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Annual Report for the Kenai Industrial Park Round-Leaved Chaff Flower (*Achyranthes splendens* var. *rotundata*) Habitat Conservation Plan July 1, 2016–June 30, 2017

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

August 2017

ANNUAL REPORT FOR THE KENAI INDUSTRIAL PARK ROUND-LEAVED CHAFF FLOWER (*ACHYRANTHES SPLENDENS* VAR. *ROTUNDATA*) HABITAT CONSERVATION PLAN JULY 1, 2016–JUNE 30, 2017

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 project impacts to round-leaved chaff flower individuals 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 continuing during Year 2 and moving into Year 3 of the HCP implementation at the Kalaeloa Unit (the mitigation site) from July 1, 2016, to June 30, 2017. During this time, maintenance and monitoring occurred at the mitigation site as required in the HCP, with 10 horticultural (qualitative) monitoring events and two botanical (quantitative) monitoring events. Photographic documentation occurred during each event. The monitoring program is designed to document mitigation success and to inform the need for remedial and adaptive management measures. Monitoring was led by SWCA Project Manager Jaap Eijzenga, SWCA Botanist Danielle Frohlich, and SWCA Field Technician Bryson Luke. All maintenance was conducted by local plant nursery Hui Kū Maoli Ola and supervised by their 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. The mitigation site is approximately 3.2 kilometers (2 miles) from the KIP project. The Kalaeloa Unit was established during the 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 plain. The Natural Resources Conservation Service 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 (37.4-acre) Kalaeloa Unit were under active management within designated work units before this mitigation was implemented.

On April 18, 2014, Hui Kū Maoli Ola, SWCA, and the U.S. Fish and Wildlife Service (USFWS) identified four round-leaved chaff flower planting plots at the mitigation site. These plots were identified using work units that the USFWS designated for restoration through natural regeneration and outplanting of native plants 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 before HCP mitigation activities were implemented. Each planting plot is approximately 12 × 12 meters (m) (39.5 × 39.5 feet) or 144 m^2 (1,600 square feet).

On November 25, 2014, Hui Kū Maoli Ola outplanted round-leaved chaff flower plants in Plots 1 and 2, and Plots 3 and 4 were each planted on December 9, 2014.

Four round-leaved chaff flower individuals were also planted outside of Plots 1 through 4 on November 25, 2014. These plants were not previously included in the total count; however, based on discussion with the state in December 2015, these four plants were included in the total plant count as of the 16th horticultural monitoring that took place on January 14, 2016, and are referred to as planting Plot 5. Plot 5 is in Work Unit 5 between Plots 1 and 2 and is approximately 4 × 4 m (13.1 × 13.1 feet) or 16 m^2 (172 square feet).

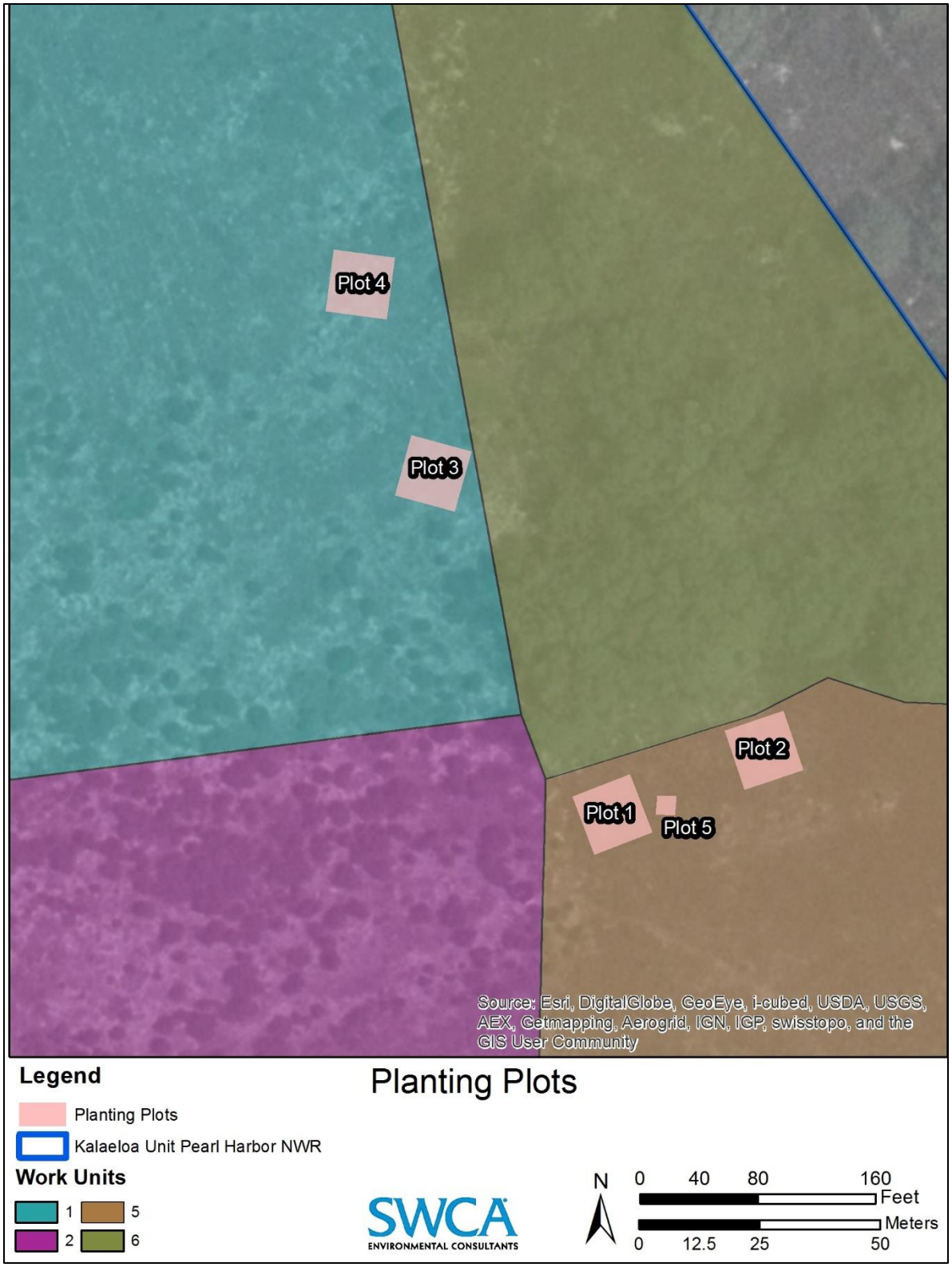

Figure 1. Planting plots in the mitigation site.

3 METHODS

Table 1 presents a timeline for activities associated with implementation of the HCP between mid-July 2016 and mid-June 2017.

Table 1. Timeline of Monitoring Activities

Year	Activity	Date
	Horticultural monitoring #22	07/14/2016
	Horticultural monitoring #23	08/16/2016
	Horticultural monitoring #24	09/20/2016
	Horticultural monitoring #25	10/13/2016
	Horticultural monitoring #26	11/11/2016
	Horticultural monitoring #27	12/20/2016
	Botanical monitoring #6	01/10/2017
	Horticultural monitoring #28	01/20/2017
	Horticultural monitoring #29	02/22/2017
	Horticultural monitoring #30	03/21/2017
	Horticultural monitoring #31	04/25/2017
	Botanical monitoring #7	06/14/2017

3.1 Maintenance

Maintenance activities included 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 remainder of Year 2, maintenance took place bimonthly until March 2017. Maintenance for Year 3 began on April 2017, and activities will continue to take place quarterly or, if deemed necessary by the project horticulturist, more frequently throughout the remainder of Years 3, 4 and 5. Maintenance activities for this reporting period are summarized in Appendix A. The project horticulturist provided observations and recommendations following each maintenance visit and implemented recommendations as necessary in consideration of the success criteria. Maintenance activities will occur as necessary for 5 years, or until mitigation goals have been met.

3.2 Monitoring

3.2.1 Horticultural Monitoring

Horticultural monitoring (qualitative assessment) was conducted once a month during the remainder of Year 2 (July 2016–March 2017) and continued quarterly after April 2017, into Year Three. The following information was 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 no green leaves or living stems are present.
- *Plant vigor categories*: Vigor of each individual is assigned to one of the following four categories:
    - 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*: Phenological stage is classified as vegetative or 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:* Threats include encroaching weeds and water stress.
- *List of maintenance requirements*
- *Visual assessment and photographic documentation of native and non-native percentage cover*: Percentage cover estimates and photographs are taken in four quadrats in each plot.

Following each horticultural monitoring event, a written memorandum was prepared listing problems (if observed) and recommending remedial measures. These memoranda were sent to Hui Kū Maoli Ola, and remedial measures were performed promptly. A letter report identifying maintenance issues and corrective measures was provided to Hui Kū Maoli Ola and to the State of Hawai‘i, Division of Forestry and Wildlife (DOFAW).

