First Annual Report for the TNC Taylor Property Habitat Restoration
Permit # 1600-2010-0196-R5

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This report details the progress of the Arundo (*Arundo donax*) removal and habitat restoration project at The Nature Conservancy's (TNC) Taylor property located along the south bank of the Santa Clara River in Santa Paula, Ventura County, CA. This project is covered by California Department of Fish and Wildlife (CDFW) Lake and Streambed Alteration Agreement No. 1600-2010-0196-R5. The project consists of habitat restoration in a 10-acre area at the southeast corner of the property. Funding for the project is being provided by the Santa Clara River Trustee Council (TC) on a yearly basis. The property is within an ecologically diverse floodplain region that has been designated as high priority for restoration by the Santa Clara River Parkway Project. This 40-acre parcel has been degraded by arundo and other non-native species, as well as from anthropogenic alteration of site hydrology. The property consists of diverse riparian habitats within the Santa Clara River floodplain, including willow-cottonwood forests, riparian scrub, and vernal pools with emergent marsh vegetation. Before project initiation, Arundo occurred at various densities throughout the property and reached greatest cover (80-100%) toward the southeast corner. Arundo cover ranged between 5 and 75% on the remaining acreage.

Initial Arundo removal using a forestry mulcher occurred between 16 November and 5 December 2012, and hand removal using cut and daub methods around native vegetation and in sensitive areas continued throughout year 1. Arundo resprouts, and other native plants, including castor bean (*Ricinus communis*), prickly lettuce (*Lactuca serriola*), bristly ox tongue (*Helminthotheca echioides*), and date palm (*Phoenix canariensis*) were sprayed with herbicide during 15-19 April 2013 and again 17-20 September 2013. In April, two herbicide treatments were used: 1) the northern half the site was sprayed with a mix of 1% glyphosate (Aquamaster) and 1% imazapyr (Polaris), and 2) the southern half of the site was sprayed with the label recommended rate of 1.5% imazapyr. In September, resprouts were sprayed with a mix of 2% glyphosate and 2% imazapyr. Results of these treatments are provided below. Pre-project surveys and biological monitoring have been conducted in accordance with permit conditions. A monitoring report detailing site assessment and monitoring results was submitted to TNC and CDFW on 11 June 2013 (revised submission on 8 August 2013). Photos of the restoration site are provided in Appendix A.

Soil survey

The soil seed bank in the project area was evaluated to provide information to guide re-establishment of native plants and develop plant palettes for future revegetation efforts. Soil samples, approximately 1 liter, were taken at a depth of 30-40cm from 15 locations throughout the restoration area. Each sample was spread over sand in a growing tray and placed in a climate controlled greenhouse at UC Santa Barbara. Trays were watered every three days, and germination, survival and species diversity were evaluated monthly (Appendix B). Most samples (87%) had no germination, and the two that did had only non-native weed, including bristly oxtongue and prickly lettuce.

We did not expect to find a substantial native woody plant seed bank since riparian tree seeds are viable for only a few days to a few weeks after maturation (Bell 1997, Stella et al. 2006). In general, recruitment of native trees in coastal riparian systems is dependent on processes associated with high flow events, and germination is dependent on silt deposition from flooding (Stella et al. 2006). Generally, the release of willow and cottonwood seeds coincides

with peak seasonal flows. The lack of a seed bank for many other species, such as native forbs, may be a legacy effect from Arundo being the dominant species in the area for so long. Over time, we expect that native plant recruitment will occur from adjacent populations as Arundo is eliminated from the area. Active seeding may also be needed to augment natural processes if native cover is not established rapidly enough over the project period.

Vegetation monitoring

Vegetation analysis and photo documentation are being used to assess the progress of revegetation in the project area. Eight monitoring (sampling) points were established throughout the site in December 2012 as shown in Figure 1. During each sampling event, vegetation along a 50 meter permanent line transect is analyzed at each point. Plant cover in five meter intervals is recorded along the transect line. Sampling does not occur in a five meter buffer between the property boundary and the beginning of the first interval, and between each sampling interval. Absolute percent cover of native and non-native plants is determined using the point-intercept method. Species richness is also being recorded over the project period.

