Successful Habitat Restoration of a Native Thistle Following Jubatagrass Control

Prepared by Don Thomas, IPM Specialist, San Francisco Public Utilities Commission

ABSTRACT

Fountain thistle (Cirsium fontinale var. fontinale) is a federally endangered native thistle that grows in serpentine seeps and in seasonally wet serpentine grassland. This habitat has been invaded by jubatagrass (Cortaderia jubata) and other invasive plants. This study describes the successful recovery of two serpentine seep populations through passive revegetation following control of jubata grass.

One fountain thistle population, located in the Peninsula Watershed of the San Francisco Public Utilities Commission, had been mostly displaced from its serpentine seep habitat by the invasion of jubatagrass. The jubatagrass was removed by cutting the stalks with a chain saw and treating cut stems with concentrated glyphosate. The recovery of this population was studied over time using a transect study. A central east-west trending line transect was placed through the population. Expansion of the population was measured by running 5-ft. wide perpendicular belt transects along this transect in both north and south directions. It was found that between 2010 and 2015 the fountain thistle population expanded to fill almost all of the available habitat, indicating successful recovery. Between 2010 and 2014 the population expanded southward at an average annual rate of 6.2 ft./yr. and northward at an average rate of 3.9 ft./yr. However, between 2014 and 2015 the rate had decreased to 1.4 ft./yr. southward and 1.9 ft./yr. northward, as the population began to reach the limits of the habitat available for re-colonization.

The second population, located on Caltrans property, had also been heavily invaded by jubata grass. After the application of glyphosate to control the jubata grass, the site has been worked on twice annually by volunteers of the California Native Plant Society to remove any new invasive plants. From fewer than 100 plants, this population has also expanded rapidly to a few thousand and has re-occupied the available habitat.

INTRODUCTION

Fountain thistle (Cirsium fontinale var. fontinale) is a federally endangered plant endemic to San Mateo County on the San Francisco Peninsula. In 1998 the San Francisco Public Utilities Commission (SFPUC) began a project to restore the habitat of one of the fountain thistle populations by removing jubatagrass (Thomas and Ciardi 2008) to help meet the objectives of the USFWS recovery plan for the species (U.S Fish and Wildlife Service 1998). This was followed up with projects in 2006, 2007 and 2008. Jubatagrass plants were cut at the base, and the cut stems were treated with 50% glyphosate herbicide. The result has been the elimination of most of the jubatagrass and the re-opening of the habitat for fountain thistle (Figure 1).

A monitoring program was begun in 2007 to track re-colonization of the habitat by fountain thistle through passive recruitment. This involved the setting up of a permanent transect through the population, using an existing transect set up by Tiffany Knight of Washington University and her students for their studies of fountain thistle (Powell and Knight 2009, Powell et. al. 2011). This transect was used to measure the expansion of the population between 2006 and 2009 (Thomas 2009). After the fountain thistle population expanded beyond the bounds of the first transect, a second transect, used for the present study, was established through the remaining mostly unoccupied seep habitat. This transect was used to monitor the expansion of the population since 2010.

Another population occurring on Caltrans land had also been invaded by jubatagrass, resulting in a great reduction in the size of the population and its near extirpation. However, treatment of the jubatagrass by Caltrans and restoration efforts organized by Jacob Sigg aided by volunteers of the Yerba Buena and Santa Clara Valley Chapters of the California Native Plant Society have resulted in the removal of almost all of the jubatagrass and the recovery of the fountain thistle population.

This study describes the progress of the passive restoration of both the SFPUC and the Caltrans fountain thistle populations through natural recruitment and also the results of an active habitat restoration project at the Caltrans site involving the establishment of a native bunchgrass (*Deschampsia cespitosa*).

Figure 1. Appearance of the SFPUC fountain thistle site in 1997 (top) before clearing of jubatagrass and in 2011 (bottom).

Figure 2. Appearance of SFPUC fountain thistle site in 2015 (top), with *Lilium pardalinum* in foreground, and Caltrans fountain thistle site (bottom), showing establishment of Deschampsia cespitosa.

METHODS

At the Calltrans site, in addition to the passive recovery of the fountain thistle population through through natural recruitment, an active habitat restoration project was carried out that involved the planting of California hairgrass (*Deschampsia cespitosa*). Approximately 1,000 plugs of hairgrass, grown from seeds collected at a nearby fountain thistle colony, were planted in 2009 in areas cleared of jubatagrass in an effort to prevent re-invasion by jubatagrass and other non-native plants. In 2011 a survey was conducted to assess survivorship and establishment of the deschampsia plants (Thomas 2009). This was followed up in by a census of the population in 2015 to evaluate survivorship and seedling recruitment.

In 2007 the SFPUC initiated a project to measure and map the fountain thistle population to provide a baseline for tracking the re-colonization of habitat cleared of jubatagrass (Thomas 2009). A permanent transect was established through the population. Along this transect transverse transects, placed at 5-foot intervals along the main transect, were used to locate the perimeter of the population. This mapping procedure was repeated in 2008, 2009, and 2010 to measure the expansion of the population through natural recruitment along its outer edge.

