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Annual Report for the Kenai Industrial Park Round-Leaved Chaff Flower (*Achyranthes splendens* var. *rotundata*) Habitat Conservation Plan

Prepared for

CIRI Land Development Company and AKC Leasing Corporation

Submitted to

State of Hawai‘i, Division of Forestry and Wildlife

Prepared by

SWCA Environmental Consultants

Revised October 2015

ANNUAL REPORT FOR THE KENAI INDUSTRIAL PARK ROUND-LEAVED CHAFF FLOWER (*ACHYRANTHES SPLENDENS* VAR. *ROTUNDATA*) HABITAT CONSERVATION PLAN

Prepared for

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1. INTRODUCTION

In February 2014, CIRI Land Development Company received an incidental take license, pursuant to Chapter 195D of the Hawai‘i Revised Statutes, to allow for the incidental take of round-leaved chaff flower (*Achyranthes splendens* var. *rotundata*), a federal- and state-listed endangered species, at the proposed Kenai Industrial Park (KIP) site. To obtain the incidental take license, CIRI developed a habitat conservation plan (HCP) to offset impacts to round-leaved chaff flower individuals that would result from the proposed KIP project by implementing measures that would protect and perpetuate the species as a whole (SWCA Environmental Consultants [SWCA] 2013). The proposed compensatory mitigation measures implemented as a result of the HCP would create new populations of round-leaved chaff flower on the Kalaeloa Unit of the Pearl Harbor National Wildlife Refuge (NWR) from the genetic stock (seeds and cuttings) of the individuals at the KIP project, as well as from an additional nearby seed source.

This annual report describes the activities, observations, and results since implementation of the HCP began at the Kalaeloa Unit in August 2014 until July 31, 2015. During this time period, the mitigation site was prepared, outplants were installed, and maintenance and monitoring occurred as required in the HCP. Informal monitoring occurred during the 120-day establishment period, and more specific monitoring requirements were followed during a total of eight horticultural (qualitative) monitoring events and two botanical (quantitative) monitoring events. Photographic documentation was ongoing during this time. The monitoring program is designed to document mitigation success and to inform the need for remedial and adaptive management measures. Monitoring was led by Project Manager and Botanist Tiffany Bovino Agostini, Botanist Danielle Frohlich, and Field Technician Bryson Luke. All maintenance has been conducted by Hui Kū Maoli Ola and supervised by Project Horticulturalist Matt Schirman.

2. DESCRIPTION OF THE MITIGATION SITE

The KIP mitigation site is on preserved lands at the Kalaeloa Unit of the Pearl Harbor NWR. This site is approximately 3.2 kilometers (2 miles) from the KIP project site. The Kalaeloa Unit was established during Barber Point Naval Air Station base-closure proceedings in 2001 to protect and enhance the habitat for the endangered coastal dryland plants, round-leaved chaff flower, and ‘Ewa Plains ‘akoko (*Euphorbia skottsbergii* var. *skottsbergii*).

The mitigation site is on a dry coastal plan. The Natural Resources Conservation Service (NRCS) classifies soils at the site as Coral Outcrop (Foote et al. 1972). Coral Outcrop includes coral or cemented calcareous sand, with small areas that contain a thin layer of soil material. Kiawe (*Prosopis pallida*), koa haole (*Leucaena leucocephala*), and buffelgrass (*Cenchrus ciliaris*) are the dominant non-native plants within the Kalaeloa Unit. Approximately 10.1 hectares (ha) (25 acres) of the 15.1-ha (937.4-acre) Kalaeloa Unit were under active management within designated work units prior to this mitigation being implemented.

On April 18, 2014, Hui Kū Maoli Ola, SWCA, and the U.S. Fish and Wildlife Service (USFWS) identified four planting plots within the Kalaeloa Unit (Figure 1). Two of the planting plots are in Work Unit 1 and two of the planting plots are in Work Unit 5. These plots did not support round-leaved chaff flower individuals prior to the implementation of the HCP mitigation activities. Each planting plot is approximately 12 × 12 meters (m) (39.5 × 39.5 feet) or 144 m^2 (1,600 square feet).

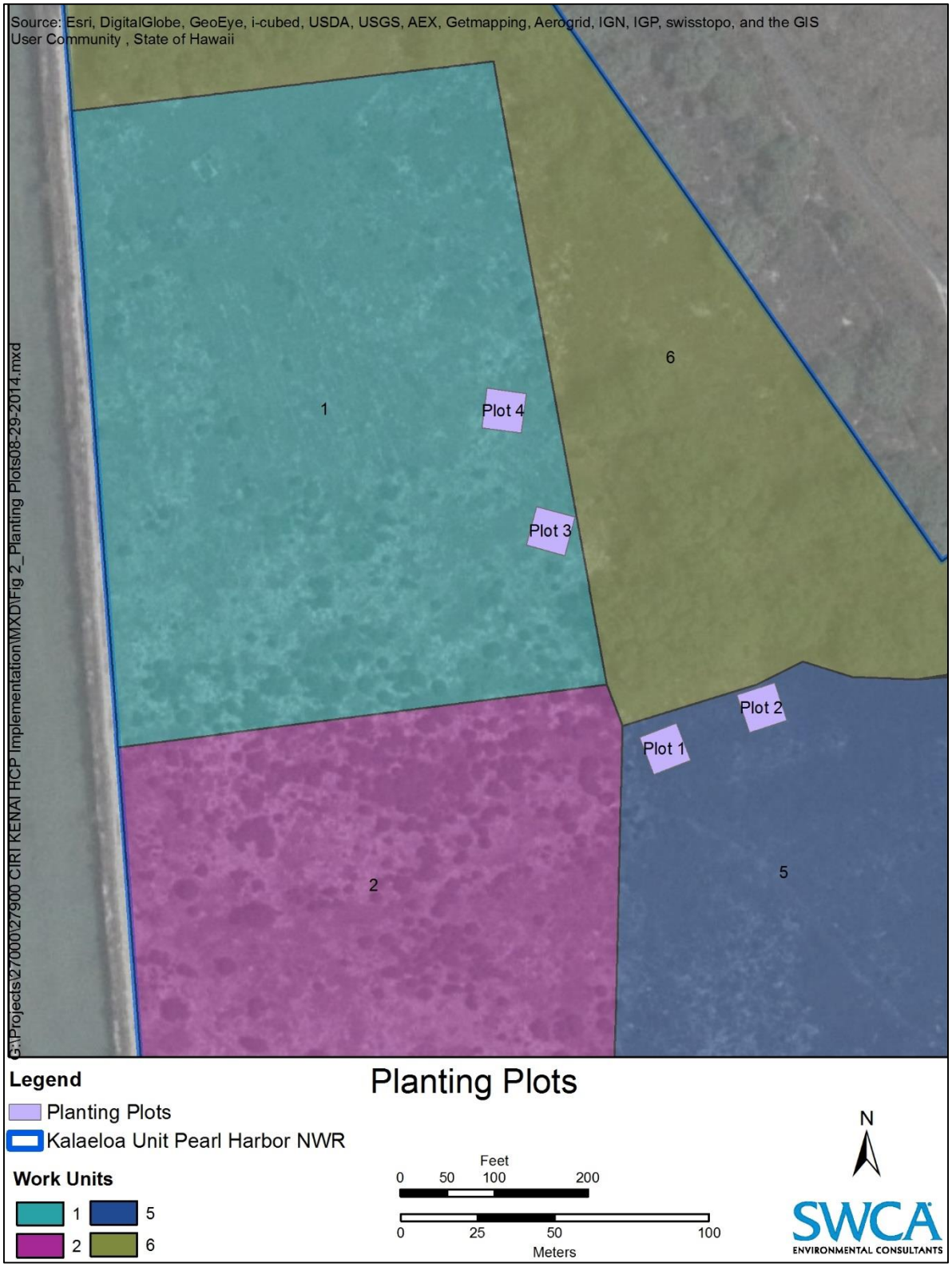

Figure 1. Plots within the mitigation site.

3. METHODS

A timeline for activities associated with implementation of the HCP between August 2014 and the end of July 2015 is summarized in Table 1.

Table 1. Timeline of Mitigation Activities

Activity	Date
Site preparation	08/06/2014–11/25/2014
Installation	11/25/2014; 12/09/2014
120-day establishment period	12/9/2014–4/08/2015
Year 1	04/09/2015–04/08/2016
Horticultural monitoring #1	4/10/2015
Botanical monitoring #1	4/14/2015
Horticultural monitoring #2	4/28/2015
Horticultural monitoring #3	5/15/2015
Horticultural monitoring #4	5/27/2015
Horticultural monitoring #5	6/10/2015
Horticultural monitoring #6	6/25/2015
Horticultural monitoring #7	7/1/2015
Horticultural monitoring #8	7/16/2015
Botanical monitoring #2	7/23/2015

*Data and data analysis from horticultural monitoring #9 and #10 (August 2015) are not included in this report.

3.1. Site Preparation and Installation

In preparation of outplanting activities, Hui Kū Maoli Ola removed all non-native vegetation from the planting plots using a combination of mechanical and chemical treatments. First, all herbaceous vegetation was cut using weed eaters and the biomass was removed from the site. This was followed by irrigation to stimulate growth and germination of the non-native seed bank. A glyphosate herbicide (Aquamaster®) was sprayed inside the plots using a backpack sprayer. Native plants within the plots were avoided as much as possible. A second and third round of spraying was conducted for re-sprouts as well as for new seedlings that germinated from the seed bank. Biomass remaining following chemical treatments was removed. Irrigation was installed for each planting plot following the initial mechanical removal. A low-pressure drip-irrigation with an automatic timer was used.

