VENTURA COUNTY WATERSHED PROTECTION DISTRICT

Ventura River Arundo Removal Demonstration Project

Final Implementation Report

Project No. 81042



August 2007

1.0 INTRODUCTION

Giant cane (*Arundo donax*) is an invasive, non-native plant that has expanded into numerous California streams, including the Ventura River. By spreading via rhizomes and small stem sections carried during floods, growing rapidly, effectively competing for limited moisture supplies (depleting groundwater supplies in the process), and shading adjacent plants, giant cane has overtaken native riparian vegetation along much of the Ventura River. In addition, because this species does not support native insects, its presence indicates a decreased food supply for local wildlife. Although it grows densely, its shallow root system is undermined during floods, resulting in bank erosion. The uprooted biomass increases flood hazards by clogging downstream culverts and bridges. Giant cane also burns much more readily than native trees such as willows and cottonwoods. Consequently, riparian areas that were once relatively safe from fires are now subject to repeated fire damage. Burned native vegetation is often smothered by giant cane, which quickly resprouts and spreads following fires.

Removal of giant cane is vital to improving the quality of the Ventura River watershed, which supports a variety of threatened, endangered, and other sensitive species, among them the federal listed threatened southern California steelhead population. However, many Ventura County residents are not convinced of the need to remove giant cane from their properties, especially if it involves herbicide use.

To improve public support for future watershed-wide giant cane removal, the Ventura County Arundo Task Force (ATF) designed the Ventura River *Arundo* Removal Demonstration Project (project). The project evaluates the cost-effectiveness of four different methods of giant cane removal on a relatively small (5-acre) site easily accessible to the public. This work was administered by the Ventura County Watershed Protection District. The project also tests three different methods of native plant installation in areas cleared of giant cane. The Natural Resources Conservation Service performed this work at a different site. Project data provide critical information for the planning and implementation of future giant cane removal projects in all Ventura County watersheds.

The ATF is a consortium of federal, state and local agencies, publicly elected officials, and public and private interest groups formed to address issues associated with reducing or eliminating giant cane infestations. Its mission includes providing technical and monetary assistance for giant cane removal efforts. The Ventura County Resource Conservation District (RCD) chairs the ATF, acting as the repository and accountant for ATF funds. For this project, the RCD received and disbursed a Wetlands Recovery Project (WRP) grant awarded by the California Coastal Conservancy (CCC). The California Department of Fish and Game (CDFG), Natural Resources Conservation Service (NRCS), and Ventura County Watershed Protection District (District), all of which are ATF

members, also contributed funding for the project. In addition, the City of San Buenaventura and the District allowed the project to be conducted on their properties.

2.0 CEQA AND REGULATORY PERMIT COMPLIANCE

For the purposes of California Environmental Quality Act (CEQA) compliance for the project, the District assumed the lead agency role. An Environmental Impact Report (EIR) was prepared and certified by the Board of Supervisors on September 9, 2003. The District filed a Notice of Determination with the Ventura County Clerk and the State Clearinghouse on September 10, 2003. Project impacts to biological resources, water resources, air quality, and transportation/circulation were mitigated below a level of significance. Despite mitigation, temporary noise impacts could not be reduced below significant levels.

Under sections 404 and 401 of the Clean Water Act, the U.S. Army Corps of Engineers (USACE) and Los Angeles Regional Water Quality Control Board (LARWQCB) have jurisdiction over wetlands exhibiting hydrophytic vegetation, wetland hydrology, and hydric soils as well as non-wetland waters of the U.S. in the stream bottom up to the ordinary high water mark. The CDFG has jurisdiction over the bed, bank, and channel of the affected portion of the Ventura River. Permits obtained to complete the project are listed in Table 1. This report has been prepared in compliance with monitoring and reporting requirements set forth in the permits.