Arundo and native plant cover was measured in September 2012 before work began to provide a baseline for evaluating project progress. Arundo comprised approximately 91% of the plant cover in the restoration area at that time. Willows (*Salix* spp.), cottonwoods (*Populus* spp.), and black walnuts (*Juglans californica*) were the most abundant native plants and contributed an average cover of 9%. Plant species identified during the pre-project surveys are listed in Table 1. Only native trees growing above the Arundo stands had extensive canopies. Crown depth of native trees was markedly suppressed when mixed with Arundo, and was most likely caused by competition and decreased light intensity. Black walnut was the only sensitive plant species identified in the project area and all trees were marked with orange flagging tape to enable the machine operator to visualize and avoid the plants while mowing.

Vegetation transects in the Arundo removal area were analyzed on 2 May 2013 after the first herbicide treatment, and again on 16 September 2013 before the second herbicide treatment.

In May, Arundo was the most abundant species in terms of number of individual stems and total cover (Table 2). However, cover was substantially reduced by mowing and herbicide application compared with pre-restoration conditions. Percent cover of other plant species encountered during the transect analysis is listed in Table 2. The sprayed Arundo resprouts were stunted and showed signs of herbicide-induced mortality, including yellowing leaf tissue, dead apical meristems, reduced stem height, and plant mortality. Although only seven plant species were detected along transect lines, a total of 21 native plant species and four non-native species were observed during monitoring events (Table 3). There has been a noticeable increase in volume (or recovery) of native trees within the Arundo removal area – this trend should continue and will be evident in future evaluations of percent cover. By the end of May, all sprayed stems were dead. However, by mid-June, Arundo resprouted vigorously.

