the "all-purpose" seeding method, other seeding methods maybe more applicable in certain situations².

Traditional methods for distributing native seed during habitat restoration projects include broadcast seeding (or hand seeding), hydroseeding, or imprint seeding. An alternative method for distributing native seed is to use seed balls, which consist of a mixture of clay, compost, seed and water, and are thrown onto a site. The clay helps to hold the ball together and prevent herbivory or wind transport of seed, while the compost provides nutrients for the germinating seedlings. This method is purported to have benefits over other traditional seeding methods in certain circumstances, such as at sites that are difficult or dangerous to access, and in dry climates.

There is anecdotal evidence regarding the success of seed balls in habitat restoration, but to date few studies have been found that demonstrate this with experimental data. In order to test the effectiveness of seed balls compared to traditional seeding methods, former Habitat Authority Ecologist, Amy Henderson, planned a seed ball experiment in 2007. This study was conducted from Fall 2009 through Spring 2010, and is discussed below.

Methods

Seed Ball Creation

The recipe used in making the seed balls was prescribed by the former Ecologist and is as follows³:

- 5 parts dry terracotta clay
- 3 parts dry organic compost
- 1 part seed

¹ Puente Hills Habitat Authority. 2007. Resource Management Plan. Adopted July 26, 2007. Section 6.2.3 – Biological Monitoring, page 97.

² *Ibid.* Appendix N, Habitat Restoration Framework Plan, page 397.

³ www.pathtofreedom.com/pathproject/gardening/seedballs.shtml

- Enough water to bind all ingredients and allow for rolling into penny-sized balls.

Seed was purchased from S&S Seed in mid-2008, and consisted of native plant seeds that were collected on the Preserve. The seed mix of native shrub and herbaceous species was selected by the former Ecologist and is given in Table 1 below. Half of the seed mix was used to make the seed balls, and half was reserved for the Hand Seed treatment area.

Table 1. Native Seed Purchase for Seed Ball Experiment Treatment Areas

| Scientific Name | Common Name | Pounds of Seed |
|-------------------------------|---------------------------|----------------|
| <i>Deinandra fasciculatum</i> | Fascicled tarweed | 1.5 |
| <i>Encelia californica</i> | California bush sunflower | 1.5 |
| <i>Eriogonum fasciculatum</i> | California buckwheat | 6.0 |
| <i>Gnaphalium bicolor</i> | Bicolored cudweed | 0.5 |
| <i>Isocoma menziesii</i> | Goldenbush | 1.5 |
| <i>Malosma laurina</i> | Laurel sumac | 1.5 |
| <i>Phacelia ramossissima</i> | Phacelia | 0.5 |
| <i>Plantago insularis</i> | Plantain | 10.0 |
| Total | | 23.0 |

On November 21, 2009, over 11,000 seed balls were made according to the above recipe, with the help of a local Girl Scout troop and other volunteers (see attached photographs). The seed balls were generally larger than the penny-sized balls recommended in the recipe, and ranged from marble to golf ball size. The seed balls were allowed to dry completely on wire mesh racks in the Sycamore Barn.

Site Selection, Preparation and Seed Ball Distribution

The experiment site was selected by former Ecologist Amy Henderson, located on a southeast-facing slope on the west side of the Turnbull Canyon Trail. The entire experiment site was one acre, and it was divided into three treatment areas, each 1/3-acre in size: Seed Ball Area, Hand Seed Area, and Control Area (where no seeding occurred).

The Habitat Authority's Restoration Contractor, Nakae and Associates, cleared the entire experiment site of all vegetation in November 2009. However, the seed balls and seed were not ready to distribute on the site until late December, and non-native plants had already begun to grow on the experiment site in the interim. As a result, Nakae was directed to spray an herbicide (Round-up) on the site on December 23, 2009, to kill the non-native plants prior to seeding.

On December 28, 2009, a troop of local Girl Scouts helped to distribute the dried seed balls (more than 11,000) over the 1/3-acre Seed Ball treatment area (see attached photographs). Seed balls were distributed by throwing the seed balls over the entire area to evenly cover the treatment area.

On January 4, 2010, Nakae seeded the Hand Seed treatment area by raking the native seed mix into the soil.

Monitoring

All treatment areas were periodically monitored seedlings from January through April, 2010 by walking the site and visually inspecting the integrity of the seed balls and noting any germination (see attached photographs). Photomonitoring was also conducted for each treatment area at regular intervals during this time period.