By 2010, the fountain thistle population had expanded beyond the limits this transect, and a second transect was established through the remaining mostly unoccupied habitat that had been cleared of jubatagrass. The expansion of the population through this area was tracked using the same method as with the first transect, employing transverse transects placed at 5-foot intervals both to the north and to the south of the main transect. Measurements of population expansion were made in 2011, 2012, 2013, 2014 and 2015, and the results are reported in the present study.

RESULTS

At the Caltrans fountain thistle site the census of hairgrass carried out in 2011 produced a count of about 200 plants, indicating an establishment rate of about 20 per cent. In 2015 a second count of plants was conducted, and it was found that there were about 350 deschampsia plants. These included all age classes, from small presumably seedling plants to large flowering tussocks (Figure 2).

The results of the population survey conducted at the SFPUC site are presented in the table in Figure 3 and also displayed in the chart in Figure 4. These shows the annual change in the distance measured from the transect to the population edge at 5-foot increments both north and south of the transect. The population expanded an average distance of 12 feet in 2010-2011, 9.1 feet in 2011-2012, 15.7 feet in 2012-2013, 3.1 feet in 2013-2014 and 3.3 feet in 2014-2015, with an overall average expansion of the population of 13.2 feet between 2011 and 2015. Figure 5 displays the cumulative increase in population size both north and south of the transect between 2010 and 2015.

DISCUSSION

This study documents the progress of recovery of a serpentine seep fountain thistle population in the SFPUC Peninsula Watershed. In the earlier transect study conducted between 2007 and 2009 (Thomas 2009) it was found that the initial recovery of the population was relatively slow, with an expansion rate of 1.7 ft/yr between 2007 and 2008 and 2.6 ft/yr between 2008 and 2009. This rate is consistent with the expected short natural dispersal range for the seeds, based upon the large achene size, dehiscent pappus and nodding flowerheads of *C. fontinale*, which are adaptations to prevent seed dispersal outside its restricted serpentine seep habitat (Chipping 1994).

After the fountain thistle population expanded beyond the bounds of the first transect and the present transect study was initiated, it was found that recent expansion of the population has been much more rapid, averaging 12.3 ft/yr between 2010 and 2013. (See Figures 3, 4 and 5.) Population expansion north and south of the transect was tracked separately and averaged 5.2 and 7.1 ft/yr, respectively. The greater rate of expansion southward corresponds to the greater amount of habitat available for re-colonization; the smaller amount of habitat north of the transect had become mostly occupied by 2013.

The rapid expansion rate observed between 2010 and 2013 does not seem consistent with the short-range seed dispersal expected for fountain thistle. This more rapid expansion of the population seems to suggest the presence of an animal seed vector that is transporting seeds greater distances from the parent plant. While movement of seeds to the north of the transect (downslope) may have been aided by gravity and water flow, this does not explain the equal rapid spread of plants in the southward direction (uphill). Though the pappus may not dehisce from all achenes, long-distance dispersal by wind is unlikely because of the greater seed weight of *C. fontinale* seeds compared to seeds of most other thistles (Chipping 1994, Hillman 2007).

One possibility is movement by ants. Fountain thistle achenes possess elaiosomes (Jessica Appel , personal communication), fleshy structures with food rewards for ants which transport the seeds (myrmecochory). However, all the ants observed at the site appear to be Argentine ants, which are too small to carry the seeds and which exclude the larger native ants from the site.

Another candidate for a vector is the wood rat. Dusky-footed wood rats are present on the site, as indicated by the occurrence of wood rat nests in the adjacent oak woodland. Deer are also present, as indicated by footprints and scat, and browsing damage has been observed on C. fontinale, probably caused by deer. Both of these animals may transport seeds. To detect activity of wood rats, deer and other animals, a motion-detecting infrared wildlife camera was set up at the SFPUC fountain thistle site, but no photos of possible seed vectors were captured by the camera.

Another likely seed vector is a seed-eating bird. Goldfinches were observed at the site feeding on seedheads and moving between plants in June 2015. Goldfinches are known to feed on seeds of many species of thistles and were found to help to disperse seeds of another rare species of thistle (Molan-Flores 2000).

In recent years the expansion rate of the SFPUC population both north and south of the transect has slowed (Figures 4 and 5), as fountain thistle has reclaimed most of the available habitat. This reflects the successful recovery of the SFPUC population.

This study also followed the recovery of the Caltrans fountain thistle population. This population also recovered relatively rapidly following control of juabtagrass. However, in this case the fountain thistle re-appeared in all parts of the seep habitat at about the same time, rather than progressively recolonizing the habitat, as occurred for the SFPUC population. This suggests that the recovery involved recruitment of plants from the seedbank. Though it has been found that almost all seeds tested for *C. fontinale* germinate immediately without any apparent dormancy (Powell 2007, Hillman 2007), there must be some mechanism for delayed germination in the soil. Perhaps seeds retained within seedheads that fall onto the soil do not germinate until the seedheads decompose and the seeds come into soil contact. Alternatively, there may be a small percentage of seeds that remain dormant and are able to germinate in subsequent years.