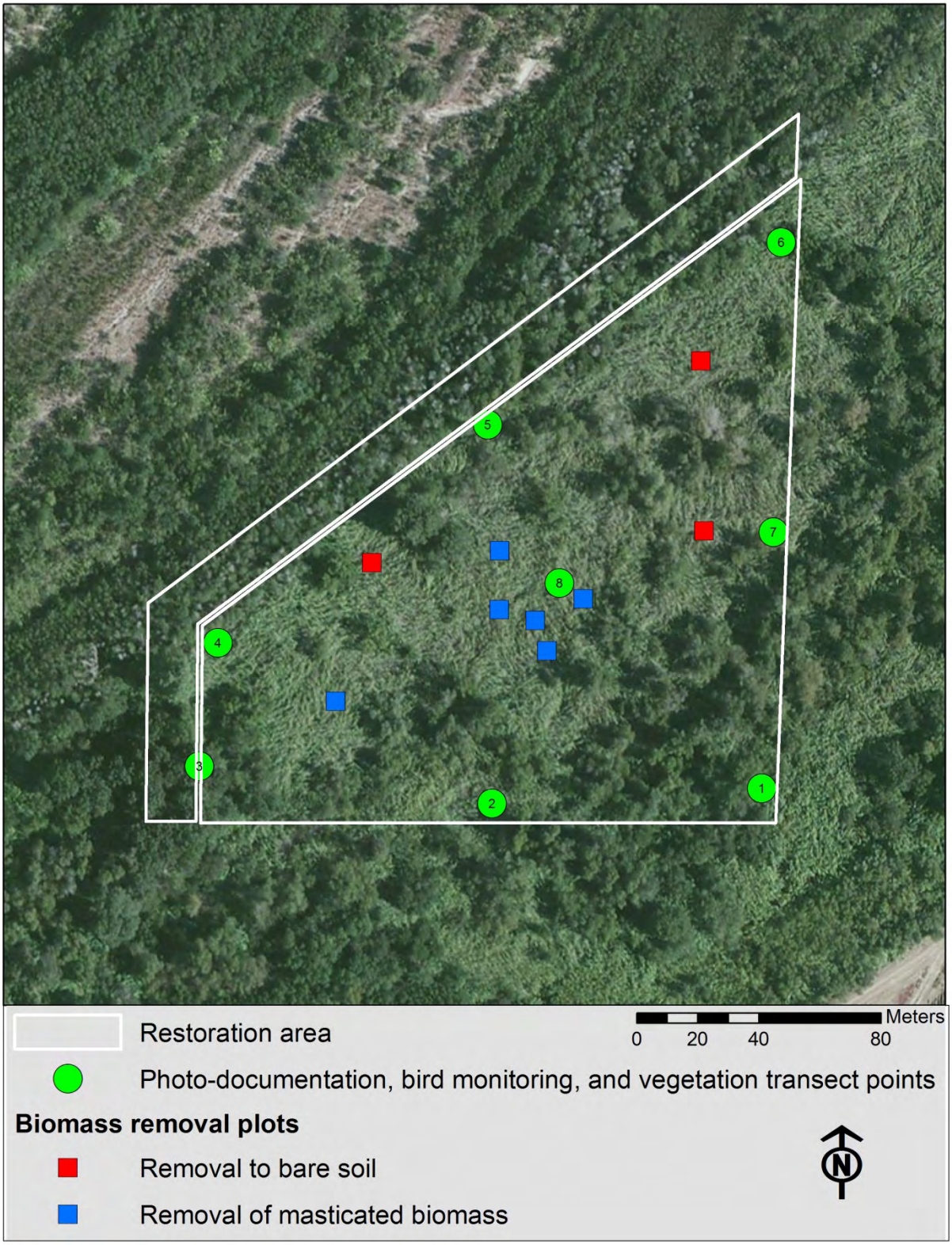

Figure 1. Restoration area at the Taylor property, and monitoring and experimental plot locations.

Table 1. Plant species observed in the project site prior to start of restoration project.

Scientific Name	Common name
Native	
Baccharis salicifolia	mulefat
Juglans californica	black walnut
Platanus racemosa	western sycamore
Populus fremontii	Fremont cottonwood
Populus trichocarpa	black cottonwood
Rubus ursinus	California blackberry
Salix exigua	sandbar willow
Salix laevigata	red willow
Salix lasiolepis	arroyo willow
Salix lucida	shining willow
Toxicodendron diversilobum	poison oak
Urtica dioica	stinging nettle
Non-native	
Arundo donax	Arundo; giant reed
Helminthotheca echioides	bristly ox-tongue
Lactuca serriola	prickly lettuce
Phoenix canariensis	date palm
Sonchus arvensis	field sowthistle
Washingtonia robusta	Mexican fan palm

Vegetation transects were analyzed on 16 September 2013 as part of the annual survey and to document conditions before the late summer herbicide application occurred. Percent cover estimates for this survey are provided in Table 2. Overall, Arundo cover increased slightly in the project area since the May vegetation survey, but varied across monitoring points. Arundo cover was very low in most shaded areas where native overstory trees were dominant. However, Arundo cover and stem densities were greater in sunny areas where it grew in monoculture. Shading causes reduced allocation to belowground plant tissues in Arundo (Lambert et al. 2013), which most likely reduces its ability to resprout due to lower energy reserves. Systemic herbicides, like glyphosate, that target root and rhizome systems may be more effective in low light environments when the plant has fewer energy reserves in those tissues. Black walnut, blackberry (*Rubus californica*), and poison oak (*Toxicodendron diversilobum*) seedlings were also abundant throughout the site and should substantially increase in cover as the project progresses. Native plant cover did increase slightly from the May sampling event (Table 2).

A second herbicide treatment occurred on 17-20 September 2013. The site was visited on 15 October 2013 and the second herbicide treatment appeared to be very effective at that time with all stems showing significant dieback (see photos in Appendix A).

Table 2. Percent cover of plant species recorded along transects in the restoration area.