On November 25, 2014, Hui Kū Maoli Ola outplanted round-leaved chaff flower plants in Plots 1 and 2. Because of concerns with the water source at the NWR, installation of the remaining plants was slightly delayed. Plots 3 and 4 were each planted on December 9, 2014. Each outplant was tagged with a unique number. A letter report notifying the Hawai‘i Division of Forestry and Wildlife (DOFAW) of installation was submitted on December 15, 2014.

3.2. Maintenance Activities

Maintenance activities include weed control, irrigation, pest control, soil amendments, outplant replacement, and outplanting other natives. All maintenance activities were conducted by Hui Kū Maoli Ola under the direction of Project Horticulturalist Matt Schirman. During the 120-day establishment period, Hui Kū Maoli Ola conducted weekly inspections and maintenance for the first 30 days after planting (until January 8, 2015), and biweekly inspections (every 2 weeks) were conducted for the remainder of the 120-day establishment period (Appendix A). During these inspections, the project horticulturist developed a list of items needed to meet the success criteria and oversaw implement. A memorandum detailing the results of the 120-day monitoring activities was submitted to DOFAW on April 17, 2015.

During Year 1, maintenance was conducted twice a month until April 2015, when monthly inspections occurred. However, maintenance increased again in June 2015 due to heavy invertebrate pest presence (see Appendix A). The project horticulturist provided observations and recommendations following each visit, and implemented recommendations as necessary in consideration of the success criteria. Maintenance will continue on (at least) a monthly basis for the remainder of Year 1. Maintenance activities will occur as necessary for 5 years, or until mitigation goals have been met.

3.3. Monitoring

3.3.1. Baseline Monitoring

Baseline monitoring occurred prior to site preparation and installation. The methods for this monitoring are outlined in the *Planting Plan for Kenai Industrial Park Round-leaved Chaff Flower (Achyranthes splendens var. rotundata) Habitat Conservation Plan Mitigation Site* (SWCA 2014).

3.3.2. 120-Day Establishment Period

The establishment period began after plants were installed in the NWR (December 9, 2014) and lasted for 120 days ending on April 8, 2015. During this period, the project horticulturist and crew from Hui Kū Maoli Ola conducted weekly inspections for the first 30 days (until January 8, 2015) and biweekly inspections (every 2 weeks) thereafter. The project horticulturist provided observations and recommendations following each visit, and implemented recommendations as necessary in consideration of the success criteria.

3.3.3. Horticultural Monitoring

After the 120-day establishment period, SWCA implemented horticultural monitoring. Horticultural monitoring is conducted bimonthly during the first 6 months of Year 1 (April 2015–September 2015). The following information is collected during horticultural monitoring:

- *Direct counts of healthy round-leaved chaff flower individuals*: Survival is measured by assessing the presence or absence of living aboveground plant material. Plants are considered living if at least one green leaf or stem is present.
- *Mortality counts of round-leaved chaff flower individuals*: Dead individuals are counted based on the presence or absence of living aboveground plant material. Plants are considered dead if at least no green leaves, stems, or flowers are present.
- *Plant vigor categories*: The following 4 categories are assessed:

  - Dead = No green leaves, stems, or flowers are present.
  - Marginal = Branches have few leaves, or mostly brown or yellow leaves. Plant is severely drought-stressed.
  - Moderate = Branches have at least 50% green leaves, plant is drought-stressed, and plant may have pests or some discoloration on leaves.
  - Healthy = Leaves are all green, branches are mostly leaved, very few to no pests are seen, and plant is not drought-stressed.
- *Phenological stage* (vegetative, reproductive)
- *General description of the status of the plantings*
- *Plant damage from rodents, insects, and other pests:* Invertebrate pest damage is classified as none, minimal, moderate, or fully infested.
- *Threats*
- *List of maintenance requirements*
- *Visual assessment and photographic documentation of native and non-native percentage cover*: Percentage cover estimates and photographs are taken at all four corners of each plot.
- *Visual assessment and chemical analysis of soil conditions*: Using a garden trowel, a single soil sample is collected in each plot from the upper 10 centimeters (4 inches) of the soil profile, or to the maximum depth possible in areas with minimal soil. Roughly 1 cup of soil is placed into a sealable plastic bag, and large stones, sticks, and vegetation are removed from the sample. All samples are taken to the University of Hawai‘i, College of Tropical Agriculture and Human Resources, Agricultural Diagnostic Service Center within 48 hours of collection and analyzed for pH, calcium, magnesium, phosphorus, potassium, and total nitrogen.

Following each horticultural monitoring event, a written memorandum is prepared listing problems (if observed) and recommending remedial measures. These memoranda are sent to Hui Kū Maoli Ola and remedial measures are performed promptly. A letter report identifying maintenance issues and corrective measures is provided to Hui Kū Maoli Ola and DOFAW.

3.3.4. Botanical Monitoring

Botanical monitoring is conducted quarterly during Year 1. The following information is collected:

- *Direct count of round-leaved chaff flower individuals:* Outplanted and naturally recruited individuals are counted. Each individual is documented with a submeter global positioning system (GPS) device and tagged with a unique number. Photographs are taken of each individual.
- *An assessment of natural regeneration*: All seedlings are counted and numbered in order to track their success.
- *A list of plant species found within the planting areas*
- *A list of wildlife species noted within the planting areas*
- *Data analysis from monitoring quadrats*: Per the HCP, each plot was divided into 1 × 1–m (3.3 × 3.3–foot) quadrats (144 quadrats). Ten quadrats were randomly selected in each plot (at least 5 quadrats are required in the HCP [SWCA 2013]). Percentage cover of each plant species is evaluated in each quadrat using PVC reference frames.
- *Site photography from permanent photo-points:* Photographs are taken from the same location time and taken of each monitoring quadrat.
- *List of maintenance requirements*

The data from the botanical monitoring events are included in the annual report submitted to DOFAW.

3.3.5. Photographic Documentation

Permanent photo-points were established before plant installation to document baseline conditions of the mitigation site. Photographs are subsequently taken from the same location each monitoring visit (Appendix B). Photographs are also taken of installation activities and maintenance. Representative photographs of healthy, dead, reproducing, and naturally recruited individuals are taken. During the botanical monitoring, photographs are taken of each individual (identified by given number), as well as of each monitoring quadrat.

4. RESULTS

4.1. Site Preparation and Installation

The mitigation site was prepared for installation by removing non-native species and preparing the soil and topography for plant installation (see section 3.1). Site preparation occurred between August and November 2014. Planting occurred on November 25, 2014, in Plots 1 and 2, and on December 9, 2014, in Plots 3 and 4. A letter report notifying DOFAW of installation was submitted on December 15, 2014.

4.2. Maintenance Activities

To date, maintenance activities have included weed control, irrigation, and pest control. Some level of weed control (by hand pulling) has occurred during each maintenance visit. In addition to general weed control, a 0.6-meter (2-foot) buffer is maintained around each outplant to reduce competition, promote growth, and encourage regeneration.

During the initial 30 days of the 120-day establishment period, watering occurred daily, via an automatic watering system, due to drought conditions. From January 8 until January 29, the plants were watered two times per week. During February 2015, the plants were watered once per week. From March 1, 2015, until the end of the establishment period, watering only occurred as needed, but no more than once per month. Outplants received supplemental watering in June (two times) and July (one time), and will continue to receive supplementary watering as needed during the dry season, but sparingly, because too much watering can result in lush growth, which attracts pests.

Ants, likely longhorned crazy ants (*Paratrechina longicornis*), were observed in the plots. These ants are known to farm scales and mealybugs. A soapy water treatment was initially used to control the pests, but heavy pest damage resulted in the need for chemical treatment (see section 4.3.3). The pesticides Prev-Am and Safari have been applied to control mealybugs and other pests, and treatments will continue until pests do not appear to threat obtaining the success criteria.

A summary of the observations and recommendations from the project horticulturalist's site visits is provided in Appendix A.

4.3. Monitoring

The baseline monitoring activities that occurred in April 2014 are summarized in the planting plan (SWCA 2014). Monitoring results during the 120-day establishment period are summarized in a memorandum submitted to DOFAW on April 17, 2015.

In all, 155 plants were initially installed, and 148 living plants were observed at the end of the 120-day establishment period on April 10, 2015 (Table 2). Three additional individuals were unintentionally planted just outside of Plot 1..

Table 2. Number of Plants Installed and Surviving in the Plots 1–4 Throughout the 120-Day Establishment Period

Plot	Date Installed	Number of Individuals Installed	Number of Individuals Living (04/10/2015)
1	11/25/2014	42	39
2	11/25/2014	49	47
3	12/09/2014	30	30
4	12/09/2014	34	32
Total		**155**	**148**

Eight horticultural monitoring events and two botanical monitoring events have taken place from April through the end of July 2015 (see Table 1). The results are summarized below.

4.3.1. Survival

Of the 155 plants initially installed in December 2014, 139 individuals (89.7%) survived as of the most recent monitoring at the end of July 2015 (Figure 2). In all, 16 plants (or slightly more than 10%) have died since installation.[1]

Survival decreased in all plots over time since the end of the 120-day establishment period. Plot 2 has the highest survival rate (97.9%; 46 living individuals) and Plot 4 has the lowest survival rate (87.5%; 28 individuals), as shown in Table 3.