3.2.2 Botanical Monitoring

Botanical monitoring took place twice during this reporting period. One botanical monitoring took place as part of Year 2 (January 2017), and the second took place as part of Year 3 (June 2017). Botanical monitoring will take place twice a year (in January and June of each year) through the end of the mitigation period. The following information was collected during botanical monitoring:

- *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 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 planting plot is divided into 1 × 1–m (3.3 × 3.3–foot) quadrats (144 quadrats total). Ten quadrats are randomly selected in each plot (at least five quadrats are required in the HCP [SWCA 2013]) and percentage cover of each plant species is evaluated in each quadrat delineated by polyvinyl chloride pipe reference frames.
- *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.

- *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 discussed solely in the annual report submitted to DOFAW.

3.2.3 Photographic Documentation

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

4 RESULTS

4.1 Maintenance

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. A 0.6-m (2-foot) buffer is also maintained around each outplant to reduce competition, promote growth, and encourage regeneration.

Supplemental watering occurred at the site in November 2016 and again in January 2017. Watering has been reduced to encourage plants to develop deep root systems and other adaptations to living in this hot, dry environment.

The persisting presence of mealybugs (species of scale insects in the family Pseudococcidae) and the newly discovered occurrence of a highly destructive Bostrichid beetle (*Amphicerus* sp.) identified in early 2017, led to the implementation of a consistent schedule for chemical treatment at the plots. Safari, one of two pesticides approved by USFWS to be used at the NWR, was applied three times in Year 2 (November 2016, January 2017, and February 2017), followed by two applications in Year 3 (April and June 2017). Safari was applied at a rate of 1 gallon per visit over all affected plants.

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

4.2 Monitoring

Ten horticultural monitoring events and two botanical monitoring events took place from mid-July 2016 through mid-June 2017 (see Table 1). The results are summarized below.

4.2.1 Survival

In all, 159 individual plants were initially planted by December 2014 in Plots 1–4. Four individual plants were planted outside of Plots 1 through 4 on November 2014, in Plot 5. These four individuals were added to the total count on January 14, 2016 (16th horticultural monitoring event). Ninety-five of the originally outplanted individuals (60%) survived as of the most recent horticultural monitoring on April 25, 2017 (Figure 2). During the botanical monitoring on June 14, 2017, ninety-three of the original outplants were found to be surviving.

Numbers of surviving individuals decreased in all plots over time since the last monitoring event in the second annual report (June 21, 2016). At the end of April 2017, Plots 5 and 3 had the highest survival rate, with 75% of the four original outplants surviving in Plot 5, and 77% of the original 30 plants surviving in Plot 3. Plots 1 and 4 had the lowest survival numbers, with 60% and 59% survival, respectively (Table 2).

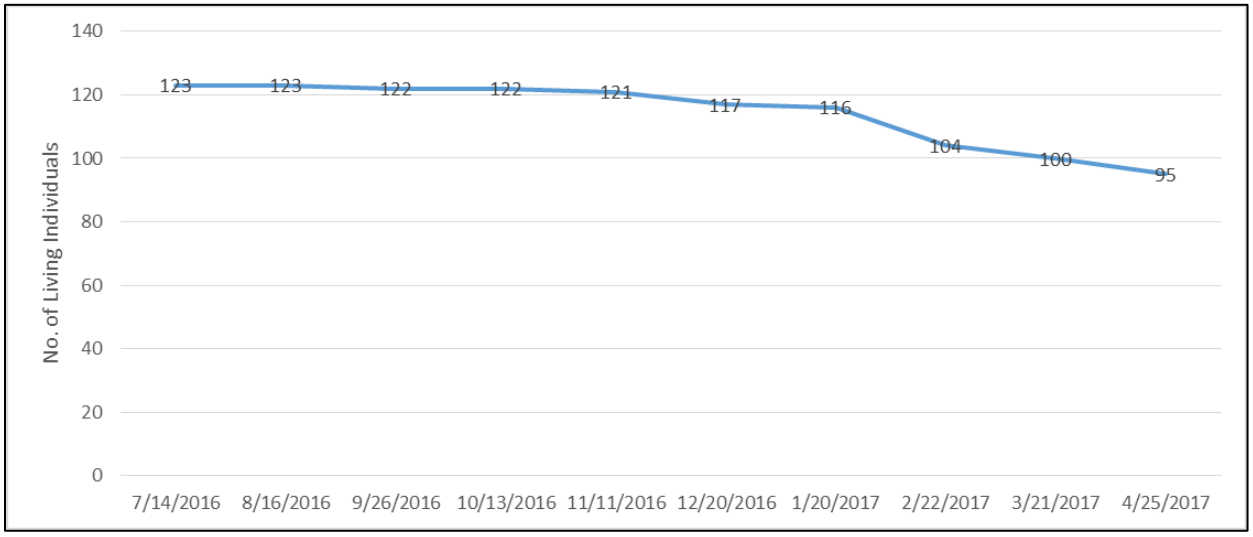

Figure 2. Survival of plants during the horticultural monitoring events (July 14, 2016 to April 25, 2017).

Table 2. Survival from the First and Last Horticultural Monitoring Events (July 14, 2016 and April 25, 2017)

Plot	Number of Individuals Living (07/14/2016)	Number of Individuals Living (04/25/2017)	Survival (%) of Original Outplants
1	33	25	60%
2	35	24	49%
3	27	23	77%
4	24	20	59%
5	4	3	75%
Total	**123**	**95**	**60%**

4.2.2 Plant Vigor

The fluctuations in vigor seen during this reporting period reflect those seen in previous years. These fluctuations can be attributed primarily to drought stress and to hot temperatures during the dry season, as well as to infestations of mealybug that arise when plants are stressed. Vigor of the outplants significantly improved between July and October 2016, jumping from 0% to 28% healthy vigor, up to a peak of 48% in March 2017, and decreasing again to 19% in April 2017 (Figure 3). The percentage of plants considered moderately vigorous fluctuated throughout the monitoring period from 28% in July 2016, jumping to 50% in October 2016, and reaching its lowest point in March 2017 (14%). This category had the highest percentage of individuals throughout the reporting year. As plants became more established in the plots, the percentage of individuals with marginal vigor dropped to less than 10%, which held steady throughout Year 3. Representative photographs depicting different vigor categories are shown in Figures 4–6.

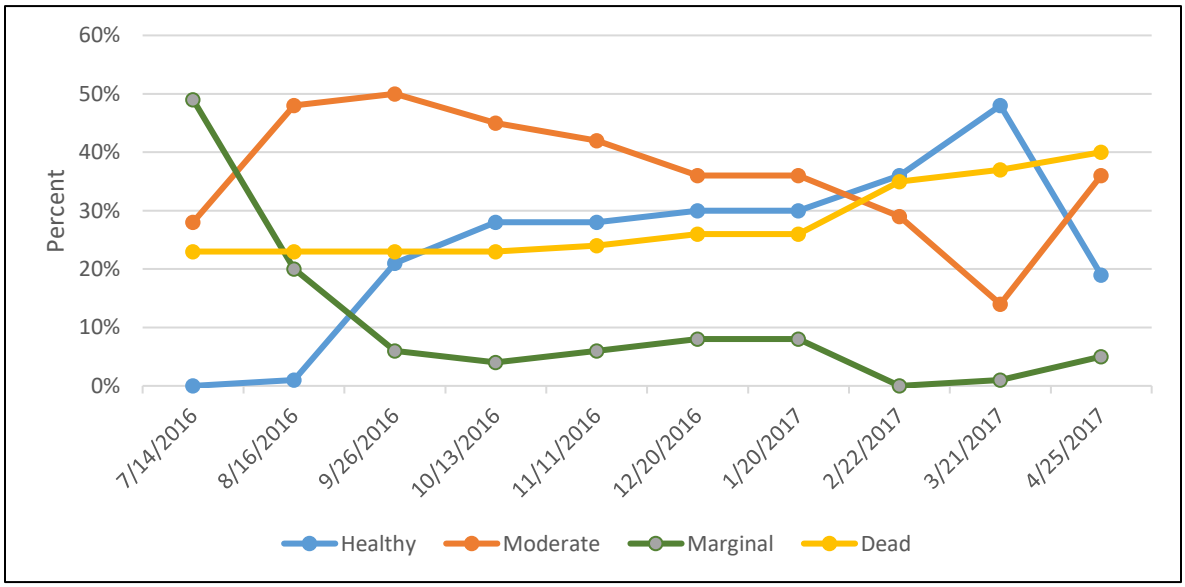

Figure 3. Percentage of plants in the various vigor categories during the horticultural monitoring events (July 14, 2016 to April 25, 2017).

Figure 4. Representative plants showing healthy vigor.

Figure 5. Representative plants showing moderate vigor.