Scientifc name	Common name	Percent cover ± Standard deviation
2 May 2013		
Arundo donax	arundo; giant reed	13.6 ± 8.9
Populus trichocarpa	black cottonwood	4.2 ± 11.2
Rubus ursinus	blackberry	0.4 ± 0.9
Salix laevigata	red willow	12.4 ± 12.8
Sonchus oleraceus	common sowthistle	0.6 ± 1.5
Toxicodendron diversilobum	poison oak	1.5 ± 4.1
16 September 2013		
Arundo donax	arundo; giant reed	12.7 ± 10.0
Juglans californica	black walnut	0.1 ± 0.2
Populus trichocarpa	black cottonwood	4.2 ± 11.2
Rubus ursinus	blackberry	1.5 ± 1.6
Salix laevigata	red willow	13.7 ± 13.6
Sonchus oleraceus	common sowthistle	0.1 ± 0.2
Toxicodendron diversilobum	poison oak	1.8 ± 4.1

Table 3. Plant species observed in the project site during the first year.

Scientific Name	Common name
Native	
Artemisia douglasiana	mugwort
Azola filiculoides	Pacific mosquito fern
Baccharis salicifolia	mulefat
Juglans california	black walnut
Lemna sp.	duckweed
Platanus racemosa	western sycamore
Pluchea odorata	salt marsh fleabane
Populus fremontii	Fremont cottonwood
Populus trichocarpa	black cottonwood
Rosa californica	California rose
Rubus ursinus	California blackberry
Salix exigua	sandbar willow
Salix laevigata	red willow
Salix lasiolepis	arroyo willow
Salix lucida	shining willow
Stachys ajugoides	ridge hedge-nettle

Scientific Name	Common name
Toxicodendron diversilobum	poison oak
Typha latifolia	common cattail
Urtica dioica	stinging nettle
Verbena sp.	Unidentified
Xanthium strumarium	cocklebur
Non-native	
Arundo donax	giant reed
Lactuca serriola	prickly lettuce
Ricinus communis	castor bean
Sonchus arvensis	field sowthistle
Helminthotheca echioides	bristly oxtongue

Herbicide treatments

An objective of this restoration project is to test methods for increasing herbicide effectiveness in controlling Arundo, reducing herbicide use, and increasing cost effectiveness. Several herbicide mixture and concentration treatments were used to 1) determine if dosage could be decreased in an effort to reduce the amount of pesticide being released into the environment and 2) determine if two aquatic herbicides (glyphosate and imazapyr) that have different modes of action are more effective in concert than traditional methods (one herbicide alone). During April, three herbicide treatments were applied to the site: 1) the northern portion of the site (north of photopoint 8 in Figure 1) was sprayed with a mix of 1% imazapyr/1% glyphosate, 2) the southern portion was sprayed with 1.5% imazapyr, and 3) a 0.5 acre plot within the site was left untreated as a control. A glyphosate only treatment was not used because it is virtually ineffective in the spring and data are available on its effectiveness for Arundo control.

Both herbicide treatments significantly reduced stem height and density compared with the no herbicide control, but there was no significant difference in effectiveness between herbicide treatments. Resprouting (new stems) of Arundo was also similar between herbicide treatments. These results suggest that early season control is equally effective using imazapyr alone as it is with the two herbicides combined. Imazapyr is more expensive than glyphosate, but can be applied at lower rates and fewer re-applications are needed, so is a viable alternative to glyphosate for spring applications (when glyphosate is virtually ineffective). These results also indicate that it is not necessary to use both herbicides at this time of year. Other studies have shown imazapyr to be less effective in the fall (Spencer et al. 2009). Further studies should evaluate the effectiveness of fall treatments using these herbicides alone and in combination.

Biomass removal

There is some concern that leaving masticated Arundo biomass in place may inhibit establishment of native plants. To determine the effects of masticated Arundo mulch on native plant recruitment, two biomass removal treatments were established using 2 x 2 meter plots. In six plots, all masticated Arundo from the current project was removed (old litter from before

project implementation was left in place). Three additional plots, where all biomass was removed, were established in areas where the mower scraped down to the soil surface during work. Each treatment plot was paired with a control plot where all biomass was left in place. Arundo regrowth and establishment of other plants were evaluated in May and August 2013.