1 The three additional individuals planted just outside of Plot 1 are living, but are not included in the survival estimates due to difficulties of integrating them in the monitoring.

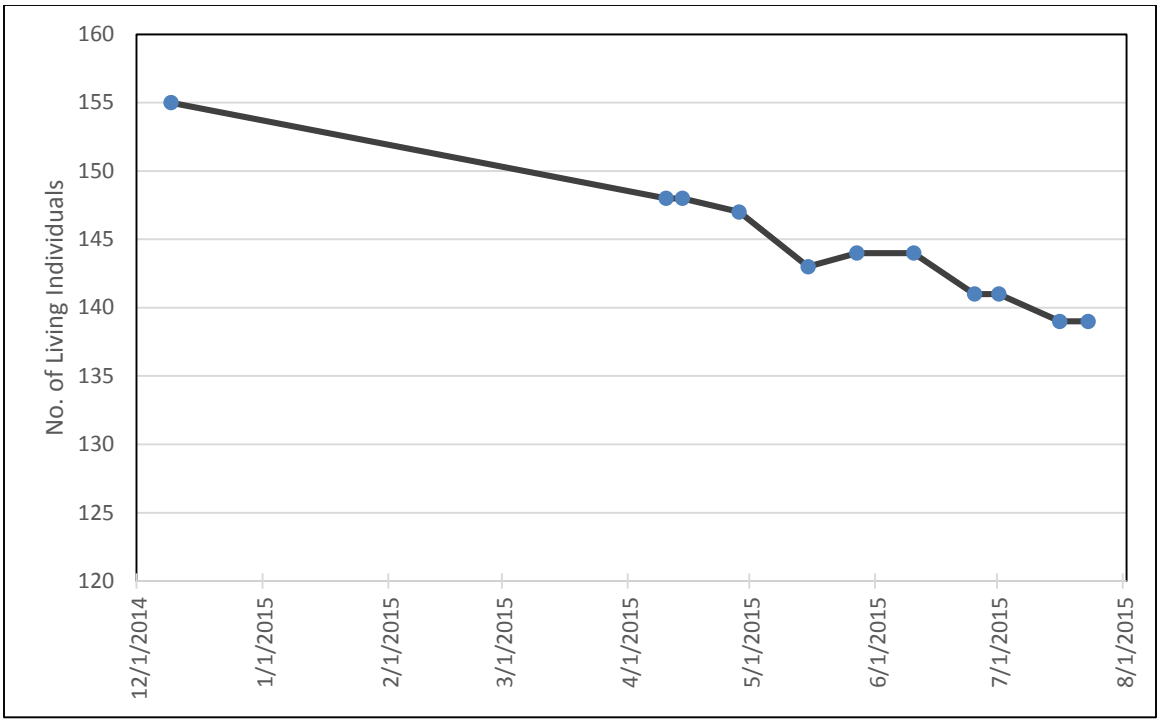

Figure 2. Survival of all round-leaved chaff flower outplants over time.

Table 3. Survival from End of 120-day Establishment Period to July 2015

Plot	Number of Individuals Living (4/10/2015)	Number of Individuals Living (7/23/2015)	Survival (%)
1	39	37	94.9%
2	47	46	97.9%
3	30	28	93.3%
4	32	28	87.5%
Total	**148**	**139**	93.9%

4.3.2. Plant Vigor

Overall, plant vigor has been decreasing consistently since the beginning of Year 1. This is mainly because of drought stress and hot temperatures during the dry season. Another major contributing factor for the decrease in vigor has been a significant mealybug infestation (see section 4.3.3). The percentage of plants considered healthy in all plots has decreased from 41% to 1.3%, and the number of plants considered moderately vigorous decreased from 46% to 25.8% (Figure 3). Representative photographs depicting different vigor categories are shown in Figures 4 – 6.

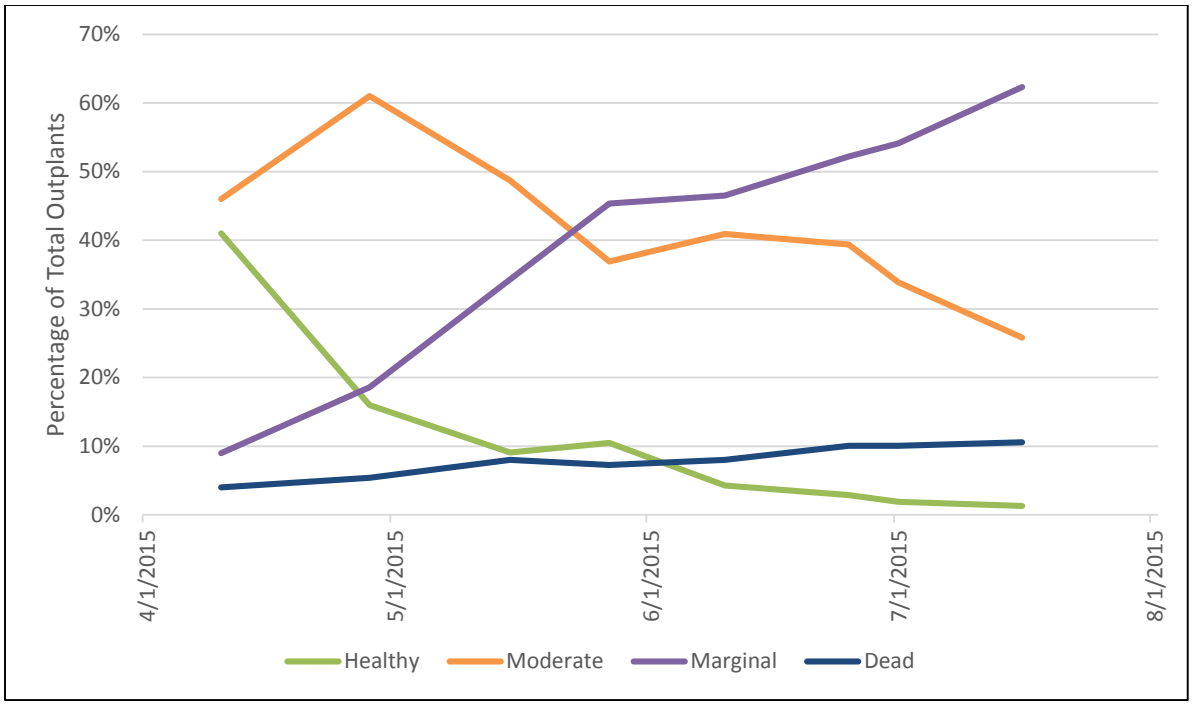

Figure 3. Percentage of plants in the various vigor categories over time.

Figure 4. Representative plants showing healthy vigor.

Figure 5. Representative plants showing moderate vigor.

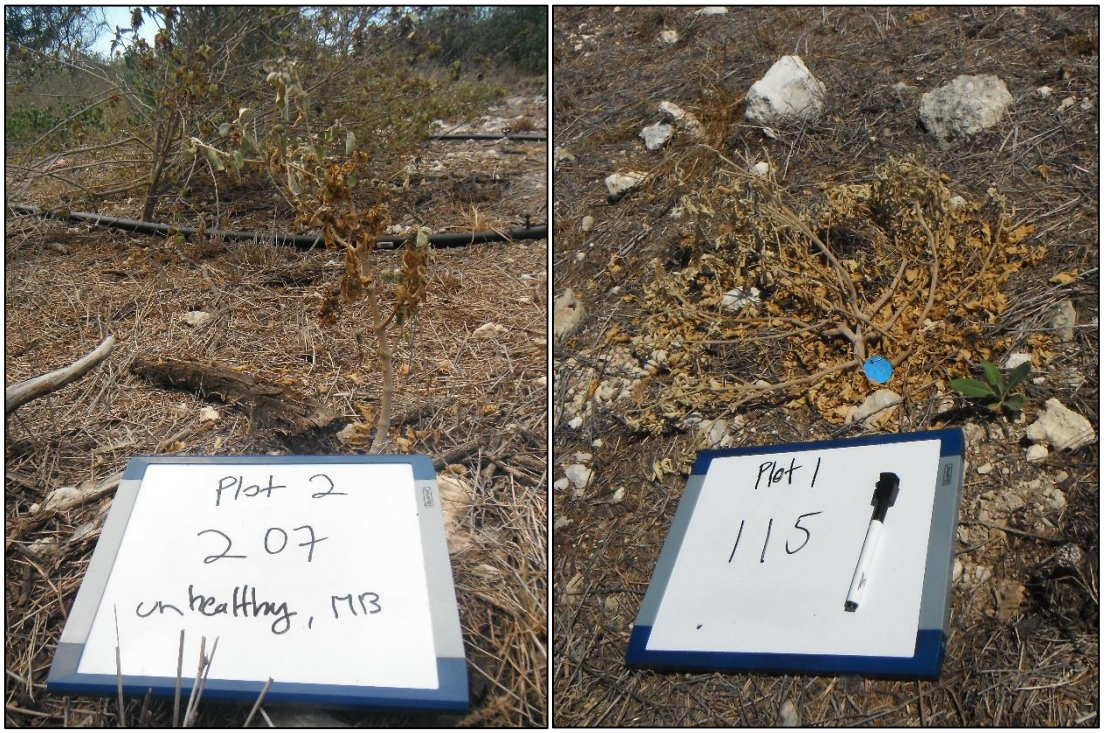

Figure 6. Representative plants showing marginal vigor (left) and dead vigor (right).