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

4.2.3 Pests

Mealybug continues to be an ongoing pest issue in the plots, with over half of all individual plants having some degree of pest presence throughout the reporting year (Figure 7). Herbicide applications decreased the severity of infestations, however, with most individuals showing minimal pest presence post-herbicide application. In addition to mealybug, a Bostrichid beetle (*Amphicerus* sp.) was discovered in January 2017, causing mortality in the outplants, in some cases killing a plant with moderate to healthy vigor in a matter of months. Discovery of this species' impact on the outplants led to a more rigorous pesticide application schedule in 2017. No rodent or other vertebrate damage has been seen in any of the plots.

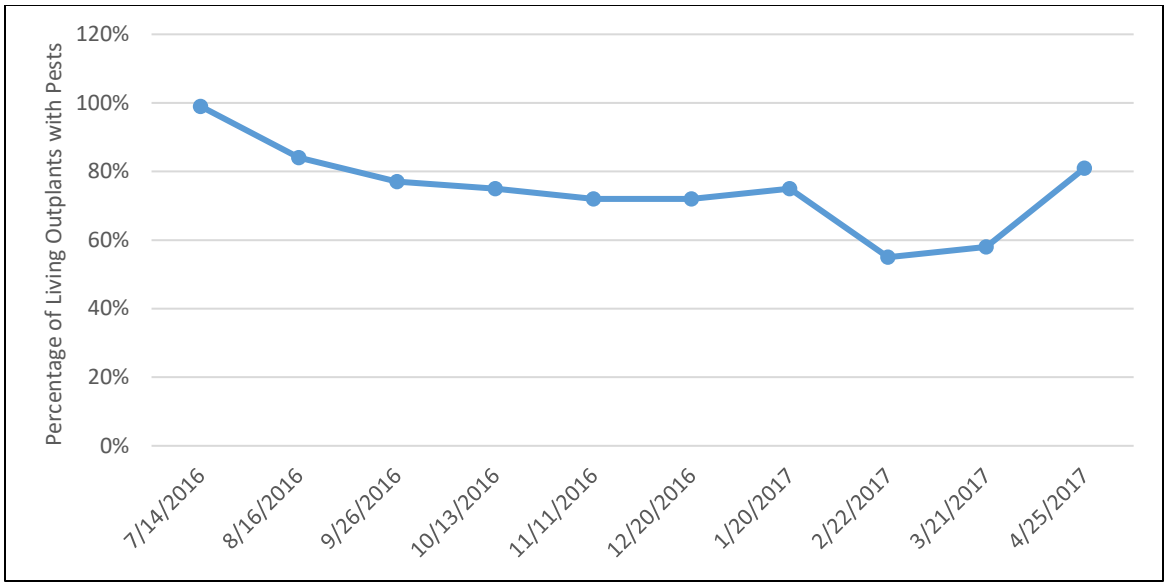

Figure 7. Percentage of all live plants with pests during the horticultural monitoring events (July 14, 2016 to April 25, 2017).

4.2.4 Plant Cover

Percentage plant cover estimates were taken during both the botanical and horticultural monitoring events using different methods (see sections 3.2.1 and 3.2.2). During both monitoring types, non-native plant cover was found to be relatively low in all plots, and native plant cover was generally higher than non-native cover in all plots.

During horticultural monitoring, the estimated percentage cover of native plants ranged from 20% in Plot 3 in July 2016, to 54% in the same plot at the end of the reporting year in April 2017 (Figure 8). Native cover was generally consistent between and within all plots, decreasing during dry periods to approximately 25% of all cover and increasing to approximately 50% with increased rainfall. Plots were regularly weeded, and as a result, non-native cover stayed low, never reaching above 25% in all plots during the horticultural monitoring events (July 2016 through April 2017).

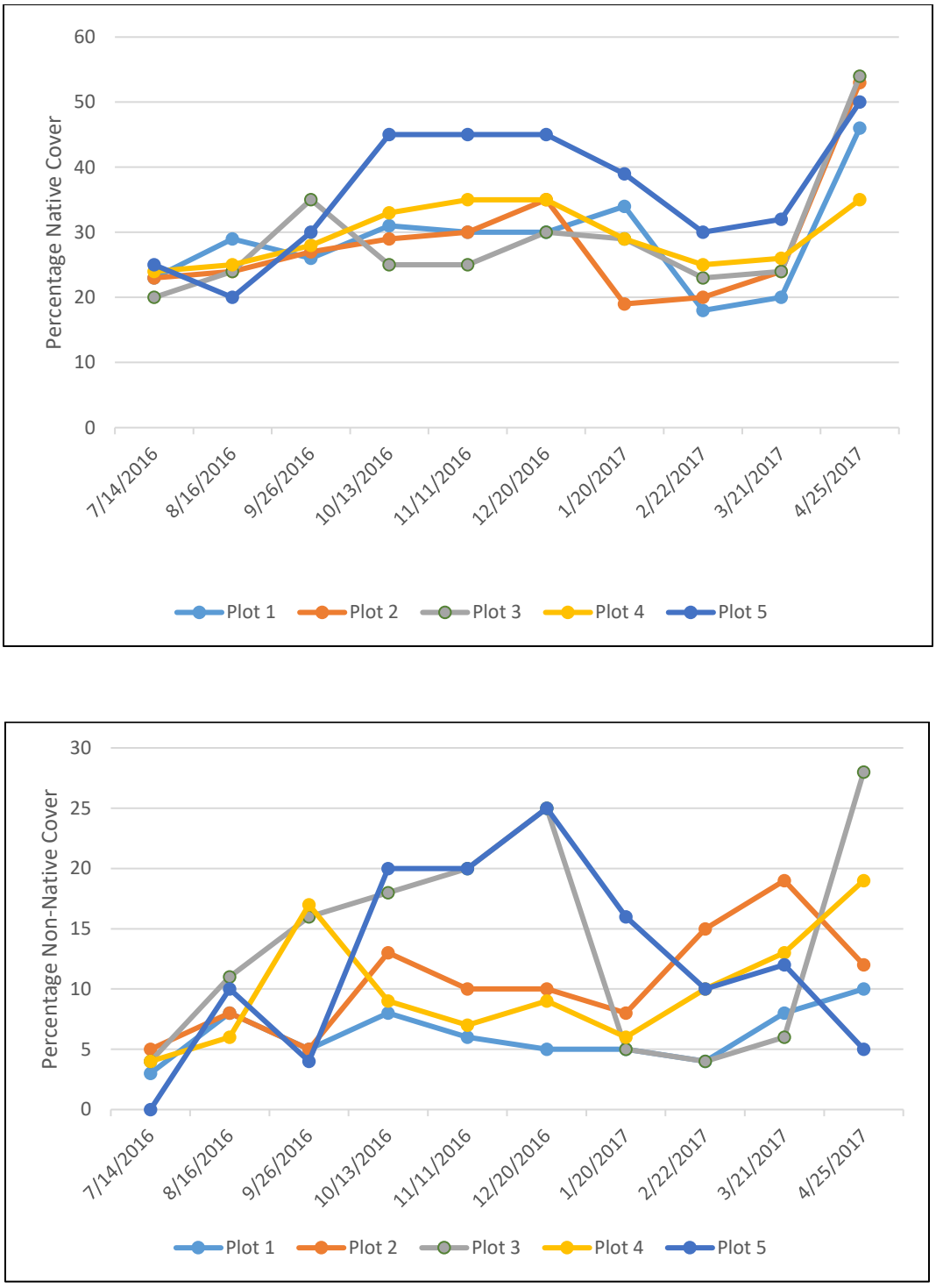

Figure 8. Estimated native (above) and non-native (below) plant cover in Plots 1–4 during the horticultural monitoring events (July 14, 2016 to April 25, 2017).

Botanical monitoring did not occur often enough in the reporting year to warrant statistical analysis; however, cover percentages for native and non-native species in the quadrats reflected the seasonal fluctuations and general trends seen during horticultural monitoring (Table 3).

Table 3. Mean Cover of Native and Non-Native Species in Plots 1– 4 during the two Botanical Monitoring Events (January 10, 2017 and June 14, 2017)

Plot	Mean Native Cover (%)		Mean Non-Native Cover (%)	
	January 10, 2017	June 14, 2017	January 10, 2017	June 14, 2017
1	24.6%	18.9%	2.6%	12.5%
2	10.8%	28.5%	9.1%	7.00%
3	23.8%	28.00%	7.8%	10.00%
4	17.5%	12.00%	1.5%	10.20%

Five native plants were documented during the botanical monitoring: round-leaved chaff flower, ʻilima (*Sida fallax*), naio (*Myoporum sandwicense*), ʻuhaloa (*Waltheria indica*), and kīpūkai (*Heliotropium curassavicum*). Most of the round-leaved chaff flower individuals are planted, with some seedling regeneration occurring below planted individuals. The round-leaved chaff flower had the highest cover percentage of any of the native plants, ranging from 7% to 24.5% in January 2016, and from 6.5% to 19.5% in June 2017. For the non-native plants, scarlet spiderling (*Boerhavia coccinea*), pillpod sandmat (*Euphorbia hirta*), and Australian saltbush (*Atriplex semibaccata*) were shown to have the highest overall cover for non-native species. Total average non-native cover was at or below 10% in quadrats in January and June 2017.