Agency	Permit	Permit No.
USACE	Section 404 Regional General Permit No. 41	2003-00971-MWV
LARWQCB	Section 401 Water Quality Certification	03-111
CDFG	Streambed Alteration Agreement	1600-2003-5050-R5

 Table 1. Regulatory Permit Summary

3.0 GIANT CANE REMOVAL

The project site is located adjacent to the east flood control levee within the Ventura River near the community of Casitas Springs (see site map in Attachment A-1). The 5-acre site is approximately 4,500 feet long and 50 feet wide. The contract for this project was awarded to ProTec Engineering. Work began September 1, 2004 and was completed on October 13, 2004 (see photos in Attachment B). A District inspector was on site at all times to ensure compliance with removal techniques and regulatory permit conditions. The site was divided into four sections, each of which received a different giant cane removal prescription to test the cost and efficacy of each method.

All removal activities were completed mechanically using hand held equipment. A small Bobcat was used to transport cut material from the stream bottom to the staging area; the Bobcat performed no excavation work. Giant cane removed included any cane attached to existing sub-surface root mass, both living and/or dead. Unattached cane and native vegetation were not removed from the project site. Cut cane was stockpiled in a designated staging area and chipped to no greater than 4 inches in length. Chips were spread within the staging area at a minimum depth of 6 inches, and no greater than 12 inches.

3.1 Method 1

This removal method involved cutting giant cane stems approximately 6 inches above ground level using hand held equipment such as loppers, chain saws, and power brush cutters. Aquamaster®, a glyphosate-based herbicide, was "painted" onto the cut surface of each stem within two minutes of cutting. A dye was added to the herbicide to track its application, but no surfactant was used. The herbicide was applied at a concentration of 100 percent volume-to-volume (v/v). The total area treated by this method was 0.5 acre.

3.2 Method 2

Giant cane treatment under Method 2 consisted of foliar spray application of Aquamaster® herbicide (1.5 percent v/v) mixed with Pro-Spreader® surfactant and dye. A truck-mounted boom and bucket were used for access to all portions of the cane, which can reach heights of over 20 feet. To minimize possible drift to adjacent native vegetation, herbicide was applied in a downward motion and when winds did not exceed 4 miles per hour. On most days the herbicide was applied before noon, avoiding onshore winds that typically develop in Ventura County each afternoon. Following treatment, the biomass was left in place. Dead biomass was cut using hand held equipment and removed from the site in October 2006. A total of 0.25 acre was treated using Method 2.

3.3 Method 3

This method involved cutting giant cane stems approximately 6 inches above ground level using hand held equipment such as loppers, chain saws, and power brush cutters. Unlike Method 1, however, cut giant cane was permitted to resprout before herbicide was applied. The first herbicide application occurred in October 2006, about 2 years after the giant cane was initially cut. With the exception of the boom, herbicide was applied as described in Method 2. A nearly 4-acre area was treated in this manner.

3.4 Method 4

Method 4 involved removal of all giant cane above-ground biomass and buried root and rhizome mass using only hand-held equipment such as chainsaws, weed-whips with triangular/saw blade attachments, loppers, shovels, picks, and digging bars. A hand-held pneumatic air hammer powered by a generator or aircompressor was also used during root and rhizome removal. Roots and rhizomes were not chipped but instead disposed at a landfill as "destruction loads," avoiding the possibility of spreading giant cane by introducing it into the green waste stream. Mechanical removal of the giant cane biomass was to be followed by monitoring and hand removal of regrowth, if any. This method was applied to a 0.25-acre area.

3.5 Follow-Up Treatments

Initially, the District was to perform quarterly herbicide treatment of re-sprouts within the removal areas for one year (through October 2005). Treatment would then have been reduced to an as-needed basis for the remainder of the seven-year monitoring period. Subsequent herbicide treatments on resprouts were to have been closely documented to determine the rate of resprouting within each removal area.

Unfortunately, within the first quarter after completing the work, Ventura County experienced record rainfall events that triggered severe flooding in the Ventura River and other watersheds. As a direct result of that flooding, much of the project area was scoured by high flows during peak rain events (see photos in Attachment B). Site conditions in the locations of Methods 1 and 2 were largely unaffected, but the river elevation dropped substantially in the location of Method 3. The location of Method 4 was completely scoured of all vegetation. The main channel of the river altered its course during the flooding events and flowed directly against the rock levee, eliminating safe access to the site for over a year.