4.3.3. Pests

Pests have generally increased over the monitoring period. By the end of July 2015, roughly 69.7% of all plants had at least some degree of pest infestation (Figure 7; Table 4). Only invertebrate pests have been observed at the site, and most are mealybugs. Other pests seen in the plots included hemispherical scale, cottony cushion scale, and ants (likely longhorned crazy ants), which are known to farm scales and mealybugs. No rodent damage has been seen in any of the plots. Pest presence is consistently highest in Plot 2 (range = 77.7%–95.8% of plants). In general, pest presence has been lowest in Plot 3 (range = 30%–47.6% of plants).

The severity of the pest infestation has recently declined likely due to the application of the pesticides Prev-Am and Safari in June 2015. Pests were previously being treated with soapy water until a pesticide use permit was obtained for the NWR. More involved manual pest treatments (severely infested portions of plants clipped) have also been implemented in recent months. As of the July 16th monitoring event (July 15, 2015), most of the plants (81.3%) were considered to have no or minor pest presence.

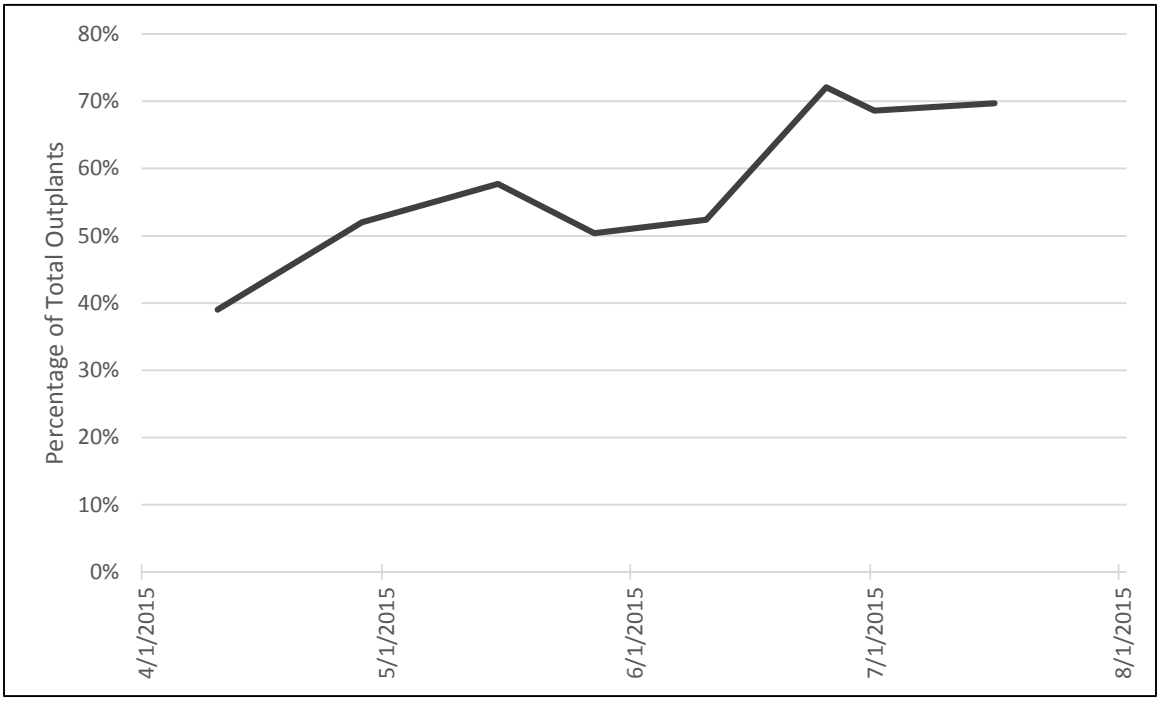

Figure 7. Percentage of plants with pests throughout the monitoring period.

Table 4. Pest Damage in the Plots 1–4 During the First Horticultural Monitoring Event (04/10/2015) and the Eighth Horticultural Monitoring Event (07/16/2015)

Plot	% With Pests (04/10/2015)	% With Pests (07/16/2015)
1	14.30%	47.6%
2	77.60%	87.8%
3	30.00%	66.7%
4	20.60%	76.5%
Total	39.00%	**69.7%**

Figure 8. Pests on plant in Plot 2.

4.3.4. Plant Cover

Plant cover estimates were taken during both the botanical and horticultural monitoring events using different methodologies (see sections 3.3.3 and 3.3.4). During both monitoring types, non-native plant cover was found to be relatively low in all plots, and native percentage cover was generally higher than non-native percentage cover in all plots.

During horticultural monitoring (qualitative approach), estimated cover of native plants has ranged from approximately 18% in Plot 4 in May 2014 to 49% in Plot 2 in May and June 2014 (Figure 9). Native cover has consistently been higher in Plot 2 compared to the other plots. In contrast, non-native cover has ranged from approximately 2% in Plot 1 in April 2015 to 19% in Plot 4 in April 2015 (Figure 9). Plot 4 has slightly higher non-native plant cover compared to the other plots.

During botanical monitoring (quantitative approach), mean cover of native plants in the permanent quadrats ranged from 3.7% in Plot 3 in July to 15.0 % in Plot 2 in April (Table 5). Similar to the horticultural monitoring, native cover has consistently been higher in Plot 2 compared to the other plots. Non-native cover ranged from 0.6% in Plot 3 to 11.8% in Plot 4 in April 2015. Non-native cover was only higher than native cover in Plot 4 in April 2015. No cover of non-native species was documented in Plots 1, 2, or 3 in July 2015, and very minimal cover was recorded in Plot 4 (Figure 10).

Four native plants were documented in the quadrats during botanical monitoring – round-leaved chaff flower, ʻilima (*Sida fallax*), naio (*Myoporum sandwicense*), and ʻuhaloa (*Waltheria indica*). All of the round-leaved chaff flower individuals are planted, and the remaining natives are naturally occurring. The round-leaved chaff flower has had the highest amount of cover of any of the native plants, ranging from 4.0% to 9.0% in April and 3.5% to 6.7% in July. For the non-native plants, buffelgrass (*Cenchrus ciliaris*), Chinese violet (*Asystasia gangetica*), and slender mimosa (*Desmanthus pernambucanus*) have had the highest mean cover values in the quadrats.

Photographs of each quadrat assessed for cover during the botanical monitoring in April 2015 and July 2015 are provided in Appendix C and D, respectively.

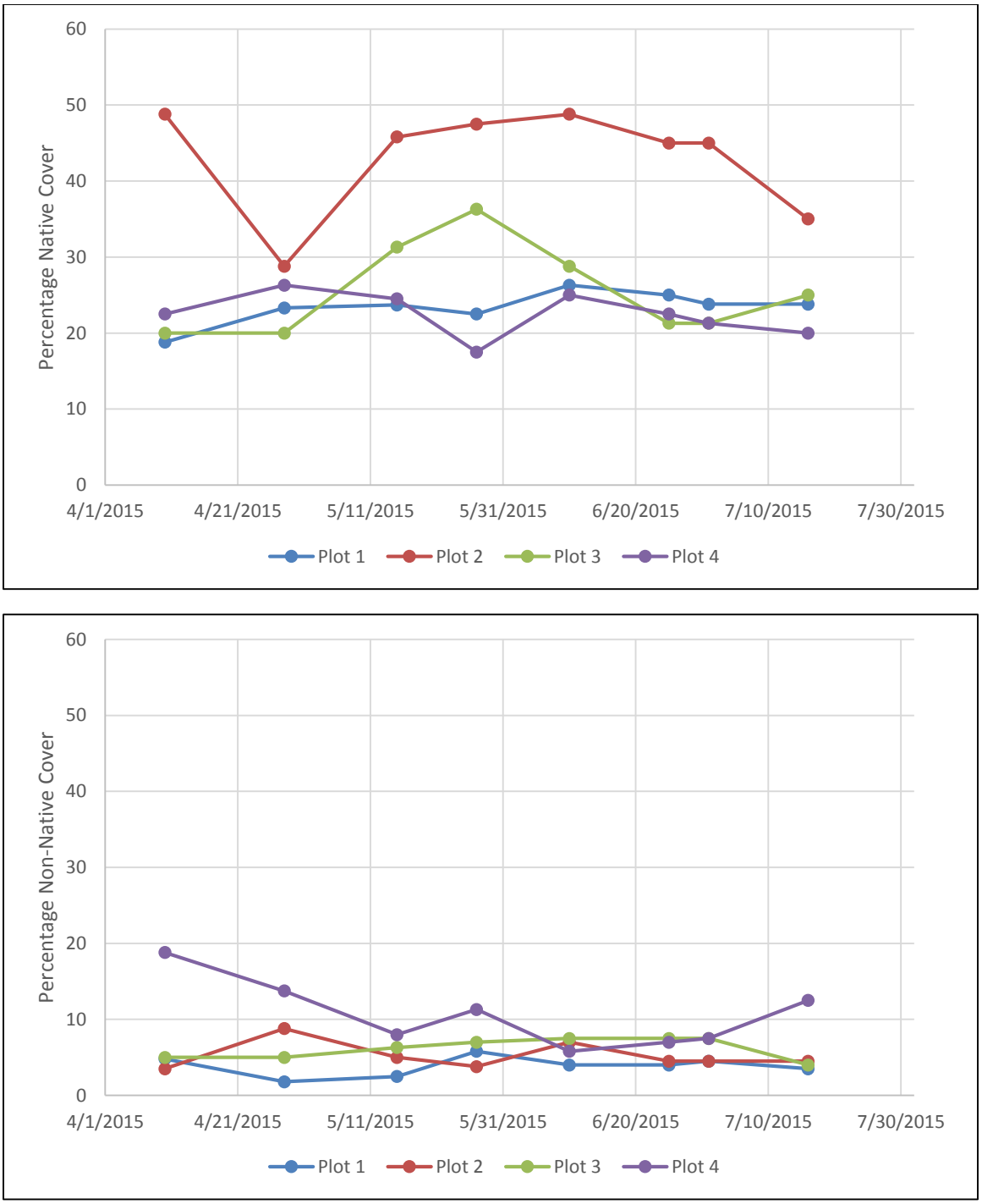

Figure 9. Estimated native (above) and non-native (below) plant cover in Plots 1–4 during horticultural (qualitative) monitoring.