On April 20, 2010, Habitat Authority Ecologist, Shannon Lucas, with assistance from an intern, conducted point-intercept transects in each treatment area to collect data on the relative abundance of plant species germinating at the site. Three transects were conducted per treatment area: one in the upper third of each area, one in the middle, and one in the lower third. Each transect was 28 meters long, and at each meter along the transect, a wooden stick (0.5-inch diameter) was placed perpendicular to the soil surface, and each species touching or “hitting” the stick was recorded. Data was used to determine the relative abundance of each species per treatment area by totaling the number of “hits” per transect, dividing the number of “hits” per species by the total, and then averaging the results from all three transects per treatment area. Other species observed growing along transects were also recorded separately.

Following transect data collection, each treatment area was intensively searched in order to locate and note any other plant species that had germinated, in case the transect sampling did not adequately capture the diversity of native species germination.

Results

Initial monitoring of seed balls and seed germination from January through April was promising. Most seed balls had begun to break down following winter and spring rains, and did not appear to have washed downhill. Also, germinating seed was observed growing out of some of the seed balls. However, by April, all treatment areas had begun to be dominated by non-native grasses.

Transect data revealed that all treatment sites were heavily dominated by non-native species, particularly the non-native grass ripgut brome (*Bromus diandrus*). Only the Hand Seed treatment area exhibited any native species, accounting for only two percent of the relative abundance. See results in Table 2 below.

Table 2. Relative Percent Abundance per Species per Treatment Area from Transect Data

| Scientific name | Common name | Relative Percent Abundance per Species | | |
|--------------------------|---------------|--|----------------|--------------|
| | | Seed Ball Area | Hand Seed Area | Control Area |
| Bare ground only | Bare ground | 1.0 | | |
| <i>Bromus diandrus</i> | Ripgut brome | 77.0 | 88.5 | 76.9 |
| <i>Brassica nigra</i> | Black mustard | 0.7 | 5.2 | |
| <i>Chenopodium album</i> | Goosefoot | 1.5 | | |

| | | | | |
|---------------------------------|----------------------|------------|-----------|------------|
| <i>Eriogonum fasciculatum</i> * | California buckwheat | | 1.0 | |
| <i>Lactuca serriola</i> | Prickly lettuce | | 1.1 | |
| <i>Marah macrocarpa</i> * | Wild cucumber | | 1.0 | |
| <i>Ricinus communis</i> | Castor bean | 8.4 | 1.1 | 23.1 |
| <i>Silybum marianum</i> | Milk thistle | 11.3 | 1.1 | |
| <i>Sonchus oleraceus</i> | Sow thistle | | 1.1 | |
| Total Native | | 0 | 2 | 0 |
| Total Non-native | | 100 | 98 | 100 |

*Native species

Intensive searches of the treatment areas did reveal the presence of a few additional native species that had germinated but were not observed on the transects, such as plantain, phacelia, goldenbush, and doveweed (*Croton setigerus*). These observations also indicated that the Hand Seed treatment area exhibited the most germinated native species, but that the Seed Ball treatment area had more natives than the Control treatment area. The Hand Seed treatment area also exhibited more germinated species from the seed mix than other treatments, and the Seed Ball area had more than the Control area. See results in Table 3 below.

Table 3. Total Number of Native Species and Species from Seed Mix Observed per Treatment Area

| Treatment Area | Total Number of Native Species Observed* | Total Number of Species from Seed Mix Observed |
|-----------------------|---|---|
| Seed ball Area | 4 | 2 |
| Hand seed Area | 6 | 4 |
| Control Area | 1 | 0 |

* Other natives observed aside from those in Tables 1 and 2 included doveweed (*Croton setigerus*) and wire lettuce (*Stephanomeria virgata*).

Discussion

Native seed germination was very low in all treatment areas with no substantial difference detected between them. Although the Hand Seed treatment area had the highest relative abundance of native species, and the highest number of native species observed, it was not substantially higher than the Seed Ball treatment area. This experiment, therefore, indicates that seed balls are not more successful than hand seeding, but is not really less successful either. Seeding via either method did yield more natives than the control area, where no seeding occurred, but this difference was not dramatic. More apparent differences between treatments may have resulted if more native seed had germinated, as was anticipated. Possible reasons for low native seed germination include (1) poor seed viability, (2) low precipitation, (3) inappropriate seed mix, or (4) abundance of non-natives; each of these reasons is evaluated below.

- (1) Poor seed viability. Viability test results provided by S&S Seed for most of the species in the seed mix ranged from “O.K.” to “good”. The seed mix was delivered in August

2008, and was stored in the Habitat Authority office for over one year; it is unknown whether this length of time or the conditions in the office may have decreased the seed viability. It is unknown if this could be a factor in the low seed germination.