Photographs of each quadrat assessed for cover during the botanical monitoring in January and June 2017 are provided in Appendix C and D, respectively.

4.2.5 Natural Regeneration and Reproduction

The outplants are showing a seasonality with their reproduction, which is consistent with what is known about round-leaf chaff flower phenology (USFWS 1994). Outplants were reproductive beginning in the winter and extending into late spring (Figure 10). Not surprisingly, during the wet winter months, hundreds of seedlings sprouted under and near mother plants. These seedlings were monitored, and new individuals reaching a height of 6 inches were tagged and numbered, and their growth, pest presence, and vigor were tracked. In all, 20 seedlings were tagged and tracked during the last quarter of this reporting year, 40% of which have already reached maturity. This brings the total number of living, tagged individuals in the plots to 115 plants.

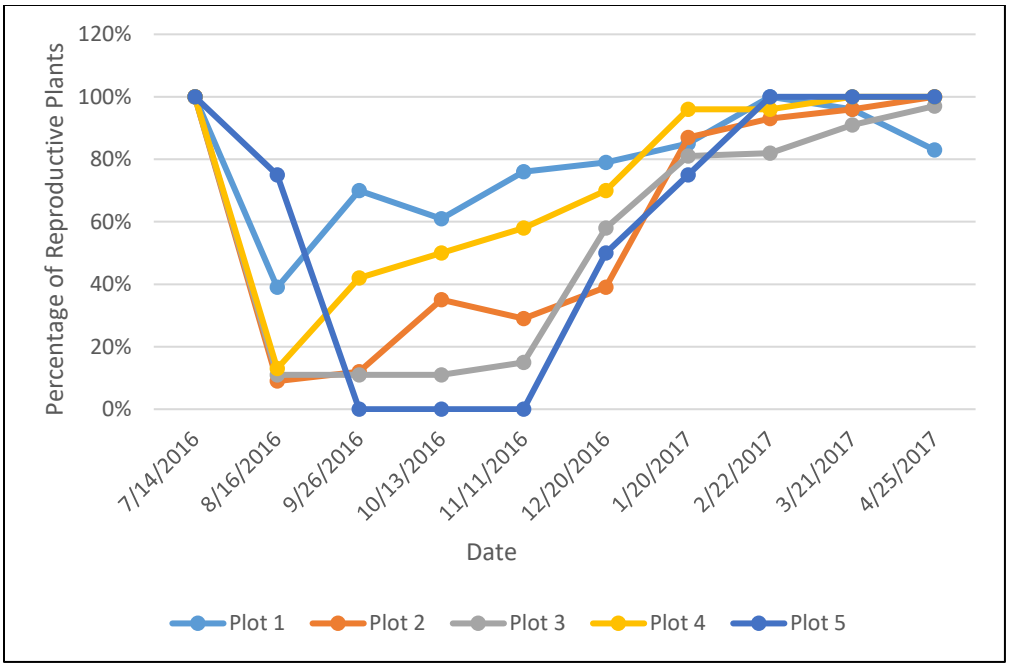

Figure 10. Percentage of living plants that are reproductive in Plots 1–5 during the horticultural monitoring events (July 14, 2016 to April 25, 2017).

4.2.6 Plant Species

In all, 27 plant species have been observed in the plots during the botanical monitoring events (Table 4).

Table 4. Plant Species Found within the Plots during The Botanical Monitoring Events

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
Amaranthus viridus	Slender amaranth	X
Asystasia gangetica	Chinese violet	X
Atriplex semibaccata	Australian saltbush	X
Boerhavia coccinea	Red boerhavia	X
Cenchrus ciliaris	Buffelgrass	X
Chloris barbata	Swollen fingergrass, mauʻu lei	X
Cucumis dipsaceus	Hedgehog gourd, teasel gourd	X
Desmanthus pernambucanus	Slender mimosa	X
Euphorbia hirta	Hairy spurge	X
Euphorbia hypericifolia	Graceful spurge	X
Heliotropium curassavicum	Kïpūkai, nena, seaside heliotrope	I
Leucaena leucocephala	Koa haole	X

Table 4. Plant Species Found within the Plots during The Botanical Monitoring Events

Scientific Name	Hawaiian, Common Name(s)	Status*
Malva parviflora	Cheeseweed	X
Merremia aegyptia	Hairy woodrose	X
Melinis repens	Natal red top	X
Momordica charantia	Bitter melon	X
Myoporum sandwicense	Naio, bastard sandalwood	I
Pluchea carolinensis	Sourbush, marsh fleabane	X
Ricinus communis	Castor bean	X
Setaria verticillata	Bristly foxtail	X
Sida fallax	‘Ilima	I
Tridax procumbens.	Coat buttons	X
Verbesina encelioides	Golden crownbeard	X
Waltheria indica	‘Uhaloa	I
Total		**27**

* Status: E = endemic (native only to the Hawaiian Islands); I = indigenous (native to the Hawaiian Islands and elsewhere); 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]).

4.2.7 Wildlife Species

In all, 11 wildlife species have been noted within the plots or in the immediate vicinity during the botanical monitoring events (Table 5). Nearly all of these are not native to the Hawaiian Islands.

Table 5. Wildlife Observed within the Plots or Immediate Vicinity during the Botanical Monitoring Events

Scientific Name	Common Name	Status*
Invertebrates		
Agraulis vanillae	Gulf fritillary	X
Apis mellifera	Honey bee	X
Paratrechina longicornis	Longhorn crazy ant	X
Phenococcus solenopsis	Cotton mealybug	X
Pieris rapae	Cabbage butterfly	X
Polycaon stoutii	bostrichid beetle	X
Avifauna		
Cardinalis cardinalis	Northern cardinal	X
Haemorhous mexicanus	House finch	X
Mimus polyglottos	Northern mockingbird	X
Paroaria coronata	Red-crested cardinal	X

Table 5. Wildlife Observed within the Plots or Immediate Vicinity during the Botanical Monitoring Events

Scientific Name	Common Name	Status*
Pycnonotus cafer	Red-vented bulbul	X
Pycnonotus jocosus	Red-whiskered bulbul	X
Mammalian Fauna		
Herpestes javanicus	Small Indian mongoose	X
Total		**13**

* 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]).

4.2.8 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 11–16).

After receiving stable soil data during the monitoring period covered in the first annual report, after consulting with soils specialists at the University of Hawai'i, and after further discussions with DOFAW (personal communication, Afsheen Siddiqi, DOFAW, September 22, 2015), it was decided that only semi-annual chemical analysis of soil will be conducted unless future results show significant changes from existing conditions.

Two soil collections took place during this reporting period: one on December 20, 2016, and one on June 14, 2017. A soil analysis was done for pH, calcium, magnesium, phosphorus, potassium, and total nitrogen.

The results of these soil analyses were consistent with previous reporting years. The pH levels in the plots remain between 7.2 and 7.6, which is naturally higher compared to other Hawaiian soils because of a dominant presence of coral substrate. Nitrogen and phosphorous levels remain relatively high (see Figures 13 and 14) and are consistent with previous reporting of between 0.11 and 2.10 parts per million (ppm) microgram/gram (ug/g) for nitrogen and between 76 and 165 ppm ug/g for phosphorus. Potassium levels were between 58 and 466 ppm ug/g (see Figure 15). Calcium levels continued to be high at the site (see Figure 16) because of the presence of limestone, especially in Plot 4, which has the highest levels of limestone. Magnesium levels were between 395 and 2333 ppm ug/g (see Figure 16).