Table 5. Mean Cover of Native and Non-Native Species in Plots 1–4 During the Botanical (qualitative) Monitoring Events

Plot	Mean Native Cover (%)		Mean Non-Native Cover (%)	
	April 2015	July 2015	April 2015	July 2015
1	6.4%	8.2%	3.1%	0.0%
2	15.0%	11.8%	0.7%	0.0%
3	4.6%	3.7%	0.6%	0.0%
4	5.5%	5.0%	11.8%	0.3%

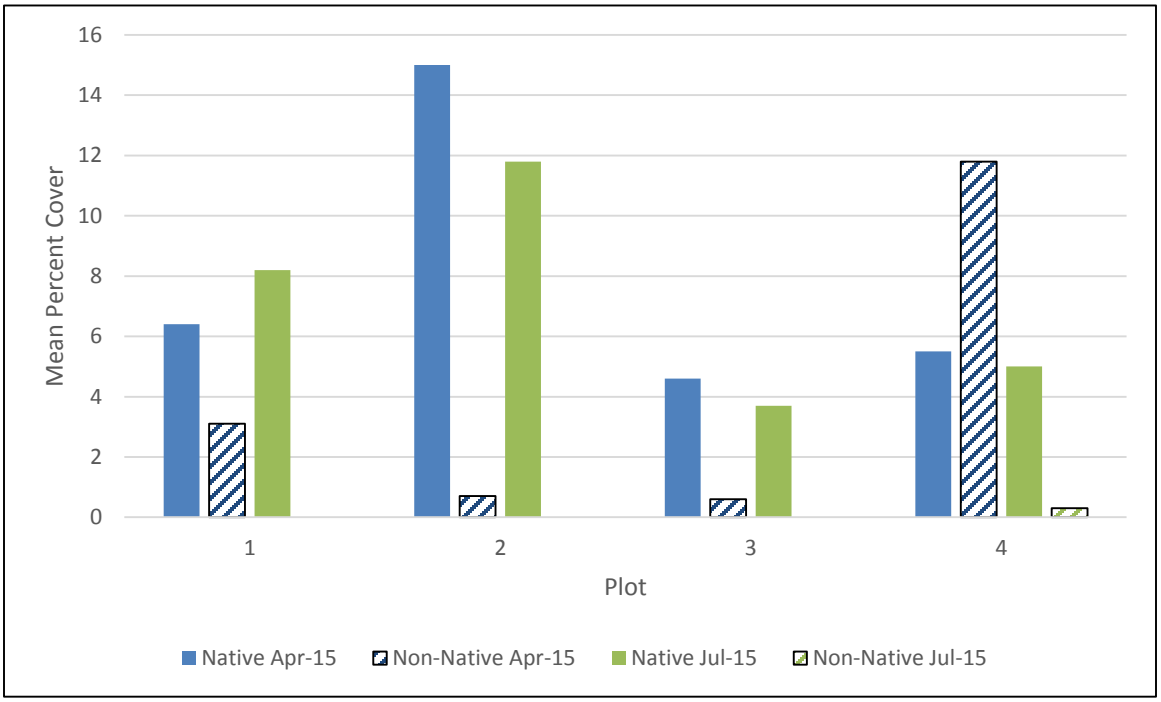

Figure 10. Mean cover of native and non-native species in Plots 1–4 during botanical (qualitative) monitoring in April and July.

4.3.5. Natural Regeneration and Reproduction

To date, no natural regeneration of the round-leaved chaff flower has been observed. This is likely due to the weather, which is too hot and dry for sprouting seedlings.

However, many of the outplants were flowering or fruiting during the course of monitoring (Figure 11), which is not surprising because this species is known to quickly reach a reproductive stage. The species has been reported to fruit in mid-summer to early fall (USFWS 1994). Survival of seedlings that germinate from fallen seed will likely be influenced by the availability of moisture.

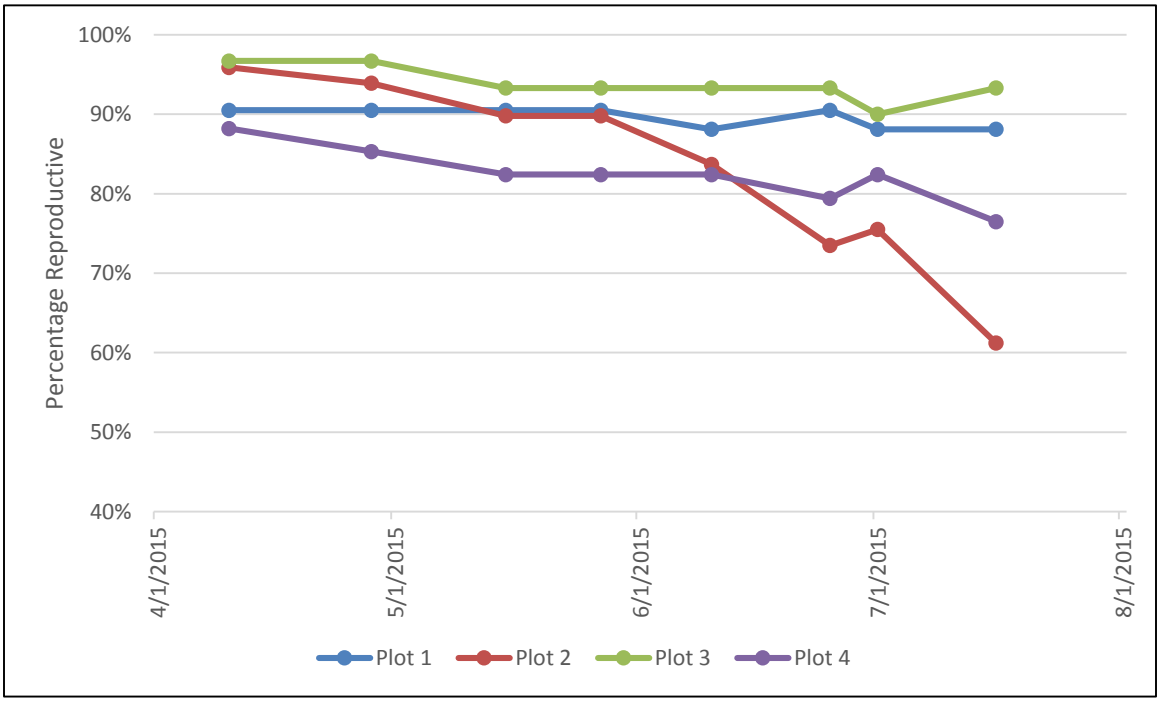

Figure 11. Percentage of living plants that are reproductive in Plots 1–4 over the monitoring period.

4.3.6. Plant Species

In all, 22 plant species have been observed in the plots (Table 6).

Table 6. Plant Species Found within the Plots

Scientific Name	Hawaiian, Common Name(s)	Status*
Abutilon incanum	maʻo, hoary abutilon	I
Acacia farnesiana	klu	X
Achyranthes splendens var. rotundata	round-leaved chaff flower	E
Asystasia gangetica	Chinese violet	X
Atriplex semibaccata	Australian saltbush	X
Cenchrus ciliaris	buffelgrass	X
Chloris barbata	swollen fingergrass, mauʻu lei	X
Cucumis dipsaceus	hedgehog gourd, teasel gourd	X
Desmanthus pernambucanus	slender mimosa	X
Galinsoga parviflora	–	X
Heliotropium curassavicum	kīpūkai, nena, seaside heliotrope	I
Leucaena leucocephala	koa haole	X
Myoporum sandwicense	naio, bastard sandalwood	I
Pluchea carolinensis	sourbush, marsh fleabane	X
Plumbago zeylanica	ʻilieʻe	I
Prosopis pallida	kiawe	X
Ricinus communis	castor bean	X
Sida fallax	ʻilima	I
Sonchus oleraceus	sow thistle, pualele	X
Urochloa maxima	Guinea grass	X
Verbesina encelioides	golden crownbeard	X
Waltheria indica	ʻuhaloa	I

* Status:

E = endemic (native only to the Hawaiian Islands).

I = indigenous (native to the Hawaiian Islands and elsewhere).

P = Polynesian (introduced by Polynesians).

X = introduced/ alien (plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact [Cook's arrival in the islands in 1778]).