There was no difference in the number of Arundo resprouts between the treatment or control plots at either sampling date. However, there was a significant difference in plant establishment between the complete biomass removal treatment and the treatments where some or all biomass/litter was left in place. Only the complete removal plots had establishment of plant species other than Arundo. However only two of these species, *Pluchea odorata* and *Conyza canadensis*, were native. Weed species found in the plots included *Sonchus oleraceus*, *Ricinus communis*, *Lactuca serriola*, and *Helminthotheca echioides*. It is still early in the project period to determine the true effect of the biomass removal treatments, and plots will continue to be monitored over the next four years.

Wildlife monitoring

Assessment of wildlife populations is not required by the permit, however, evaluating wildlife use of restoration areas is essential to determine project effectiveness and is being conducted on a voluntary basis. Wildlife monitoring has focused primarily on bird diversity and abundance, but arthropod, amphibian, and reptile diversity will be evaluated as funding becomes available. Six bird species and 13 individuals were observed during a pre-project survey on 13 November 2012, and all were non-migratory species (Table 4). No sensitive animal species were detected during the pre-project survey. The initial non-native plant removal work began well outside of bird breeding season, so bird abundance was very low at this time of year. Bird abundance was also likely low because of the presence of Arundo, which provides poor habitat. A bird survey, separate from this project, which has been ongoing in and around the Arundo removal area for at least three years has shown that there is very little use of this habitat by birds (D. Orr, personal communication). Further, no nests have been detected in the Arundo monoculture in the three years prior to project initiation.

Table 4. Bird species observed within and in the immediate vicinity of the project site during a pre-project survey on 13 November 2012.

Scientific name	Common name	Number of individuals	Habitat
Buteo jamaicensis	red-tailed hawk	1	flyover
Catharus guttatus	hermit thrush	1	willow forest
Picoides pubescens	downy woodpecker	2	willow swamp/spring
Picoides villosus	hairy woodpecker	1	willow swamp/spring
Sayornis nigricans	black phoebe	7	willow-cottonwood forest, edge habitat
Carpodacus mexicanus	house finch	1	willow forest, edge habitat

Three woodrat (*Neotoma* sp.) nests were found in the removal area, however, it was not possible to determine the species or if the nests were active. The nests were marked and all efforts were made to avoid damaging them during work.

Spring bird survey

A bird survey was conducted on 28 May 2013 to evaluate species diversity and track changes as restoration progresses. Ten minutes was spent at each of eight monitoring locations to collect visual and auditory evidence of bird presence and use in and immediately adjacent to the restoration area. Twenty seven species and 126 individuals were identified. Many of the species observed use open and riparian forest habitats (Table 5). Arundo removal has created a large, open meadow with scattered native trees, which most likely promoted bird use of the area for foraging. We expect bird diversity to change (and most likely increase) as native plants recruit to and grow in this area.

Future actions

Hand removal of Arundo using cut and daub methods will continue throughout the fall and winter, and spot treatments of resprouts will occur as necessary during the Spring 2014 growing season. The project area will be surveyed to identify potential areas where active revegetation could occur during Winter 2013-2014.

Table 5. Bird species observed within and in the immediate vicinity of the project site during a pre-project survey on 28 May 2013.

Scientific Name	Common Name	# Detected	Evidence of Breeding (within 100 m buffer of property)
Ardea herodias	Great Blue Heron	1	seen/heard only
Buteo lineatus	Red-shouldered Hawk	1	seen/heard only
Calypte anna	Anna's Hummingbird	1	courtship display
Carduelis psaltria	Lesser Goldfinch	7	seen/heard only
Carpodactus mexicanus	House Finch	11	seen/heard only
Colaptes auratus	Northern Flicker	1	seen/heard only
Corvus corax	Common Raven	1	seen/heard only
Dendroica petechial	Yellow Warbler	3	singing
Geothlypis trichas	Common Yellowthroat	8	food carry
Icteria virens	Yellow-breasted Chat	2	singing
Melospiza melodia	Song Sparrow	7	singing
Myiarchus cinerascens	Ash-throated Flycatcher	1	singing
Passerina caerulea	Blue Grosbeak	1	singing
Pheucticus melanocephalus	Black-headed Grosbeak	2	singing
Picoides villosus	Hairy Woodpecker	3	seen/heard only
Pipilo crissalis	California Towhee	4	courtship display/pair
Pipilo masculatus	Spotted Towhee	8	singing
Psaltriparus minimus	Bushtit	37	seen/heard only
Sayornis nigricans	Say's Phoebe	1	seen/heard only
Tachycineta bicolor	Tree Swallow	6	seen/heard only
Tachycineta thalassina	Violet-green Swallow	2	seen/heard only
Thryomanes bewickii	Bewick's Wren	3	agitated behavior
Troglodytes aedon	House Wren	3	singing
Vermivora celata	Orange-crowned Warbler	6	singing
Vireo bellii	Bell's Vireo	1	singing
Vireo huttoni	Hutton's Vireo	3	singing
Zenaida macroura	Mourning Dove	2	seen/heard only