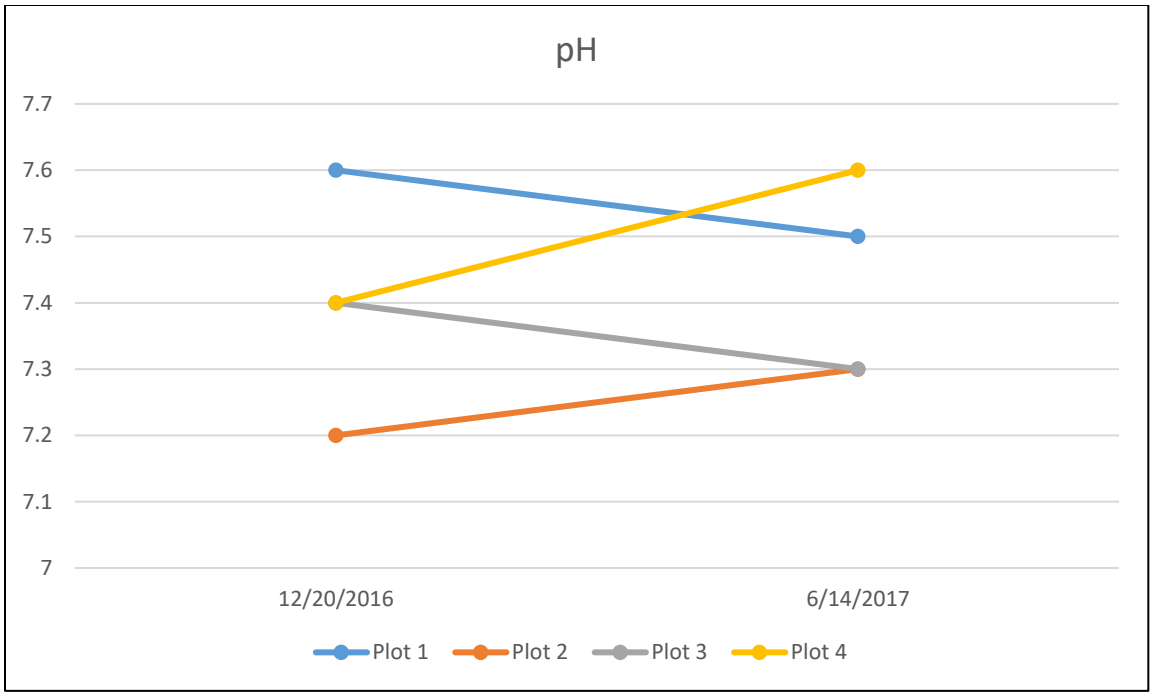

Figure 11. pH values recorded from soil samples taken during the botanical monitoring events.

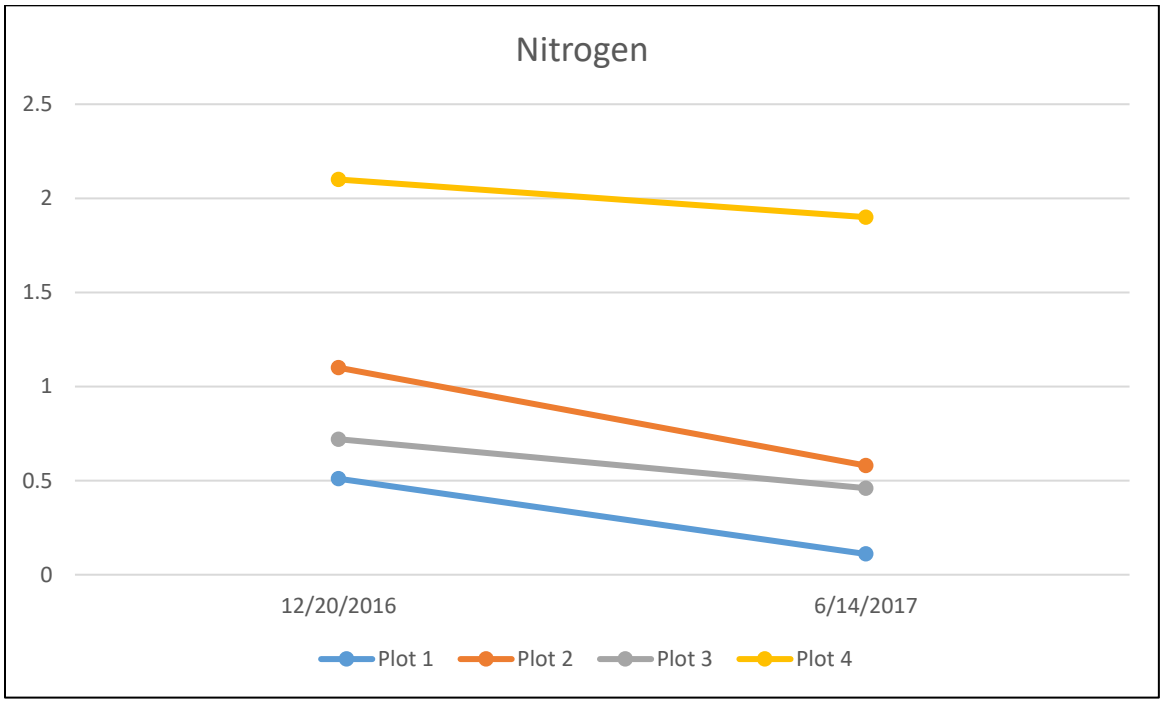

Figure 12. Nitrogen values recorded from soil samples taken during the botanical monitoring events.

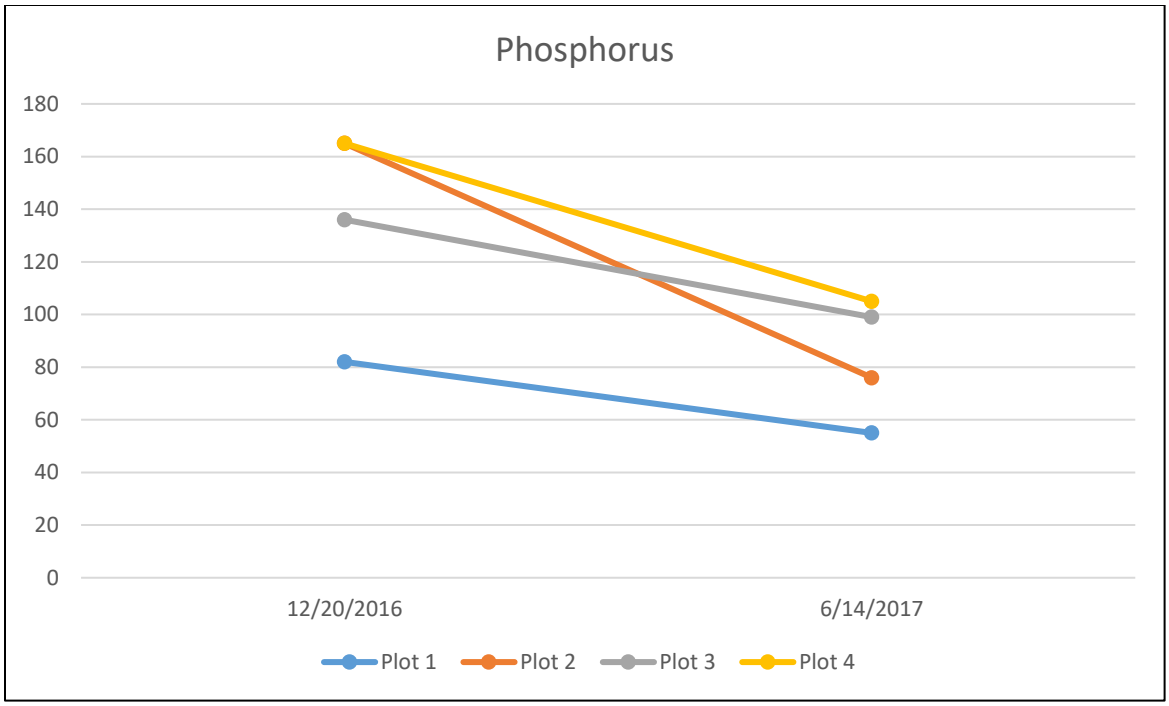

Figure 13. Phosphorous values recorded from soil samples taken during the botanical monitoring events.

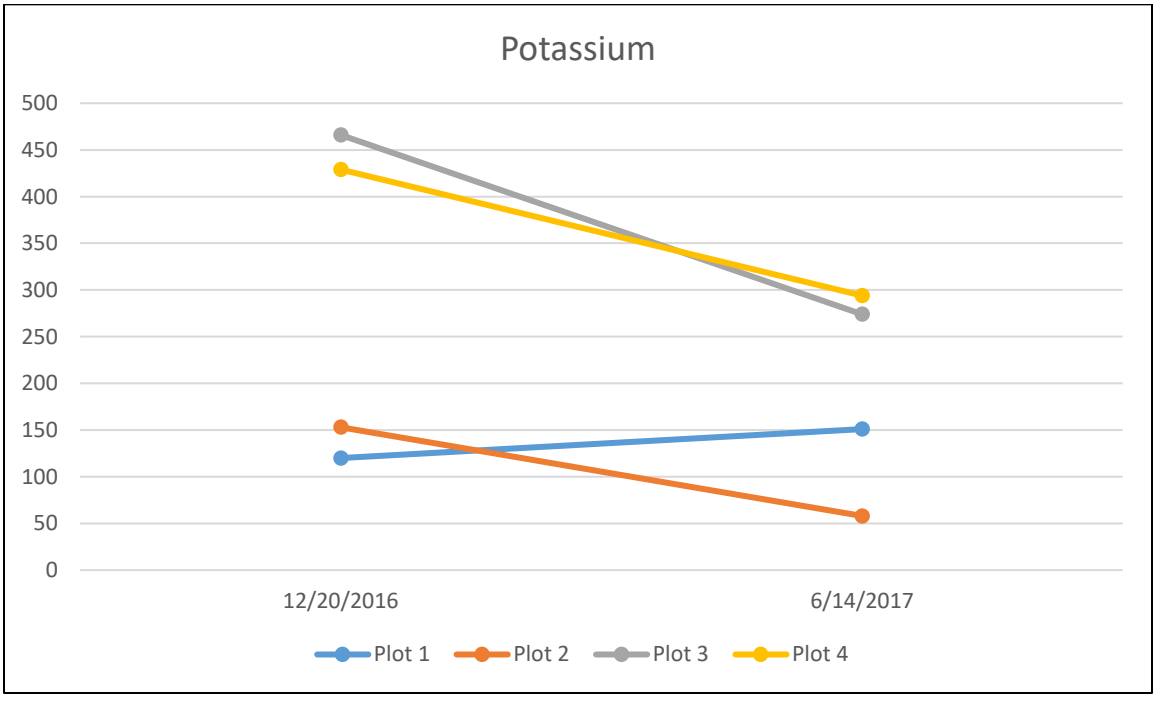

Figure 14. Potassium values recorded from soil samples taken during the botanical monitoring events.