4.3.7. Wildlife Species

A list of wildlife species noted within the plots or immediate vicinity during monitoring is provided in Table 7. Nearly all of these are not native to the Hawaiian Islands.

Table 7. Wildlife Observed within the Plots or Immediate Vicinity

Common Name	Scientific Name	Status*
Birds		
Barn owl	*Tyto alba*	NN
Black-crowned night heron	*Nycticorax nycticorax*	I
Common waxbill	*Estrilda astrild*	NN
Great frigatebird	*Fregata minor*	?
House finch	*Haemorhous mexicanus*	NN
Japanese white-eye	*Zosterops japonicus*	NN
Northern cardinal	*Cardinalis cardinalis*	NN
Northern mockingbird	*Mimus polyglottos*	NN
Red-vented bulbul	*Pycnonotus cafer*	NN
Spotted dove	*Streptopelia chinensis*	NN
White-rumped shama	*Copsychus malabaricus*	NN
Zebra dove	*Geopelia striata*	NN
Invertebrates		
Cabbage moth	*Pieris rapae*	NN
Chinese dragonfly	*Crocothemis servilia*	NN
Cotton mealybug	*Phenacoccus solenopsis*	NN
Hemispherical scale	*Saissetia coffeae*	NN
Honey bee	*Apis mellifera*	NN
Longhorn crazy ant	*Paratrechina longicornis*	NN
Yellow-jacket	*Vespula pensylvanica*	NN
Mammals		
Cat	*Felis catus*	NN
Small Asian mongoose	*Herpestes auropunctatus*	NN
	Total species	21

* Status:

E = endemic (native only to the Hawaiian Islands).

I = indigenous (native to the Hawaiian Islands and elsewhere).

NN = non-native.

M = migrant.

4.3.8. Soil Conditions

In most of the plots, only a thin layer of soil occurs over the coral outcrop. The results of soil chemical analysis have been relatively constant throughout the monitoring period and across plots (Figures 12–17).

In general, pH has been trending downward during monitoring (see Figure 12). Soil pH is naturally higher at the site compared to other Hawaiian soils due to the type of parent material and coral. Nitrogen and phosphorous levels are relatively high (see Figures 13 and 14). Fertilizer does not appear necessary based on these results. Potassium has been relatively constant, and slightly higher in Plot 4 (see Figure 15). The outlying potassium value was likely due to a sampling error. Calcium levels are also high at the site (see Figure 16) due to the presence of limestone.

Soil specialists at the University of Hawai‘i do not anticipate any major changes in the soil nutrient values that would threaten plant growth in the short term (personal communication, Raymond Uchida, Soil Specialist, University of Hawai‘i Mānoa, August 25, 2015). Therefore, it is proposed that chemical analysis of soils only occur quarterly rather at each horticultural monitoring event. Any visual changes in soil will be noted.

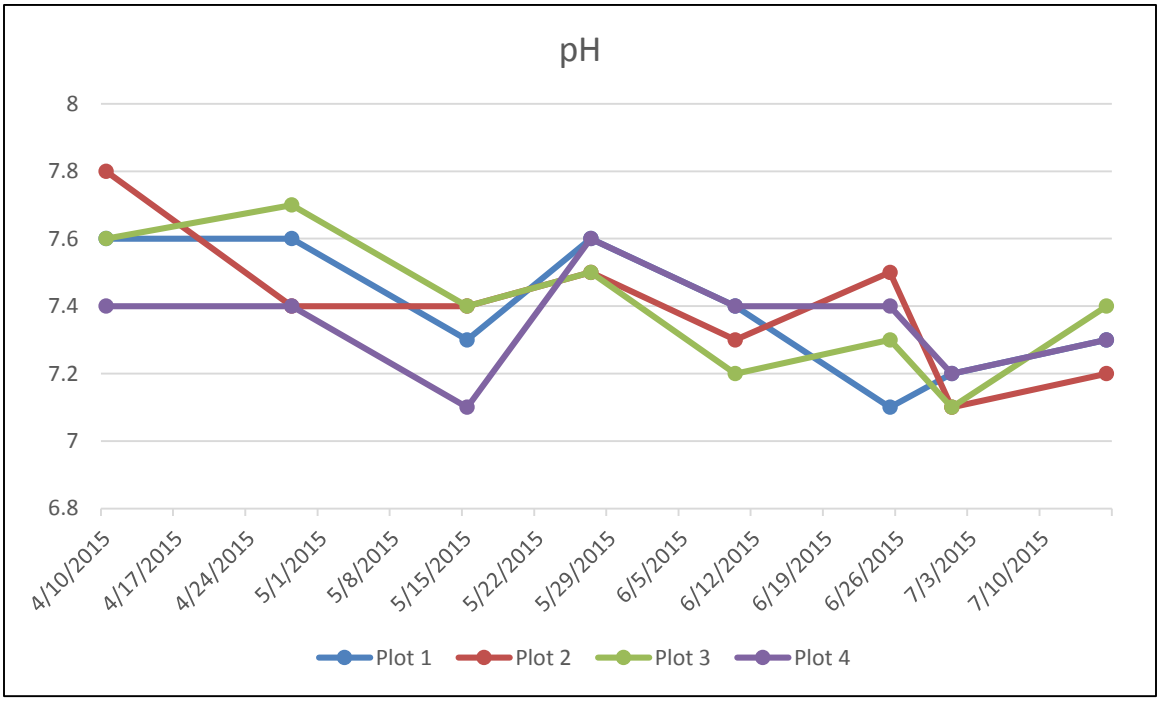

Figure 12. pH values recorded from soil samples taken during the horticultural monitoring events.

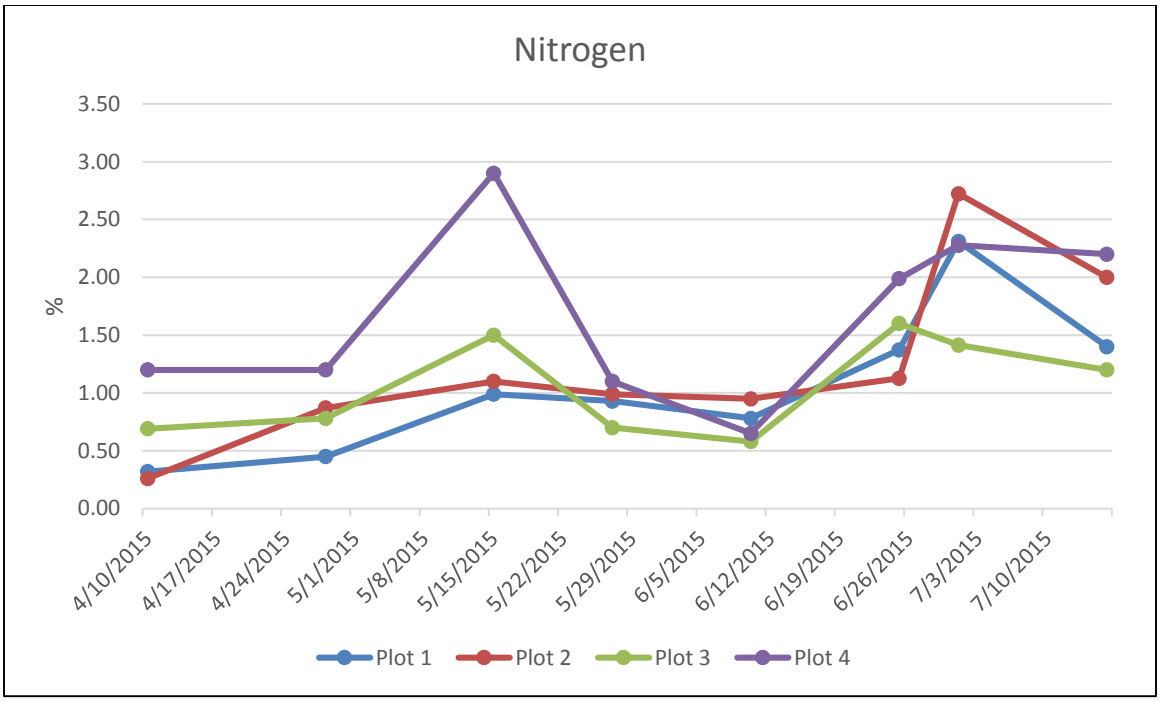

Figure 13. Nitrogen values recorded from soil samples taken during the horticultural monitoring events.

