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**“Restoration of Disturbed Salt Marsh-Upland Transition
in the Tijuana Slough National Wildlife Refuge”**

(Phase 9 – Tijuana River Valley Invasive Plant Control Program)

Final Monitoring Report

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1.0 INTRODUCTION

The goal of this project was to restore and enhance 5 acres (2.02 ha) of degraded salt marsh-upland transition habitat in the Tijuana Slough National Wildlife Refuge. The project started in early 2015. We treated and controlled invasive plants, planted appropriate native shrubs, and conducted continuous vegetation maintenance activities in the site.

This report describes the tasks undertaken and shows the successful establishment of the vegetation in the site.

2.0 THE SITE

The project site is in the northern part of the Tijuana Slough National Wildlife Refuge, near the Visitor’s Center. The vegetation in the site at the start of the project was dominated by annual weeds, particularly chrysanthemum (*Glebionis coronaria*) and various ice plants (*Mesembryanthemum* spp.). It had great potential for restoration and enhancement because it was protected from human disturbance, and surrounded by areas of native High Salt Marsh and Maritime Succulent Scrub.

3.0 THE TASKS

Task 1. PLANS

SWIA was required to map the vegetation in the project area and develop a Planting Plan for the site.

The vegetation mapping was completed in February 2015 by John Boland and Mônica Almeida using a Spectra Precision Epoch 50 GNSS rover. The maps showed the elevations and extents of the various vegetation types in the site (Table 1 and Figure 1). The map also showed the two large areas of Disturbed Uplands (areas of red in Figure 1) that would be the main focus of our restoration efforts.

Table 1. Sizes of the vegetation types in the Project Area.

Vegetation Type	Acres
High Salt Marsh	0.46
High Salt Marsh-Upland Transition	0.75
Maritime Succulent Scrub and Coastal Sage Scrub	2.17
Disturbed Upland (dominated by annual weeds)	1.61
TOTAL ACREAGE	5.00



Figure 1. Map of the northern area of the Tijuana Slough National Wildlife Refuge showing the project site and habitats at the start of the project. The red areas are the parts of the site that were dominated by annual weeds.

The Planting Plan (Boland 2015) was completed and approved in early 2015. The plan called for conducting the planting in two phases with the current funding being used to get the project underway (Phase 1) and later funding and volunteers to complete the project (Phase 2).

The Planting Plan used the nearby native vegetation communities as reference sites and the site elevation data to determine the vegetation goals, and the

densities and species compositions of each part of the project site. The plan called for most of the Disturbed Uplands to be restored to Maritime Succulent Scrub and Coastal Sage Scrub because of their relatively high elevations.

Task 2. MONITORING

SWIA was required to conduct monitoring of the project and the project site. The monitoring was conducted mainly by John Boland, with some assistance from USFWS staff and volunteers.

The vegetation monitoring had three aspects:

a) Overall appearance of the restored site - photos

Photos, taken from ten Photo Points, were used to document the changes in the overall appearance of the project site. The Photo Point sites are shown in the Appendix (Figure A1). At each site, several photos (in a full 360 degrees arc) were taken to capture the appearance of the site and the surrounding area. The photos were taken seven times during the course of the project (Table 2).

b) Detailed examination of vegetation – percent cover measurements

Changes in the structure of the vegetation were documented by monitoring the vegetation along seven 25-meter transects. These transects were chosen in a stratified-random manner in the Disturbed Uplands where the native plants were rare, the invasives were abundant, and the project was to focus its efforts. Along each transect, the percent cover of each species was determined using the line-intercept method. The vegetation survey sites are shown in the Appendix (Transects 1-7 in Figure A2). These main vegetation transects were surveyed four times during the course of the project (Table 2).

In addition, another seven transects were surveyed in August 2016. These transects were chosen in a stratified-random manner outside the Disturbed Uplands. Together the 14 transects covered the entire project area.

c) Survivorship and growth rates of installed plants

The native plants were planted during September and October 2015. In order to determine the success of these plants we followed the growth and survivorship of 125 of them. The labeled plants were in five general areas (A – E) and 25 plants were labeled in each area. Each plant was labeled with an aluminum tag on a wooden stick (Appendix A3). These plants were surveyed six times during the course of the project (Table 2).

Table 2. Monitoring schedule.

	2015												2016											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Monitoring																								
Photos																								
Vegetation																								
Invasives %																								
Plants																								

Task 3. TREATMENT OF INVASIVES and PLANTING OF NATIVES

SWIA treated the invasive plants, laid irrigation lines and planted native plants in the project area. SWIA was assisted by USFWS staff and USFWS staff-trained volunteers.

The site was first prepared by spraying the invasives and clearing the trash and debris. The invasive plant species were sprayed with herbicide in March 2015 and the site was cleaned up in August and September 2015. Volunteers, estuary staff and CDF crews worked to fill a 40 cy dumpster with the abundant concrete, glass and invasive plant debris. All of the site clean-up work was monitored by a State archaeologist.