Follow-up treatment was delayed until October 2006 because of the lack of safe access and because work in flowing waters is prohibited by regulatory permits. Treatments will continue through December 2007. With the exception of the Method 4 area, which required no further work, treatment of resprouting giant cane in October 2006 followed the Method 1 (cut and paint) prescription throughout the project area. Method 2 (foliar herbicide application) was selected as the preferred method for all subsequent treatments through December 2007.

4.0 NATIVE RIPARIAN REVEGETATION

Originally, the NRCS was to install an irrigation system and plant native riparian species on the site in October 2005 to test planting methods and densities. The NRCS would also have routinely maintained the site for approximately four years after revegetation. As a result of the storm damage and altered low flow path, an alternative planting site needed to be identified. The NRCS, therefore, coordinated with the District to plant native cuttings, container stock, and seeds on a portion of a 1.5-acre District mitigation site known as the Tierra Rejada Bridge Exotics Removal Area located in the City of Moorpark (Attachment A-2).

The Tierra Rejada Bridge site was selected because giant cane removal had been conducted in a manner similar to the Ventura River site. Method 3 was used for initial biomass removal. Resprouts were treated according to Method 2 within 100 calendar days of initial removal but after reaching an average maximum height of 18 to 36 inches. The work was completed between September 1 and October 15, 2004 on the infrequently flooded south terrace of the Arroyo Simi. The District has periodically applied herbicide to giant cane resprouts at this site through the present.

The Tierra Rejada site was also chosen because it had space to replicate plots of different treatments. In April 2007, the NRCS established twelve 20-foot by 20-foot test plots on open areas in the west half of the mitigation area (0.11 acre total plot area). Three plots received native seed, three received native plant cuttings, three received native container plants, and three control plots were not planted to track natural plant growth. The District installed and will maintain irrigation for all twelve plots. Experiment results are expected to help landowners and land managers make informed decisions when revegetating following giant cane removal; the NRCS intends to publish its findings in a technical report at a later date. Table 2 lists native species that were planted at the Tierra Rejada site.

Scientific Name	Common Name
Artemisia californica	California sagebrush
Baccharis pilularis	Coyote brush
Baccharis salicifolia	Mule fat
Encelia californica	Bush sunflower
Eriogonum fasciculatum	California buckwheat
Leymus condensatus	Giant wildrye
Populus balsamifera subsp. trichocarpa	Black cottonwood
Quercus agrifolia	Coast live oak
Salix lasiolepis	Arroyo willow
Salvia leucophylla	Purple sage
Sambucus mexicana	Blue elderberry

Table 2. Native Plant Palette for the Tierra Rejada Bridge Mitigation Site

5.0 GIANT CANE TREATMENT RESULTS

5.1 Method 1

The 0.5-acre Method 1 treatment area is located on a slightly elevated river terrace. Based on visual estimates, 65 percent of the Method 1 area was infested with giant cane in October 2004. Two years after initial cut and paint work, approximately 10 percent of the treated giant cane had resprouted, the second lowest amount observed among the four treatment methods (Table 3). Because this treatment area was not substantially adversely affected by floods in 2005, the reduction of giant cane cover is attributed predominantly to the removal effort.

Prescription	Area (acres)	Pre-Project Cover (%)	Proportion of Treated Giant Cane that Resprouted as of October 2006 (%)
Method 1	0.50	65	10
Method 2	0.25	95	25
Method 3	3.75	40	70
Method 4	0.25	2.4	0

Table 3. Giant Cane Cover Estimates*

*With the exception of Method 4, which was measured, percent cover values are based on rough visual estimates only.

Tables 4, 5, and 6 quantify labor hours, costs, and herbicide quantities, respectively, expended during initial giant cane removal. Laborers worked a total of 161.65 hours on the Method 1 treatment area at a cost of \$9,565. The cost does not include purchase of 1.5 gallons of herbicide (all herbicide used on this project was donated). Extrapolated to 100 percent giant cane cover on 1 acre for easier comparison, Method 1 required the second largest expenditure of labor (497.4 hours), funds (\$29,431), and herbicide (4.6 gallons). This expenditure is due to the two-step process of cutting reeds and painting stumps with concentrated herbicide.