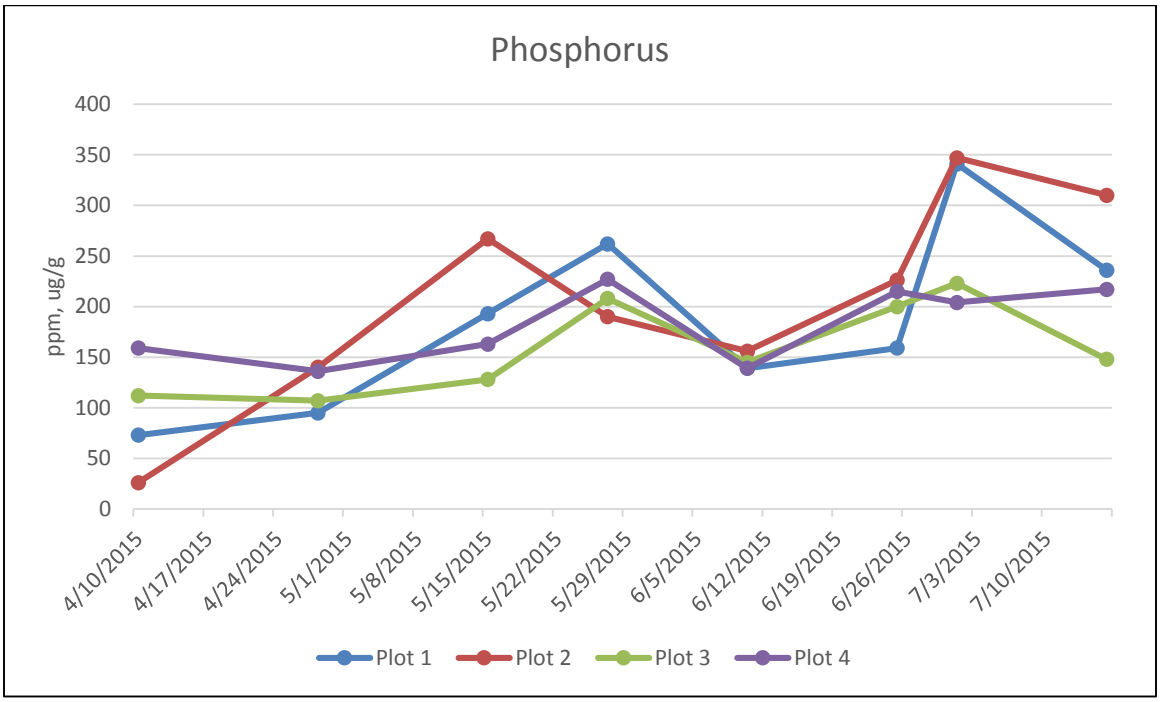

Figure 14. Phosphorous values recorded from soil samples taken during the horticultural monitoring events.

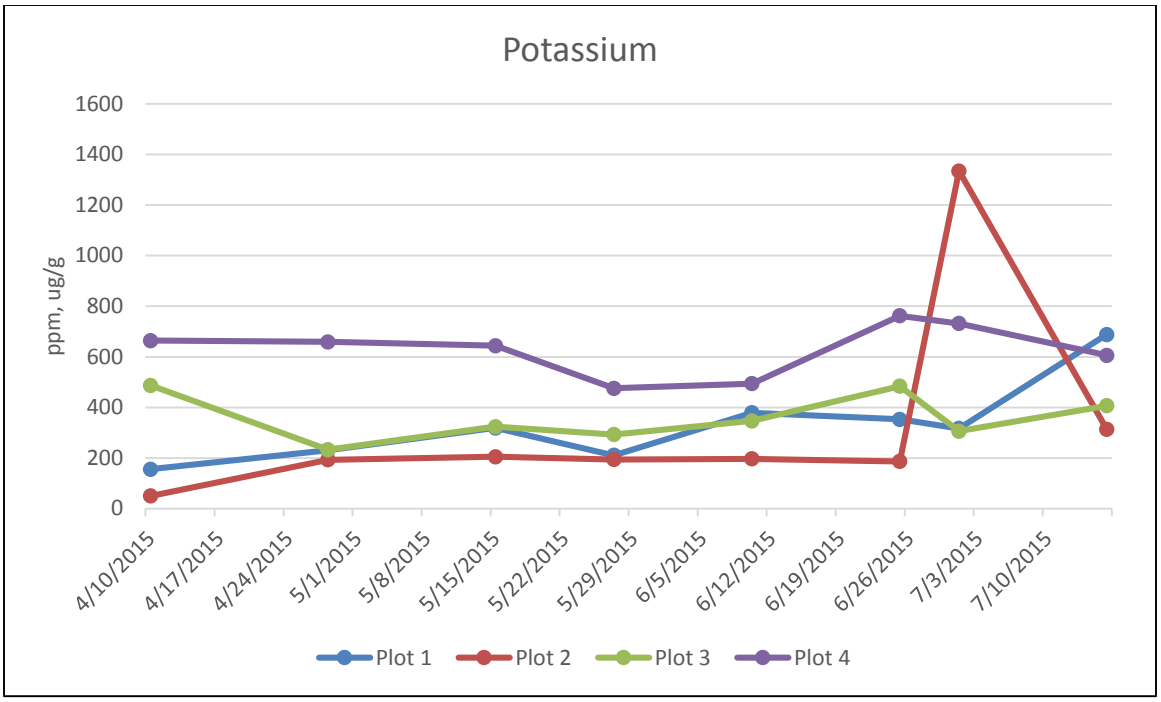

Figure 15. Potassium values recorded from soil samples taken during the horticultural monitoring events.

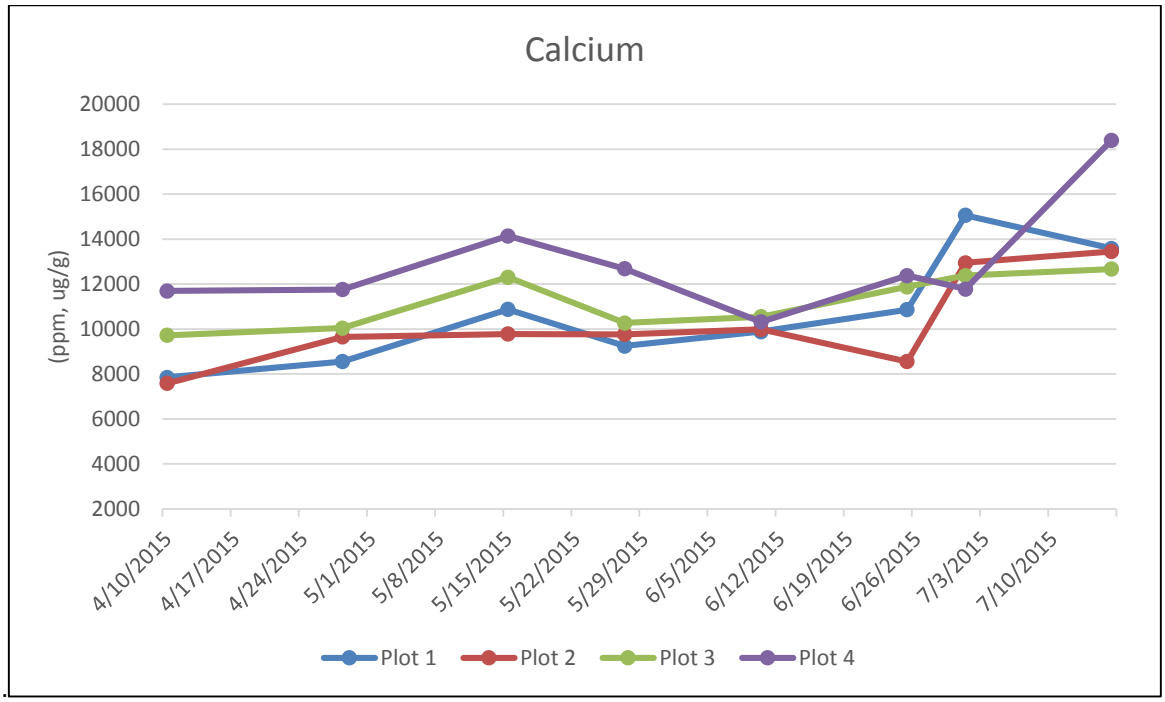

Figure 16. Calcium values recorded from soil samples taken during the horticultural monitoring events.

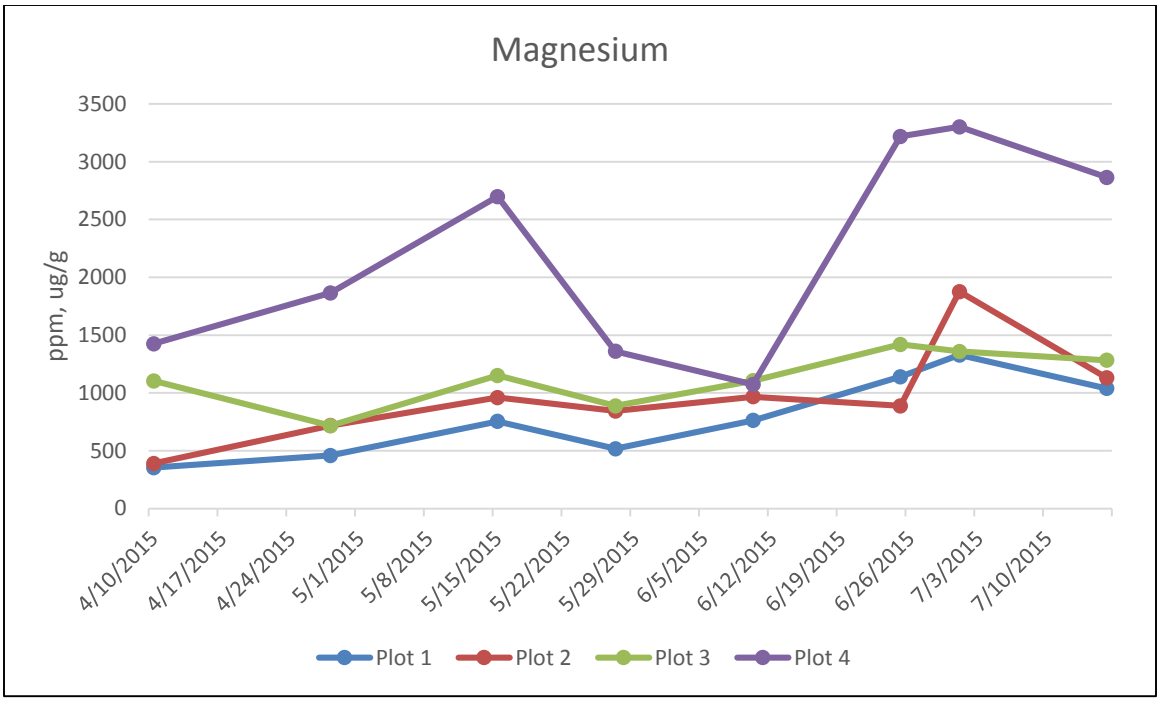

Figure 17. Magnesium values recorded from soil samples taken during the horticultural monitoring events.