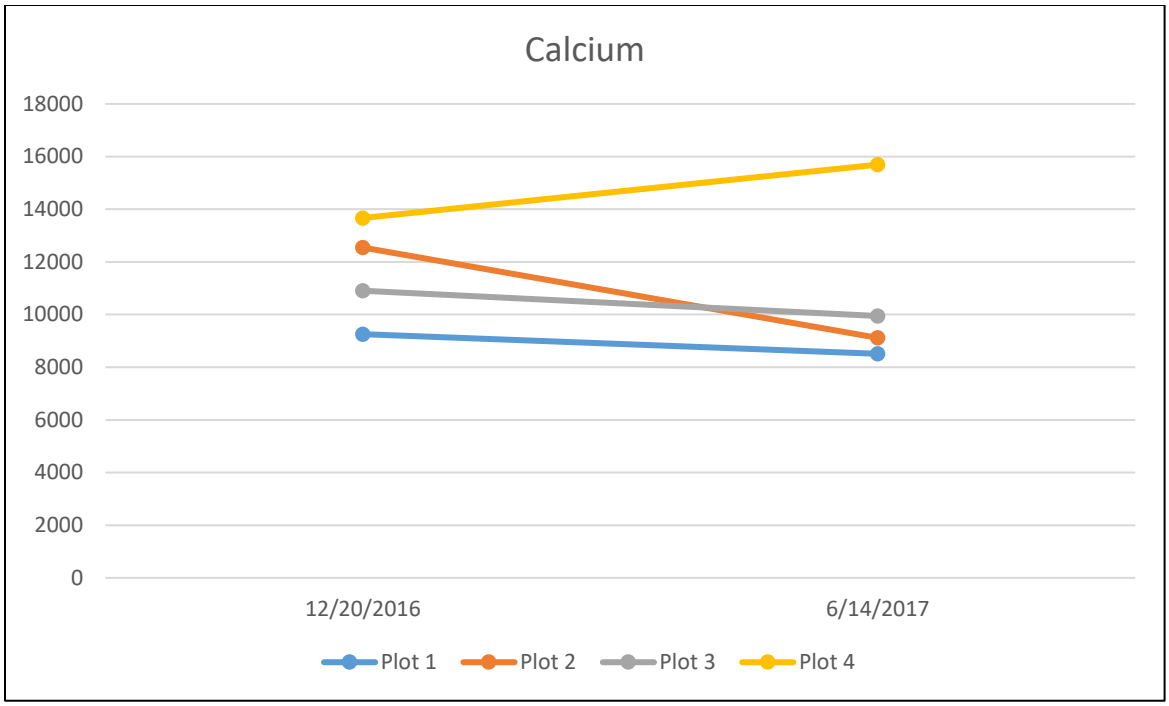

Figure 15. Calcium values recorded from soil samples taken during the botanical monitoring events.

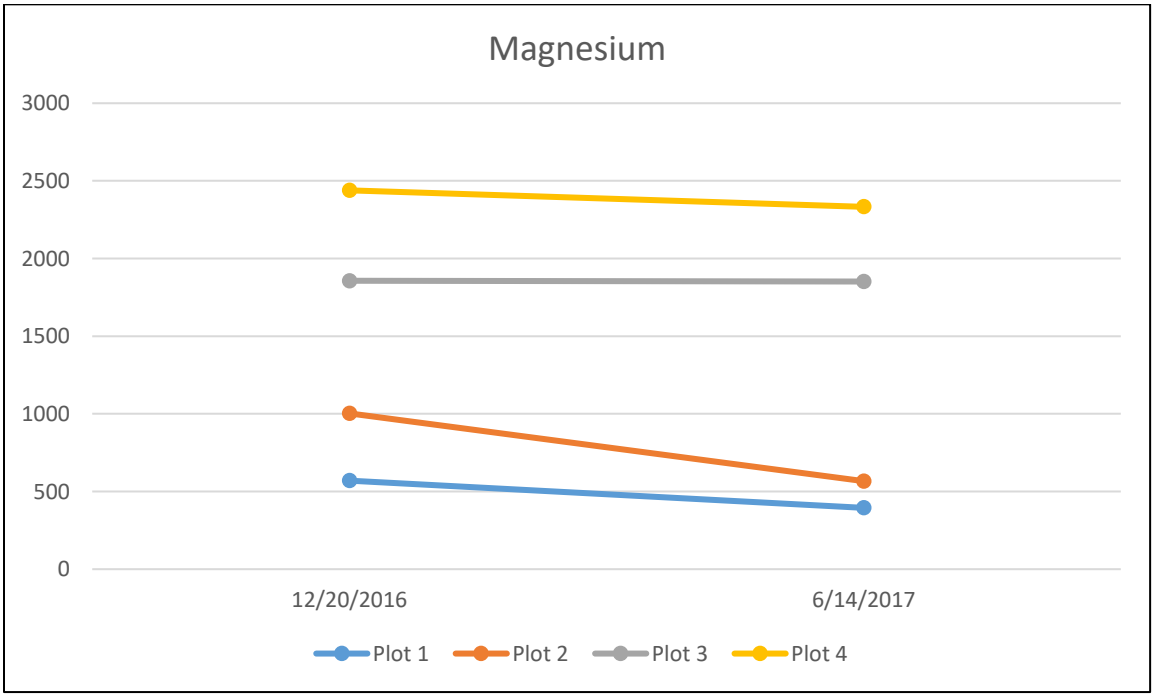

Figure 16. Magnesium values recorded from soil samples taken during the botanical monitoring events.

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 seven 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 are 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 [*Alternanthera pungens*], and golden crownbeard) will be less than 25% within the planting plots by Year 5.

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

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

Success criteria were met again this reporting year, with the exception of Criterion 1, outplant survivorship. Criterion 1 for Year 3 requires that 102 of the original outplants remain at the end of the reporting year. During the last horticultural monitoring on April 25, 2017, ninety-five of the originally outplanted individuals (60%) were alive, and the number had dropped to ninety-three by the last botanical monitoring on June 14, 2017, thus this criterion is not being met. Reports on the life expectancy of round-leaved chaff flower vary, ranging from 2 to 10 years (A Native Hawaiian Garden 2017); however, restoration managers generally agree that this species has a relatively short lifespan, relying on its high reproductive output to perpetuate its populations in the harsh, dry environments in which it is found (personal communication, Matt Schirman, July 25, 2017). After survivorship of the original outplants dipped below the level specified in Criterion 1, SWCA and DOFAW agreed to discuss with ESRC adjusting the survivorship criterion in the HCP to reflect the realities of this species' life history as seen in the plots (personal communication, Glenn Metzler, DOFAW, August 17, 2017). In response to this discussion, SWCA suggests to ESRC eliminating Criterion 1 because it is not realistic to expect a high percentage of the original outplants to survive 5 years, seeing as the lifespan of this species often falls below this time period. Criterion 4 (No fewer than 120 mature plants, which will include plants recruited from the planted lineages, will be established by Year 5) adequately captures the ultimate goal of the HCP, to ensure round-leaved chaff flower becomes established at the mitigation site and has a stable and viable self-producing population. In addition, Criterion 3 has proven very difficult to track because it is not obvious in many cases which plant the recruits originate from, particularly when the mother plant has

died or when seedlings are found away from mature plants. SWCA suggests eliminating Criterion 3 because of the logistical difficulty it presents, and because the outplants were propagated from a small pool of individuals, which diminishes the practical significance of this criterion (ensuring genetic diversity). SWCA suggests that an amendment to the HCP be created that removes Criteria 1 and 3.