In preparation for planting, irrigation lines were installed, and holes for the native plants were dug with a Boxer light power machine with an auger attachment in early September 2015 (Figure A4 in the Appendix). Then, during late September and October, more than 2,000 native plants were planted in the project site in accordance with the Planting Plan. The native plants included high salt marsh, maritime succulent scrub and coastal sage scrub species.

Since then the site has been maintained by further spraying of the weeds in February 2016, frequent watering and weeding and cleanup by volunteers and mulching by CDF crews (Figures A5 and A6 in the Appendix). In addition, we found that the plants were being eaten by rabbits and so we installed cones to protect the plants from being grazed (Figures A7 and A8 in the Appendix).

4.0 RESULTS AND DISCUSSION

4.1 Overall appearance of the restored site

The restoration site is now looking much better than it did at the start of the project (Figure 3). The site has many fewer weeds and the native plants that were planted are starting to thrive.



Figure 3. The restoration site from Photo Point 10 in January 2015 (above) and August 2016 (below). In 2015 the vegetation was exclusively invasive plants, whereas in 2016 it was a diverse stand of Maritime Succulent Scrub.

4.2 Detailed examination of vegetation – percent cover measurements

The main transects show that the restoration of the Disturbed Uplands went well. The invasives were successfully treated (Figure 4A) and the native perennials are starting to flourish (Figure 4B). The native species at the start of the project had an average of only 5% cover along the transects and by August 2016 they had an average of 20% cover along the transects.