5. EVALUATION OF SUCCESS CRITERIA

The goal of the measures of success is to ensure that the outplanted populations of round-leaved chaff flower become established and are stable and viable self-producing populations. The criteria presented below were developed based on consultation with the NWR and in accordance with the goals and objectives presented in the Pearl Harbor NWR comprehensive conservation plan for the Kalaeloa Unit (USFWS 2010). Measures for mitigation success will be determined by the following:

1. Outplanted individual survivorship:
    a. 100% of 120 outplanted individuals will survive by Year 1.
    b. 95% of 120 outplanted individuals will survive by Year 2.
    c. 85% of 120 outplanted individuals will survive by Year 3.
    d. 75% of 120 outplanted individuals will survive by Years 4 and 5.

2. There must be a) recruitment of seedlings that survive through the dry season, in absence of any supplemental watering; and b) seed production by at least 25% of the outplanted lineages by Year 5.

3. Number of seedlings recruited into the mature age class must be greater than the mortality rate of existing adult plants over a 5-year period, with a minimum recruitment of 25% of the number of outplanted individuals over a 5-year period.

4. No fewer than 120 mature plants, which will include plants recruited from the planted lineages, will be established by Year 5.

5. Cover of herbaceous non-native plants (e.g., buffelgrass, khaki weed, and golden crownbeard) will be less than 25% within planting plots by Year 5.

6. No mature kiawe will be within the planting plots over the 5-year period.

7. Native species cover within the planting plots will be greater than 25% by Year 5.

All success criteria that apply to Year 1 are currently being met. More than 120 plants were planted at the site to meet the goal of 120 individuals by the end of Year 1. Although slightly more than 10% have died since installation, 139 individuals have survived. With continuation of the recent remedial pest control measures, at least 120 plants are expected to survive until the end of Year 1.

Furthermore, cover of non-native species is low compared to native species. Herbaceous non-native plant cover is less than 25% in all plots based on qualitative and quantitative monitoring. No mature kiawe are present within the plots.

Although recruitment has not been observed to date, it is anticipated to occur during the wet season. Rain gauges from the National Weather Service report exceptionally low rainfall from January to July 2015 for the Kalaeloa Airport. Although average year-to-date rainfall for this area is 9.3 inches, only 2.3 inches (25% of YTD) have been reported this year (National Oceanic and Atmospheric Administration/National Weather Service, Weather Forecast Office Honolulu 2015).

6. REMEDIAL MEASURES

Remedial measures that have been recommended and implemented by Hui Kū Maoli Ola and SWCA are summarized in the horticultural letter memoranda submitted to DOFAW. A summary of maintenance activities and notes is also provided in Appendix A. All required remedial measures are performed within 2 weeks of the receipt of the letters.

The following are recommended to meet the success criteria established for Year 1:

- Watering: Because most of the plants are showing signs of drought stress, plants will continue to receive supplementary watering, as needed. Supplemental watering needs to be balanced with USFWS concerns over the cost of water use, as well as the horticulturalist's concerns about attracting more pests with lush growth.

- Pest Control: Although mealybugs are being observed in all plots, the severity of the infestation is declining after the application of pesticides Safari and Prev-Am. Plants will continue to be treated chemically and manually, as needed.

- Weed Control: Plant competition has been minimal and not determined to be a threat to the survival and success of most outplants during this survey period. A 0.6-meter (2-foot) buffer around each outplant will continue to be maintained to reduce competition, promote growth, and encourage regeneration. This buffer will be cleared and maintained by hand.

7. LITERATURE CITED

Foote, D.E., E.L. Hill, S. Nakamura, and F. Stephens. 1972. *Soil Survey of the Islands of Kaua'i, O'ahu, Maui, Moloka'i, and Lana'i, State of Hawai'i.* U.S. Department of Agriculture, Soil Conservation Service.

National Oceanic and Atmospheric Administration/National Weather Service, Weather Forecast Office Honolulu. 2015. Hydrology in Hawai'i. Available at: http://www.prh.noaa.gov/hnl/hydro/pages/oahu_ytd_07.gif. Accessed on August 25, 2015.

SWCA Environmental Consultants (SWCA). 2013. *Round-Leaved Chaff Flower (*Achyranthes splendens *var*. rotundata*) Habitat Conservation Plan, Kenai Industrial Park Project*.

———. 2014. *Planting Plan for Kenai Industrial Park Project Round-Leaved Chaff Flower (Achyranthes splendens var. rotundata) Habitat Conservation Plan.* Prepared for CIRI Land Development.

U.S. Fish and Wildlife Service (USFWS). 1994. *Draft recovery plan for* Chamaesyce skottsbergii *var.* kalaeloana *and* Achyranthes splendens *var*. rotundata. Portland, Oregon.

———. 2010. *Pearl Harbor National Wildlife Refuge Comprehensive Conservation Plan*. Prepared by Oahu National Wildlife Refuge Complex and USFWS. Available at: http://www.fws.gov/pacific/planning/main/docs/HI-PI/James%20Campbell%20Pearl%20Harbor%20CCP/Pearl%20Harbor%20NWR%20Final%20CCP.pdf. Accessed August 28, 2015.

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Appendix A.

Summary of Maintenance Activities

Table A1. Summary of Maintenance Activities

Maintenance and Monitoring Period	Date of Visit	Comments
Installation		
–	11/25/2014	Plants installed in Plots 1 and 2.
–	12/9/2014	Plants installed in Plots 3 and 4.
120-Day Establishment		
Week 1: 12/14/2014 - 12/20/2014	12/9/2014	Completed plant installation.
Week 2: 12/14/2014 - 12/20/2014	12/17/2014	Nothing to note.
Week 3: 12/21/2014 - 12/27/2014	12/23/2014	Everything looked great. Nothing to report.
Week 4: 12/28/2014 - 01/03/2015	12/30/2014	Not much to report. Weeded the plots and all looks good.
Week 5: 01/04/2014 - 01/10/2015	1/7/2015	Small signs of ants problems developing. Minor weeding.
Week 6: 01/11/2015 - 01/24/2015	1/23/2015	General weeding.
Week 7: 01/25/2015 - 02/07/2015	2/4/2015	Water dropped to once a week on 1/29. Plants look good. Weeding occurred.
Week 8: 02/08/2015 - 02/21/2015	2/18/2015	Bugs manually controlled (squished) on plants.
Week 9: 02/22/2015 - 03/07/2015	3/4/2015	Automatic watering has been stopped completely. Weeding.
Week 10: 03/08/2015 - 03/21/2015	3/18/2015	Everything good. Two plants in Plot 2 look heavily pest damage. Monitoring to see if plants can recover with current pest method.
Week 11: 03/22/2015 - 04/04/2015	4/1/2015	Soap seems to be working okay for pest damage (scales and mealy) in Plot 2. Ants are still a problem, but it seems as although the bugs are much more under control compared to previous visits. Plants were dry, but doing great. No additional watering.
Year 1 (once a month monitoring)		
April	4/29/2015	Three types of activities occurred: 1) weeded plots; 2) picked mealy bugs off by hand and treated with soapy water (at some point we will need to get an approved pesticide); 3) watered plants as needed.
May	5/20/2015	Site visit went okay. Plants were watered and treated with soap. All the plots were watered and treated with soap. The plants dropping leaves is expected; they are just acclimating to the summer. However, they should be monitored closely, because although they acclimate and can be healthy, the natural process does include die off. Therefore, watering may be needed this summer.
June	6/3/2015	Supplemental watering of all plots occurred. There are some concerns over water use because of the cost of water to USFWS. Soap and water treatment conducted for pests, but chemical treatment is needed now that we have approval for chemical usage. It may be a slow recovery because the mealybugs are really bad on some of the plants. The combo threat of stressed plants and mealy bugs is not good. On the other hand, if a plant is well watered, it will attract more bugs too. So a healthy population lies somewhere in the middle of the two extremes.
	6/17/2015	Each plot was irrigated for 20 minutes. Half of the plants in Plots 1 and 2 were treated for bugs. The gnarled tips were pruned off and Prev-Am was applied after. We will do a follow up treatment next week.
	6/24/2015	Plots were treatment with chemical.

Table A1. Summary of Maintenance Activities

Maintenance and Monitoring Period	Date of Visit	Comments
July	07/01/2015	The mealybugs are a big problem. With this species and others like *Nototrichium*, once the infestation gets to this level it is difficult to get it under control. Chemicals do not always work when the population is strong, especially with such a strong ant population. Prev-am was considered the more appropriate pesticide to use in the given environment. It ii not a systemic. Safari was applied to the plots today.
	7/8/2015	Heavily gnarled leaves removed, nodes wiped down with water and sponges. Safari will be re-applied.
	7/22/2015	Bug control.