References

Bell, G. P. 1997. Ecology and management of *Arundo donax,* and approaches To riparian habitat restoration in southern California. Pages 103-113 *in* J. H. Brock, M. Wade, P. Pysek, and D. Green, editors. Plant Invasions: Studies from North America and Europe. Blackhuys Publishers, Leiden, The Netherlands.

Lambert, A. M., T. L. Dudley, and J. Robbins. 2013. Nutrient enrichment and soil conditions drive productivity in the large-statured invasive grass *Arundo donax*. Aquatic Botany.

Spencer, D. F., W. Tan, P.-S. Liow, G. G. Ksander, and L. C. Whitehand. 2009. Evaluation of a late summer imazapyr treatment for managing giant reed (*Arundo donax*). Journal of Aquatic Plant Management **47**:40-43.

Stella, J. C., J. J. Battles, B. K. Orr, and J. R. McBride. 2006. Synchrony of seed dispersal, hydrology and local climate in a semi-arid river reach in California. Ecosystems **9**:1200-1214.

Appendix B. TNC Taylor property soil sample data.

Sample Number	Mass (g)	Volume (mL)	Latitude	Longitude	Species germinated 21 February 2013	Species germinated 21 March 2013	Species germinated 21 April 2013
1	689	850	34.36475	-118.9919	none	none	none
2	582	1000	34.36478	-118.9919	none	none	none
3	248	550	34.3651	-118.9920	*Helminthotheca echioides* (2)	*Helminthotheca echioides* (2)	*Helminthotheca echioides* (2)
4	265	450	34.3652	-118.9915	none	none	none
5	541	700	34.3655	-118.9914	none	none	none
6	506	600	34.3657	-118.9913	none	none	none
7	176	400	34.3657	-118.9907	none	none	none
8	343	500	34.3652	-118.9911	*Helminthotheca echioides* (8), *Lactuca serriola* (2)	*Helminthotheca echioides* (8), *Lactuca serriola* (2)	*Helminthotheca echioides* (8), *Lactuca serriola* (2)
9	331	600	34.3648	-118.9913	none	none	none
10	120	300	34.3648	-118.9917	none	none	none
11	347	450	34.3644	-118.9921	none	none	none
12	891	1100	34.3645	-118.9925	none	none	none
13	279	400	34.3642	-118.9917	none	none	none
14	935	1150	34.3644	-118.9930	none	none	none
15	738	1000	34.3647	-118.9929	none	none	none

APPENDIX A. Photos of the restoration site showing project progress.

Near Photopoint 1 before mowing began. November 16, 2012.

Mowing began on November 16, 2012.

Mowing in western side of property November 23, 2012.

Mowing continued in western side of property. Note arundo removal from around tree. Compare with previous photo.

Arundo mowing completed the first week of December 2012.

Artesian springs along the work areas western boundary are now visible after arundo removal.

Black walnut (*Juglans californica*) seedlings are abundant in the site.

Arundo resprouts were treated with herbicide April 15-19, 2013.

APPENDIX A. Photos of the restoration site showing project progress.

Arundo resprouts two weeks after herbicide application. May 2, 2013.