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 related notes is also provided in Appendix A. All required remedial measures are performed within 2 weeks of the receipt of the memoranda.

The following are recommended to meet the success criteria established for Year 3:

- Drought stress: Plants continue to exhibit signs of drought stress during prolonged dry periods. Because the outplants now have a well-established root system, the lack of water itself is not a concern; however, pests will need to be controlled to ensure the plants are not stressed further.
- Pest control: The arrival of the Bostrichid beetle this reporting year presented an additional challenge to the ongoing issues with mealybug at the mitigation site. Plants will continue to be treated chemically and manually for both pests, as needed.
- Weed control: Overall, plant competition has been minimal and not determined to be a threat to the survival and success of most outplants during this reporting year. A 0.6-m (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

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Appendix A

Summary of Maintenance Activities

Table A1. Summary of Maintenance Activities

Maintenance and Monitoring Period	Date of Visit	Comments
Year 2 (once every 2 months of monitoring)		
July	07/20/2016	Watered and weeded. Bug control was minimal.
September	09/14/2016	Regular weeding was done.
November	11/16/2016	We serviced the site on November 16. The standard hand weeding around plants and seedlings was performed. No significant bug infestations were observed. However, mealy bugs were present on several plants. We spot sprayed less than 1 gallon of Safari mixture over approximately 22 plants. Water was applied during our site visit on both occasions. We will be doing minor irrigation repairs on our next visit.
January	01/10/2017	We serviced the site on January 10. The standard hand weeding around plants and seedlings was performed. No significant bug infestations were observed. However, mealy bugs were present on several plants. We spot sprayed less than 1 gallon of Safari mixture over approximately 22 plants. Water was applied during our site visit on both occasions. We will be doing minor irrigation repairs on our next visit.
February	02/08/2017	Plants were sprayed with Safari to get the beetle infestation under control. We spot sprayed less than 1 gallon of Safari mixture over approximately 25 plants.
Year 3 (once every 3 months of monitoring)		
April	04/17/2017	General weed control activities in all plots. Verbesina was starting to move in and have been removed. Removed and trimmed off heavy clusters of mealybugs and disposed. Sprayed approximately 1 gallon of Safari on pests.
April	04/24/2017	Quick stop in to follow-up on Safari re-application. Approximately 1 gallon was sprayed.
June	06/14/2017	Light weeding and then left so SWCA staff could do work.
June	06/15/2017	Weeding of all plots. Approximately 1 gallon of Safari was sprayed on infected plants to treat mealybugs.

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Appendix B

Select Permanent Photo-Points

Figure B1. Plot 1 conditions during horticultural monitoring #22, 07/14/2016.

Figure B2. Plot 1 conditions during horticultural monitoring #23, 08/16/2016.

Figure B3. Plot 1 conditions during horticultural monitoring #24, 09/20/2016.

Figure B4. Plot 1 conditions during horticultural monitoring #25, 10/13/2016.

Figure B5. Plot 1 conditions during horticultural monitoring #26, 11/11/2016.

Figure B6. Plot 1 conditions during horticultural monitoring #27, 12/20/2016.

Figure B7. Plot 1 conditions during horticultural monitoring #28, 01/20/2017.

Figure B8. Plot 1 conditions during horticultural monitoring #29, 02/22/2017.

Figure B9. Plot 1 conditions during horticultural monitoring #30, 03/21/2017.

Figure B10. Plot 1 conditions during horticultural monitoring #31, 04/25/2017.

Figure B11. Plot 2 conditions during horticultural monitoring #22, 07/14/2016.

Figure B12. Plot 2 conditions during horticultural monitoring #23, 08/16/2016.

Figure B13. Plot 2 conditions during horticultural monitoring #24, 09/20/2016.

Figure B14. Plot 2 conditions during horticultural monitoring #25, 10/13/2016.

Figure B15. Plot 2 conditions during horticultural monitoring #26, 11/11/2016.

Figure B16. Plot 2 conditions during horticultural monitoring #27, 12/20/2016.

Figure B17. Plot 2 conditions during horticultural monitoring #28, 01/20/2017.

Figure B18. Plot 2 conditions during horticultural monitoring #29, 02/22/2017.

Figure B19. Plot 2 conditions during horticultural monitoring #30, 03/21/2017.

Figure B20. Plot 2 conditions during horticultural monitoring #31, 04/25/2017.

Figure B21. Plot 3 conditions during horticultural monitoring #22, 07/14/2016.

Figure B22. Plot 3 conditions during horticultural monitoring #23, 08/16/2016.

Figure B23. Plot 3 conditions during horticultural monitoring #24, 09/20/2016.

Figure B24. Plot 3 conditions during horticultural monitoring #25, 10/13/2016.

Figure B25. Plot 3 conditions during horticultural monitoring #26, 11/11/2016.

Figure B26. Plot 3 conditions during horticultural monitoring #27, 12/20/2016.

Figure B27. Plot 3 conditions during horticultural monitoring #28, 01/20/2017.

Figure B28. Plot 3 conditions during horticultural monitoring #29, 02/22/2017.

Figure B29. Plot 3 conditions during horticultural monitoring #30, 03/21/2017.

Figure B30. Plot 3 conditions during horticultural monitoring #31, 04/25/2017.

Figure B31. Plot 4 conditions during horticultural monitoring #22, 07/14/2016.

Figure B32. Plot 4 conditions during horticultural monitoring #23, 08/16/2016.

Figure B33. Plot 4 conditions during horticultural monitoring #24, 09/20/2016.

Figure B34. Plot 4 conditions during horticultural monitoring #25, 10/13/2016.

Figure B35. Plot 4 conditions during horticultural monitoring #26, 11/11/2016.

Figure B36. Plot 4 conditions during horticultural monitoring #27, 01/14/2016.

Figure B37. Plot 4 conditions during horticultural monitoring #28, 01/20/2017.

Figure B38. Plot 4 conditions during horticultural monitoring #29, 02/22/2017.

Figure B39. Plot 4 conditions during horticultural monitoring #30, 03/21/2017.

Figure B40. Plot 4 conditions during horticultural monitoring #31, 04/25/2017.

Figure B41. Plot 5 conditions during horticultural monitoring #22, 07/14/2016.

Figure B42. Plot 5 conditions during horticultural monitoring #23, 08/16/2016.

Figure B43. Plot 5 conditions during horticultural monitoring #24, 09/20/2016.

Figure B44. Plot 5 conditions during horticultural monitoring #25, 10/13/2016.

Figure B45. Plot 5 conditions during horticultural monitoring #26, 11/11/2016.

Figure B46. Plot 5 conditions during horticultural monitoring #27, 12/20/2016.

Figure B47. Plot 5 conditions during horticultural monitoring #28, 01/20/2017.

Figure B48. Plot 5 conditions during horticultural monitoring #29, 02/22/2017.

Figure B49. Plot 5 conditions during horticultural monitoring #30, 03/21/2017.

Figure B50. Plot 5 conditions during horticultural monitoring #31, 04/25/2017.

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Appendix C

Photographs of Quadrat Assessment from Botanical Monitoring on January 10, 2017

Figure C1. Plot 1, Quadrat 1 (10, 10) from botanical monitoring on 01/10/2017.

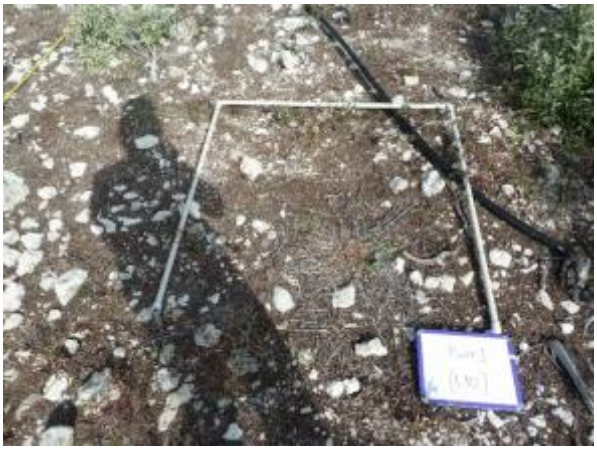

Figure C2. Plot 1, Quadrat 2 (1, 10) from botanical monitoring on 01/10/2017.

Figure C3. Plot 1, Quadrat 3 (5, 6) from botanical monitoring on 01/10/2017.

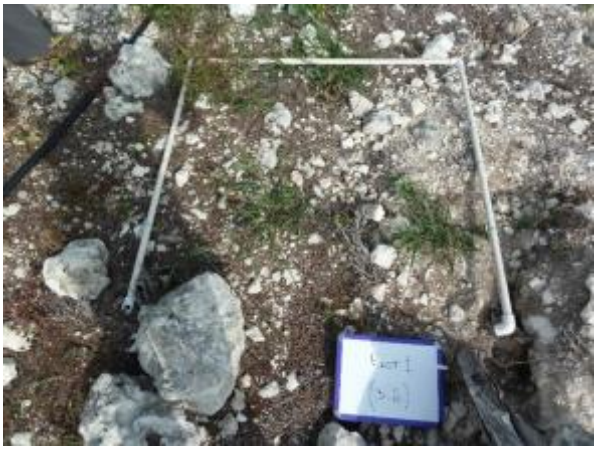

Figure C4. Plot 1, Quadrat 4 (3, 6) from botanical monitoring on 01/10/2017.