In addition to the passive regeneration of the Caltrans fountain thistle population through natural recruitment, the restoration of the habitat also involved active revegetation, involving the planting of nursery-grown plugs of hairgrass (*Deschampsia cespitosa*). In 2015 it was observed that enough plants had survived in suitable habitat bordering the seeps that they appeared to constitute a self-sustaining population with both mature flowering plants and recruitment of new seedlings (Figure 2).

These two serpentine seep populations of the federally endangered fountain thistle, once were threatened with extirpation because of the invasion of jubatagrass, now appear to be close to full recovery. However, ongoing management is required to prevent the re-invasion of jubatagrass and secondary invasion by other invasive plants. The SFPUC population, for example, is now being invaded by tall fescue (*Festuca arundinacea*), which tolerates both wet serpentine and dry serpentine soil conditions. It is also being colonized by coyote brush, an early successional native shrub that is threatening to produce a type conversion from forbs to woodland (Thomas 2015).

	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
South	7.7	3.4	10.1	3.6	1.4
North	4.3	5.7	5.6	-0.5	1.9
Total	12	9.1	15.7	3.1	3.3

Figure 3. Average annual linear expansion (in feet) of the fountain thistle population both north and south of the central transect

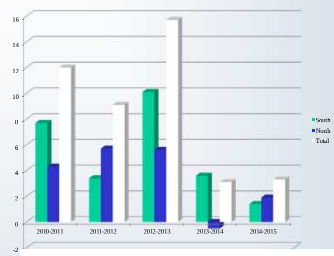

Figure 4. Annual expansion rate of the SFPUC population in feet showing rapid expansion between 2010 and 2013 and slower more recent expansion

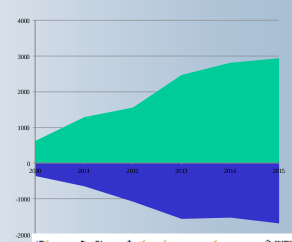

Figure 5. Cumulative increase in area of SFPUC fountain thistle population (square feet) both north and south of the central transect between 2010 and 2015

REFERENCES

Chipping, David H. 1994. Chorro Creek Bog Thistle Recovery Project Final Report. Report submitted to California Department of Fish and Game by Chipping Geological and Environmental Services.

Hillman, Janell Maella. 2007. Constraints on Population Recruitment for a Rare Serpentine Seep Thistle. San Francisco State University Master of Science Thesis.

Molan-Flores. Brenda. 2000. Population Viability Assessment for Hill`s thistle (Cirsium hillii (Canby) Fernald). University of Illinois Urbana-Champaign Center for Biodiversity Technical Report 2000 (8). https://www.ideals.illinois.edu/bitstream/handle/2142/10465/inhsbiodv02000i00008_opt.pdf?sequence=2

Powell, Kristin I. 2007. Pollination Biology and Competitive Abilities of Six Rare, Common, and Invasive Species of Californian Thistle (genus Cirsium). Washington University in St. Louis Undergraduate Honors Thesis.

Powell, K.I. and T.M. Knight. 2009. Effects of nutrient addition and competition on biomass of five *Cirsium* species (Asteraceae) including a serpentine endemic. International Journal of Plant Science 170: 918-925.

Powell, K.I., K. Krakos, and T.M. Knight. 2011. Comparing the reproductive success and pollination biology of an invasive plant to its rare and common native congeners: a case study in the genus *Cirsium* (Asteraceae). Biological Invasions 13: 905-917. http://link.springer.com/article/10.1007/s10530-010-9878-5#page-1

Thomas, Don 2009. Active and passive restoration of fountain thistle habitat following jubatagrass removal. Proceedings of the 2009 California Invasive Plant Council Symposium. www.cal-ipc.org/symposia/archive/pdf/Proceedings_2009_small.pdf

Thomas, Don. 2011. Progress in the restoration of the habitat of fountain thistle (Cirsium fontinale) invaded by jubatagrass (Cortaderia jubata). Proceedings of the 2011 California Invasive Plant Council Symposium. www.cal-ipc.org/symposia/archive/pdf/2011/2011 Program Abstracts.pdf

Thomas, Don. 2015. Managing coyote brush to protect sensitive plant habitats. 2015 California Native Plant Society Conservation Conference poster. https://www.cnps.org/cnps/conservation/conference/2015/pdf/cnps2015_poster_abstracts.pdf

Thomas, Don and Guido Ciardi. 2008. Jubatagrass control and natural regeneration of Cirsium fontinale var. fontinale (fountain thistle). Proceedings of the 2008 California Invasive Plant Council Symposium. www.cal-ipc.org/symposia/archive/pdf/2008/Proceedings_2008.pdf

U.S Fish and Wildlife Service. 1998. Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area. Portland Oregon. http://ecos.fws.gov/docs/recovery_plans/1998/980930c.pdf