- (2) Low precipitation. Precipitation for the area from January through April 2010 was 97 percent of normal⁴, so is not likely factor in poor germination.
- (3) Inappropriate seed mix. Most of the species in the seed mix have been observed as readily germinating at a variety of other restoration sites. In addition, most species in the seed mix are generally selected to be in native seed mixes due to their vigorous growth and heartiness, particularly during the first year of restoration, and are often used to produce vegetative cover to stabilize soils and provide conditions that are conducive for the growth of other slower growing native shrub species. Therefore, this is unlikely to be a major cause of low germination.
- (4) Abundance of non-natives. Non-native species, particularly non-native grasses, are known to exclude native plants by competing with them for space, light and water. Although one weed treatment with herbicide was conducted prior to seeding, it was apparently not enough to exhaust the non-native seed bank that has built up at the site over many years. The high relative abundance of invasive species such as castor bean and milk thistle, despite their near absence at the site prior to the treatments, is evidence of the persistence of non-natives in the seed bank, as these species were observed in the area several years prior and were eradicated⁵. It is likely that soil disturbance from the clearing of vegetation during site preparation caused the seeds of these invasive species to be exposed and germinate. In addition, the non-native seeds may have gotten a head-start on germination and growth, giving them an advantage over the native seeds in the seed balls; since the seed balls were dry, they first had to become wet during the next rains in order to release the seeds from the ball and promote their germination. Given the large abundance of non-native species at the site, it is very likely that they could have prevented the survival of the native seedlings that germinated early on; this is likely the major cause of low germination.

The results of this experiment are difficult to compare to other studies, as few have been found to date. Most studies do not quantify the success of seed germination or survival, but rather qualitatively describe the success of seed balls. For example, one study found that seed balls had better germination than broadcast seeding (which had no germination), but lacked quantifiable results⁶. Another study found that seedlings from seed balls were larger than seedlings from broadcast seeding⁷. Two studies attributed lack of seed ball success to germination, but that is

⁴ National Oceanic and Atmospheric Administration. National Weather Service, Los Angeles/Oxnard Office. Monthly Precipitation Data for Downtown Los Angeles. <http://www.weather.gov/climate/index.php?wfo=lox>

⁵ Personal communication. Manuel Gutierrez, Supervisor, Nakae and Associates.

⁶ Bones, J. 1996. Chihuahuan Desert Seed Ball Test Plan, Mod II Big Bend National Park, Texas. www.seedballs.com.

⁷ Caplan, T.R., Pratt, H.A., and S.R. Loftin. 1999. Influence of Mycorrhizal Source and Seedling Methods on Native Grass Species Grown in Soils from a Disturbed Site. USDA Forest Service Proceedings RMRS-P-7.

likely because the seed balls were distributed on the study sites later in the spring and, therefore, were not able to take advantage of enough of the rainy season^{8,9}. However, one of those studies did note that seed balls helped to re-establish wildflower in a burned area, with more than 60 percent of the species in the seed mix found growing on the site, sometimes in dense populations¹⁰.

Conclusions and Recommendations

This study showed that there was not a substantial difference between two different seeding methods, seed balls and hand seeding, regarding relative abundance of native seedlings, and that these methods were also not substantially different than no seeding. However, hand seeding did yield more native species observed than seed balls, and seed balls yielded more native species observed than no seeding.

Given the large amount of labor involved in creating seed balls, they may not be the most efficient and effective method of seeding for habitat restoration. However, the low germination of native seeds in both treatment areas may have been affected by seed viability and/or the abundance of non-native species. Also, further monitoring of the experiment area should be conducted to see if additional native seedlings germinate and to see how many of the native seedlings from 2010 persist into the future.

In addition, further testing of seed balls should be conducted in an area that is potentially more suitable for this method, such as an area recently burned or eroded. An area burned in September 2009 in Arroyo San Miguel was seeded with wet seed balls in January 2011, which used the same recipe as above but, counter to most seed ball recipes, the seed balls were not allowed to dry before distribution. The reasons for this were twofold: (1) less effort required to dry and store the seed balls, and (2) the moist soil will likely help give the native seeds more of a head-start in germination, giving them a possible advantage over non-native seed germination. This area will be monitored in Spring 2011 to evaluate native seedling germination under the burned area conditions.

⁸ On Seedballs. <http://sites.google.com/site/onseedballs/>

⁹ Center for Invasive Plant Management. 2005. On-the-Ground Restoration Project Questionnaire: Cerro Grande Restoration Seed Ball Project. http://www.globalrestorationnetwork.org/wp-content/uploads/cipm_pdfs/NMLosAlamosCraigMartinFinal.pdf

¹⁰ *Ibid.*

Photographs



Volunteers making seed balls November (above), and dried seed balls December (below), 2009

Photographs



Girl Scouts distributing seed balls December 2009 (above), germinating seed ball January 2010 (below)

Photographs



Photographs of the Seed Bally Treatment Area, 2010

January 28th (left), March 18th (center), and April 20th (right)