Arundo resprouts in biomass removal plot two weeks after herbicide application. May 2, 2013.

Arundo resprouts one month after herbicide application. May 16, 2013.

Arundo resprouts in untreated control area. May 16, 2013.

Regrowth was again treated September 16-20, 2013.

Results of herbicide retreatment. Observed on October 15, 2013.

APPENDIX A. Photos of the restoration site showing project progress.

Photopoint 1a. Facing northwest. January 9, 2013.

Photopoint 1a. Facing northwest. April 15, 2013.

Photopoint 1a. Facing northwest. September 16, 2013.

Photopoint 1a. Facing northwest. October 15, 2013.

Photopoint 1b. Facing north. January 9, 2013.

Photopoint 1b. Facing north. April 15, 2013.

Photopoint 1b. Facing north. September 16, 2013.

Photopoint 1b. Facing north. October 15, 2013.

APPENDIX A. Photos of the restoration site showing project progress.


Photopoint 2a. Facing north. January 9, 2013.


Photopoint 2a. Facing north. April 15, 2013.


Photopoint 2a. Facing north. September 16, 2013.


Photopoint 2a. Facing north. October 15, 2013.


Photopoint 2b. Facing east January 9, 2013.


Photopoint 2b. Facing east April 15, 2013.


Photopoint 2b. Facing east. September 16, 2013.


Photopoint 2b. Facing east. October 15, 2013.

APPENDIX A. Photos of the restoration site showing project progress.

Photopoint 3a. Facing north. January 9, 2013.

Photopoint 3a. Facing north. April 15, 2013.

Photopoint 3a. Facing north. September 16, 2013.

Photopoint 3a. Facing north. October 15, 2013.

Photopoint 3b. Facing east. January 9, 2013.

Photopoint 3b. Facing east. April 15, 2013.

Photopoint 3b. Facing east. September 16, 2013.

Photopoint 3b. Facing east. October 15, 2013.

APPENDIX A. Photos of the restoration site showing project progress.

Photopoint 4a. Facing northeast. January 9, 2013.

Photopoint 4a. Facing northeast. April 15, 2013.

Photopoint 4a. Facing northeast. September 16, 2013.

Photopoint 4a. Facing northeast. October 15, 2013.

Photopoint 4b. Facing southeast. January 9, 2013.

Photopoint 4b. Facing southeast. April 15, 2013.

Photopoint 4b. Facing southeast. September 16, 2013.

Photopoint 4b. Facing southeast. October 15, 2013.

APPENDIX A. Photos of the restoration site showing project progress.


Photopoint 5a. Facing northeast. January 9, 2013.


Photopoint 5a. Facing northeast. April 15, 2013.


Photopoint 5a. Facing northeast. September 16, 2013.


Photopoint 5a. Facing northeast. October 15, 2013.


Photopoint 5b. Facing southwest. January 9, 2013.


Photopoint 5b. Facing southwest. April 15, 2013.


Photopoint 5b. Facing southwest. September 16, 2013.


Photopoint 5b. Facing southwest. October 15, 2013.

APPENDIX A. Photos of the restoration site showing project progress.


Photopoint 6a. Facing south. January 9, 2013.


Photopoint 6a. Facing south. April 15, 2013.


Photopoint 6a. Facing south. September 16, 2013.


Photopoint 6a. Facing south. October 15, 2013.


Photopoint 7a. Facing west. January 9, 2013.


Photopoint 7a. Facing west. April 15, 2013.


Photopoint 7a. Facing west. September 16, 2013.


Photopoint 7a. Facing west. October 15, 2013.

APPENDIX A. Photos of the restoration site showing project progress.

Photopoint 7b. Facing south. January 9, 2013.

Photopoint 7b. Facing south. April 15, 2013.

Photopoint 7b. Facing south. September 16, 2013.

Photopoint 7b. Facing south. October 15, 2013.

Photopoint 8a. Facing north. January 9, 2013.

Photopoint 8a. Facing north. April 15, 2013.

Photopoint 8a. Facing north. September 16, 2013.

Photopoint 8a. Facing north. October 15, 2013.