Date	Method 1	Method 2	Method 3	Method 4
9/14	43.28			
9/15	97.75			
9/16	20.62	19.5		
9/20		24.5		
9/21		16.3	33.3	
9/22			91.0	
9/23			94.25	
9/24			82.29	
9/27			98.0	
9/28			105.0	
9/29			46.25	27.5
9/30			11.7	15.0
Totals	161.65	60.3	561.79	42.5
Adjusted Totals**	497.4	253.9	374.5	7083.3

Table 4. Labor Hours Expended During Initial Giant Cane Removal*

*Figures do not include labor required to chip giant cane.

**Adjusted Totals reflect hours per acre at 100 percent giant cane cover.

Method 1		Method 2		Method 3		Method 4		
Actual Work: .5	Ac.	Actual Work: .25	5 Ac.	Actual Work: 3.75		Actual Work: .25 Ac.		
Actual Cost: \$9	Actual Cost: \$9,565		Actual Cost: \$4,722		Actual Cost: \$28,005		Actual Cost: \$3,474	
9,565 x 2 = \$ 19,13	9,565 x 2 = \$ 19,130/ Acre		4,722 x 4 = \$18,888/ Acre		28,005 x .27 = \$7,561/ Acre		3,474 x 4 = \$13,896/ Acre	
at 65% Cove	at 65% Cover		at 95% Cover		at 40% Cover		at 2.4% Cover	
Cover	Cost/Ac	Cover	Cost/Ac	Cover	Cost/Ac	Cover	Cost/Ac	
00001	0030710	00001	0030730	00001	0030710	00001	0030710	
65% (Actual)	\$19,130	95% (Actual)	\$18,888	40% (Actual)	\$7,561	2.4% (Actual)	\$13,896	
10%		10%		10%		10%		
10/65 = .15385	\$2,943	10/95 = .10526	\$1,988	10/40 = .25	\$1,890	10/2.4 = 4.16666	\$57,900	
25%		25%		25%		25%		
25/65 = .38461	\$7,358	25/95 = .26316	\$4,971	25/40 = .625	\$4,726	25/2.4 = 10.416666	\$144,750	
50%		50%		50%		50%		
50/65 = .76923	\$14,715	50/95 = .52632	\$9,941	50/40 = 1.25	\$9,451	50/2.4 = 20.83333	\$289,500	
75%		75%		75%		75%		
75/65 = 1.15384	\$22,073	75/95 = .78947	\$14,912	75/40 = 1.875	\$14,177	75/2.4 = 31.25	\$434,250	
90%		90%		90%		90%		
90/65 = 1.38462	\$26,488	90/95 = .94737	\$17,894	90/40 = 2.25	\$17,012	90/2.4 = 37.5	\$521,100	
100%		100%		100%		100%		
100/65 = 1.53846	\$29,431	100/95 = 1.05263	\$19,882	100/40 = 2.5	\$18,903	100/2.4 = 41.66666	\$579,000	

Table 5. Cost of Initial Giant Cane Removal (October 2004) by Method*

*Does not include the cost of herbicide, which was donated.

Treatment Method	Herbicide Usage (gallons)			
	Actual	Adjusted		
		(per acre at 100% density)		
Method 1	1.5	4.6		
0.5 acre at 65% cover				
Method 2*	1.2	5.1		
0.25 acre at 95% cover				
Method 3	0	0		
3.75 acre at 40% cover				
Method 4	0	0		
0.25 acre at 2.4% cover				

 Table 6. Herbicide Usage for Initial Giant Cane Removal Work

*Method 2 included actual application of 0.8 gallon of surfactant (3.4 gallons adjusted).