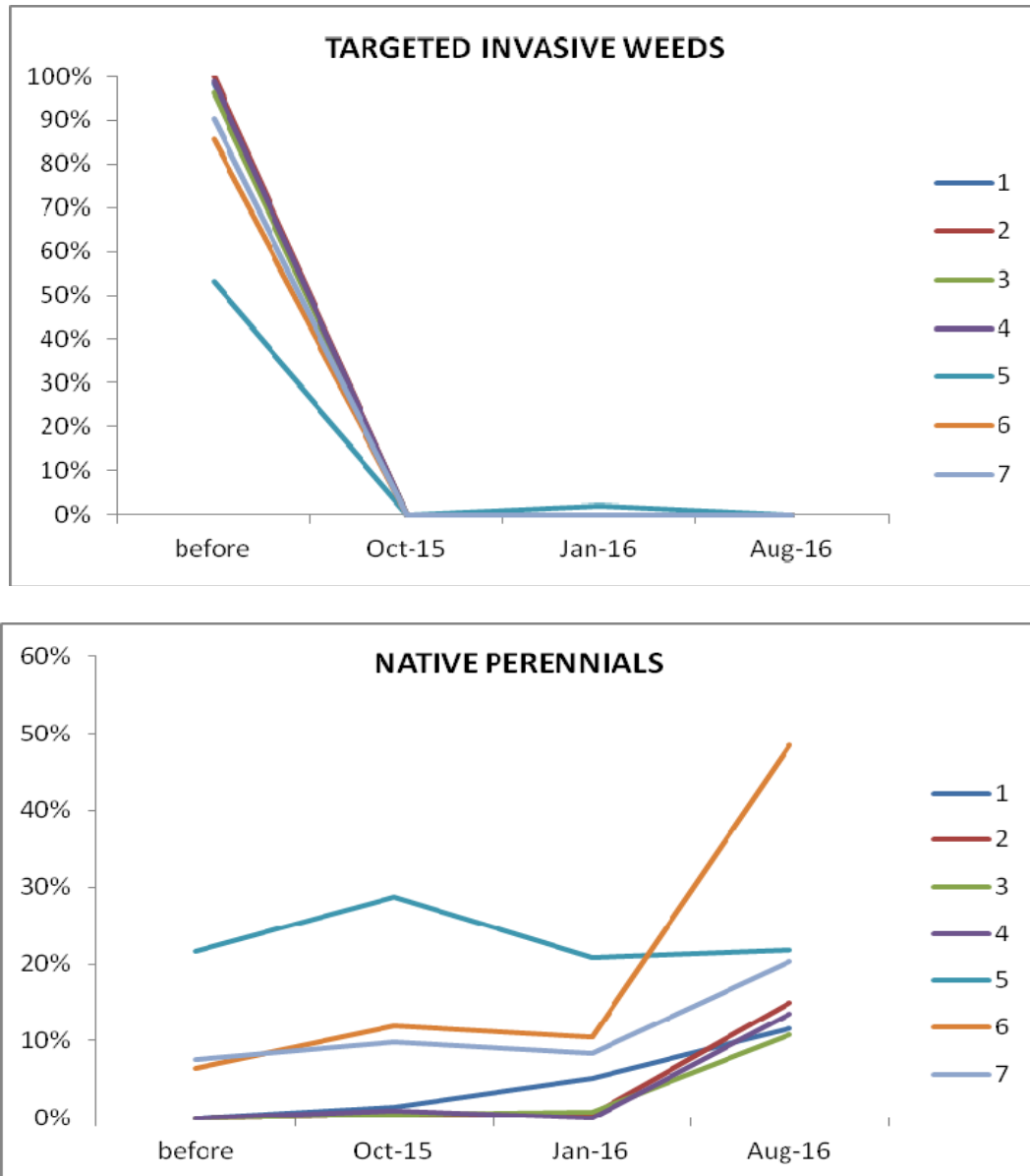


Figure 4. Changes in percent cover of targeted invasives (A) and native perennials (B) along the seven vegetation transects from the start of the project to the present.

The data from all 14 transects, which are scattered throughout the project site, show that the targeted invasive weeds average 3% cover, and the native perennials average 54% cover, across the entire project site (Figures A9 and A10 in the Appendix).

4.3 Survivorship rates and growth rates of installed plants

Survivorship

The early survivorship (October 2015 to May 2016) was poor – only 60% on average (Table 3). But the later survivorship (May 2016 to August 2016 = 90 days) was excellent – 93% on average.

The poor early survivorship was mainly due to rabbit predation. Rabbits fed abundantly at night on the rather small container plants that we had installed in the project site – as shown by a critter cam put out at night (Appendix photos). Once we placed cones around the plants to protect them from rabbits the plants grew tall and robust. We removed most of the cones during spring and summer.

Now the plants we planted in the project site are showing excellent survivorship.

Table 3. The survivorship rates of the labeled plants during the early .

species	SURVIVORSHIP		
	n	Oct '15 to May '16	May '16 to Aug '16
<i>Artemisia californica</i>	35	46%	100%
<i>Eriogonum fasciculatum</i>	42	43%	100%
<i>Isocoma menziesii</i>	14	43%	100%
<i>Lycium californicum</i>	8	63%	100%
<i>Malosma laurina</i>	6	83%	80%
<i>Rhus integrifolia</i>	9	78%	100%
Others	11	64%	71%
TOTAL	125		
AVERAGE		60%	93%

Growth

Most of the container plants have shown good growth during their first year in the ground (Table 4). The average growth rate (increase in height) has been 2.8, i.e., the average plant is now 2.8 times the size it was when it was planted. The average height of the plants is now 65.8 cm, which means that they are substantial shrubs.

In conclusion, the container plants struggled early on but now they are surviving well, growing well, and are likely to be a permanent feature of the vegetation for many years.

Table 4. The heights and growth rates of the labeled plants.

species	AVERAGE HEIGHT (cm)			GROWTH RATE
	Oct '15	May '16	Aug '16	Oct '15 to Aug '16
<i>Artemisia californica</i>	11.0	67.9	82.5	7.5
<i>Eriogonum fasciculatum</i>	10.4	45.9	50.7	4.9
<i>Isocoma menziesii</i>	49.3	64.8	99.4	2.0
<i>Lycium californicum</i>	9.5	27.8	30.0	3.2
<i>Malosma laurina</i>	37.2	45.2	70.5	1.9
<i>Rhus integrifolia</i>	24.4	36.0	53.4	2.2
Others	21.6	55.9	74.4	3.4
AVERAGE	23.3	49.1	65.8	2.8

4.4 Is the project meeting the project goals?

In order to show how the project is progressing the project goals are listed below and each is evaluated.

The specific project goals were:

- a) “to reduce the invasive plants to less than 10% cover throughout.”
The invasives, once abundant, are now relatively rare – averaging only 3% cover throughout. The frequent weeding and occasional spraying is working. The project has **successfully** met this goal.

- b) “to create a natural, native-dominated site where native perennial plants are greater than 50% cover throughout.”
The native perennials, once rare, are now abundant – averaging 54% cover throughout. The perennials that we planted in 2015 are now starting to flourish. The project has **successfully** met this goal.

- c) “install native plants that, by the end of the project (2 years), are well-established, have a 90% survivorship rate and are likely to thrive and expand after the project ends.”
The installed native plants had a 93% survivorship rate during summer 2016. They are now well-established and likely to thrive and expand next year. The project has **successfully** met this goal.

In conclusion, the project has been successful and met its goals.

4.5 Recommendations

SWIA recommends that USFWS continue to maintain and improve the site by:

- Planting more container plants according to the Planting Plan;
- Continuing to irrigate the planted plants as needed; and
- Continuing to spray and weed the annual weeds as needed.

5.0 LITERATURE CITED

Boland, J. 2015. Planting Plan for The Restoration of Disturbed Salt Marsh-Upland Transition in the Tijuana Slough National Wildlife Refuge. Submitted to SWIA. 14 pages.

6.0 APPENDICES