5.2 Method 2

The 0.25-acre Method 2 treatment area, similar to that described above for Method 1, rests entirely on a slightly elevated river terrace. Giant cane occupied approximately 95 percent of the Method 2 area as of October 2004. At the end of the second year following foliar herbicide application, approximately 25 percent of the treated giant cane had resprouted, the second greatest amount observed among the four treatment methods. Very little resprouting, however, was observed within the first few months after treatment. Some of the cover observed in 2006 may have been plants recruited from materials deposited during the 2005 floods. The Method 2 treatment area was not scoured in 2005, so flooding did not likely contribute significantly to the overall reduction of giant cane cover.

Laborers worked a total of 60.3 hours on the Method 2 treatment area at a cost of \$4,722. A total of 1.2 gallons of herbicide were applied. For an area of 1 acre containing 100 percent giant cane cover, Method 2 treatment would require the lowest amount of labor (253.9 hours) at the second lowest cost (\$19,882). Herbicide application, however, would be greatest (5.1 gallons).

Although it would seem this method should require the least amount of funding since labor use was lowest, two factors increased the cost. First, rental of the boom used during two days of foliar spraying increased costs by several hundred dollars. This equipment was not used in the implementation of any other method. Second, foliar spraying was performed almost exclusively by a licensed pesticide applicator and boom operator, which bill at higher rates than laborers. Laborers performed much of the work for Methods 1, 3, and 4.

5.3 Method 3

Prior to project implementation, approximately one third of the 3.75-acre Method 3 area was situated on a slightly elevated river terrace. The remaining two thirds of this treatment area were located on rocky stream bottom. Approximately 40 percent of the Method 3 treatment area was infested with giant cane in October 2004. Despite some erosion of the terrace and scouring of the stream bottom in this treatment area during the 2005 storm flows, 70 percent of the cut giant cane had resprouted by October 2006. The extent of resprouting far exceeded that observed among the other three treatment areas, which ranged from 0 to 25 percent. It appeared that cutting reeds without applying herbicide failed to hinder regrowth of all cane stalks left on site after the floods.

Laborers worked a total of 561.79 hours on the Method 3 treatment area at a cost of \$28,005. No herbicide was applied because this method simply prescribed cutting giant cane stalks. For an area of 1 acre containing 100 percent giant cane cover, Method 3 treatment would require the second lowest amount of labor (374.5 hours) at the lowest cost (\$18,903). The low expenditure is due to the relatively simple, one-step prescription of cutting reeds.

5.4 Method 4

All of the 0.25-acre Method 4 area was located on river bottom composed of large cobble before project implementation. In October 2004, 2.4 percent of this treatment area was covered with giant cane. During the early 2005 storms, this entire treatment area was scoured, and a new sandbar was deposited on it. Based on visual estimates, giant cane was completely absent from the Method 4 area as of October 2006. As a result, the Method 4 treatment area is the only one that did not require follow-up treatments in 2006 and 2007. While this method appears to have most successfully removed giant cane, it is impossible to determine the extent to which results were affected by flooding.

Laborers worked a total of 42.5 hours on the Method 4 treatment area at a cost of \$3,474. No herbicide was applied because this method consisted only of hand removal of giant cane biomass, including rhizomes. For an area of 1 acre containing 100 percent giant cane cover, Method 4 treatment would require by far the greatest amount of labor (7083.3 hours) at the greatest cost (\$579,000). This high cost is attributed to the extensive labor required to dig out giant cane roots and rhizomes with hand tools.

5.5 Staging Area

All stalks cut from the Method 1, 3, and 4 treatment areas were transported to the project staging area and passed through a chipper. Maximum allowable size of the chipped material was 4 inches, but most was ground into small pieces less than 1 inch long. Chipped material was spread in a thin layer 6 to 12 inches deep over the staging area. Monitoring of the chipped giant cane is ongoing, and

no resprouting has been observed. Additional treatment has therefore been unnecessary.

6.0 PUBLIC OUTREACH AND EDUCATION

Public access to the site is provided by a pedestrian trail located along the Ventura River levee, as well as access points and easements provided by the District. A community center and parking lot are also located within walking distance. The District installed a kiosk near the centrally located adjacent community center. Information about the project was posted there, and brochures (Attachment C) were available for the public to take. The brochures were also provided to ATF members for distribution. Mobile educational exhibits were prepared and set up at conferences and various public events. Presentations have been made to the ATF and to the Ventura County Weed Management Area. A project poster was recently created for display at the kiosk and other public spaces (Attachment C).

7.0 CONCLUSION AND RECOMMENDATIONS

A future watershed-wide giant cane removal program would reduce flood and fire hazards, restore degraded riparian and wetland areas, and improve conditions for native fish and wildlife. This project represents progress toward the watershed-wide program because it has provided important information to residents and landowners, whose cooperation is vital. Despite the flooding encountered during project implementation, this demonstration has yielded practical information that may be applied during future giant cane removal planning in the Ventura River and other watersheds.

Although it required no herbicide and was most effective at eradicating giant cane without need for retreatment, Method 4 was also nearly twenty times more expensive and fourteen times more labor intensive than the next costliest method. Methods 2 and 3 shared similar low costs (the difference in cost was less than \$1,000 per acre), yet Method 2 was substantially more effective than Method 3. Over a two-year period following initial removal and with no subsequent treatments, an estimated 25 percent of treated giant cane resprouted in the Method 2 area as opposed to about 70 percent in the Method 3 area.

Method 1 was more effective than Method 2 (10 versus 25 percent resprouted), and its implementation cost nearly \$10,000 more per acre. Method 2 required about half as much labor as Method 1 because giant cane biomass was left in place. The advantage of Method 1 is that it required half a gallon less herbicide per acre, no surfactant, no additional heavy equipment, and the labor rate was less costly. In Method 1, the licensed pesticide applicator supervised three other persons working at a lower hourly rate, and so contributed fewer high-rate hours to the overall total hours of labor.

The giant cane cut stalks, roots, and rhizomes left in place (Methods 1 - 3) may act as impenetrable barriers to establishment of new plants. This resulted in both positive and negative effects. While other non-native plant species did not establish in these areas, neither did native plants spread into the former giant cane strongholds. Techniques such as drilling through the root mass to plant native riparian pole cuttings may overcome this impediment on future giant cane removal projects without incurring the expense of complete root/rhizome removal. Areas outside the footprint of these former giant cane stands did experience some expansion of native species such as willow (*Salix* spp.) and mule fat (*Baccharis salicifolia*) up to the edge of the giant cane root mass. Mature willow trees appeared to benefit from removal of adjacent giant cane stands by growing more foliage and generally exhibiting more vigor, perhaps due to the reduced competition for water, nutrients, light, and space.

Recommendations provided below are based on the demonstration project data presented in this report.

- Method 1 (cut stalks and paint with herbicide) is an effective approach to removing giant cane. This method may not be ideal for very large project areas or if limited time or funding is available.
- Method 2 (foliar spray application of herbicide) is an effective approach to removing giant cane. Because of the possibility of herbicide drift onto adjacent areas, this method may not be ideal in sensitive situations, for example when threatened or endangered species, standing water, or human-occupied structures are present. Additional precautions such as covering adjacent native vegetation with tarps may also be necessary.
- Method 3 (cut only) is not recommended because it fails to effectively control giant cane. While initial implementation of this method requires expenditure of time and money similar to Methods 1 and 2, the long-term costs and labor would remain static because the giant cane would not die off as it would if herbicide were applied.
- Method 4 (hand removal) is not recommended because of its very extreme cost and labor requirements. In addition, significant soil disturbance is required to dig out roots and rhizomes. Because there is a risk of leaving portions of the root mass in the ground, it may not be as effective as suggested by this study. The floods that scoured this site in 2005 cast doubt on the observed results.
- Regardless of the method chosen, future giant cane removal projects should incorporate several years of monitoring and repeated treatments to ensure successful giant cane eradication.

No further treatments of the giant cane removal areas are planned beyond December 2007 as grant funding will be exhausted by that time. Therefore, this will be the only report prepared for the Ventura River site. The NRCS will prepare future monitoring reports for the revegetation demonstration component located along the Arroyo Simi in Moorpark.

K:\WQ\Environmental Services\Arundo Task Force\Demonstration Project\Implementation Report\2007 Report.doc

12