Figure C5. Plot 1, Quadrat 5 (11, 9) from botanical monitoring on 01/10/2017.

Figure C6. Plot 1, Quadrat 6 (9, 0) from botanical monitoring on 01/10/2017.

Figure C7. Plot 1, Quadrat 7 (1, 2) from botanical monitoring on 01/10/2017.

Figure C8. Plot 1, Quadrat 8 (3, 9) from botanical monitoring on 01/10/2017.

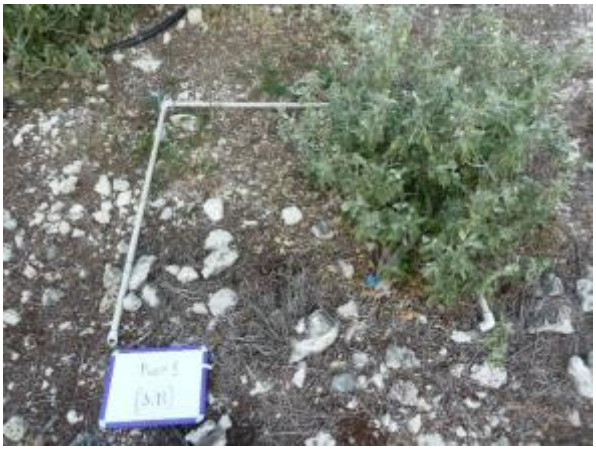

Figure C9. Plot 1, Quadrat 9 (3, 11) from botanical monitoring on 01/10/2017.

Figure C10. Plot 1, Quadrat 10 (10, 1) from botanical monitoring on 01/10/2017.

Figure C11. Plot 2, Quadrat 1 (4, 11) from botanical monitoring on 01/10/2017.

Figure C12. Plot 2, Quadrat 2 (8, 3) from botanical monitoring on 01/10/2017.

Figure C13. Plot 2, Quadrat 3 (8, 11) from botanical monitoring on 01/10/2017.

Figure C14. Plot 2, Quadrat 4 (0, 0) from botanical monitoring on 01/10/2017.

Figure C15. Plot 2, Quadrat 5 (2, 5) from botanical monitoring on 01/10/2017.

Figure C16. Plot 2, Quadrat 6 (4, 1) from botanical monitoring on 01/10/2017.

Figure C17. Plot 2, Quadrat 7 (9, 0) from botanical monitoring on 01/10/2017.

Figure C18. Plot 2, Quadrat 8 (6, 8) from botanical monitoring on 01/10/2017.

Figure C19. Plot 2, Quadrat 9 (1, 11) from botanical monitoring on 01/10/2017.

Figure C20. Plot 2, Quadrat 10 (6, 4) from botanical monitoring on 01/10/2017.

Figure C21. Plot 3, Quadrat 1 (4, 7) from botanical monitoring on 01/10/2017.

Figure C22. Plot 3, Quadrat 2 (4, 0) from botanical monitoring on 01/10/2017.

Figure C23. Plot 3, Quadrat 3 (8, 6) from botanical monitoring on 01/10/2017.

Figure C24. Plot 3, Quadrat 4 (4, 8) from botanical monitoring on 01/10/2017.

Figure C25. Plot 3, Quadrat 5 (5, 7) from botanical monitoring on 01/10/2017.

Figure C26. Plot 3, Quadrat 6 (2, 0) from botanical monitoring on 01/10/2017.

Figure C27. Plot 3, Quadrat 7 (11, 1) from botanical monitoring on 01/10/2017.

Figure C28. Plot 3, Quadrat 8 (6, 7) from botanical monitoring on 01/10/2017.

Figure C29. Plot 3, Quadrat 9 (8, 5) from botanical monitoring on 01/10/2017.

Figure C30. Plot 3, Quadrat 10 (9, 6) from botanical monitoring on 01/10/2017.

Figure C31. Plot 4, Quadrat 1 (4, 4) from botanical monitoring on 01/10/2017.

Figure C32. Plot 4, Quadrat 2 (4, 1) from botanical monitoring on 01/10/2017.

Figure C33. Plot 4, Quadrat 3 (9, 0) from botanical monitoring on 01/10/2017.

Figure C34. Plot 4, Quadrat 4 (7, 6) from botanical monitoring on 01/10/2017.

Figure C35. Plot 4, Quadrat 5 (11, 3) from botanical monitoring on 01/10/2017.

Figure C36. Plot 4, Quadrat 6 (9, 6) from botanical monitoring on 01/10/2017.

Figure C37. Plot 4, Quadrat 7 (1, 6) from botanical monitoring on 01/10/2017.

Figure C38. Plot 4, Quadrat 8 (5, 5) from botanical monitoring on 01/10/2017.

Figure C39. Plot 4, Quadrat 9 (7, 0) from botanical monitoring on 01/10/2017.

Figure C40. Plot 4, Quadrat 10 (3, 5) from botanical monitoring on 01/10/2017.

Appendix D

Photographs of Quadrat Assessment from Botanical Monitoring on June 14, 2017

Figure D1. Plot 1, Quadrat 1 (10, 10) from botanical monitoring on 6/14/2017.

Figure D2. Plot 1, Quadrat 2 (1, 10) from botanical monitoring on 6/14/2017.

Figure D3. Plot 1, Quadrat 3 (5, 6) from botanical monitoring on 6/14/2017.

Figure D4. Plot 1, Quadrat 4 (3, 6) from botanical monitoring on 6/14/2017.

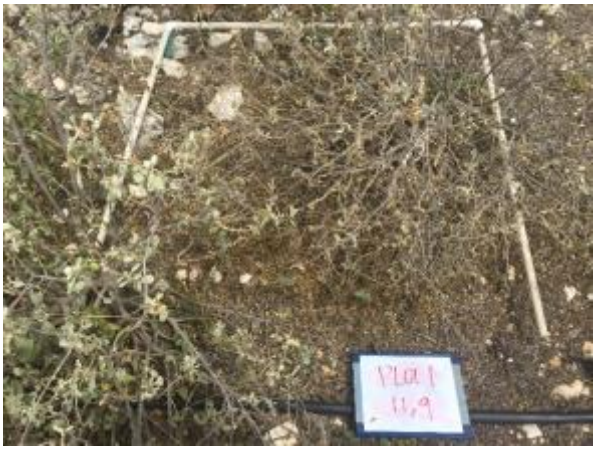

Figure D5. Plot 1, Quadrat 5 (11, 9) from botanical monitoring on 6/14/2017.

Figure D6. Plot 1, Quadrat 6 (9, 0) from botanical monitoring on 6/14/2017.

Figure D7. Plot 1, Quadrat 7 (1, 2) from botanical monitoring on 6/14/2017.

Figure D8. Plot 1, Quadrat 8 (3, 9) from botanical monitoring on 6/14/2017.

Figure D9. Plot 1, Quadrat 9 (3, 11) from botanical monitoring on 6/14/2017.

Figure D10. Plot 1, Quadrat 10 (10, 1) from botanical monitoring on 6/14/2017.

Figure D11. Plot 2, Quadrat 1 (4, 11) from botanical monitoring on 6/14/2017.

Figure D12. Plot 2, Quadrat 2 (8, 3) from botanical monitoring on 6/14/2017.

Figure D13. Plot 2, Quadrat 3 (8, 11) from botanical monitoring on 6/14/2017.

Figure D14. Plot 2, Quadrat 4 (0, 0) from botanical monitoring on 6/14/2017.

Figure D15. Plot 2, Quadrat 5 (2, 5) from botanical monitoring on 6/14/2017.

Figure D16. Plot 2, Quadrat 6 (4, 1) from botanical monitoring on 6/14/2017.

Figure D17. Plot 2, Quadrat 7 (9, 0) from botanical monitoring on 6/14/2017.

Figure D18. Plot 2, Quadrat 8 (6, 8) from botanical monitoring on 6/14/2017.

Figure D19. Plot 2, Quadrat 9 (1, 11) from botanical monitoring on 6/14/2017.

Figure D20. Plot 2, Quadrat 10 (6, 4) from botanical monitoring on 6/14/2017.

Figure D21. Plot 3, Quadrat 1 (4, 7) from botanical monitoring on 6/14/2017.

Figure D22. Plot 3, Quadrat 2 (4, 0) from botanical monitoring on 6/14/2017.

Figure D23. Plot 3, Quadrat 3 (8, 6) from botanical monitoring on 6/14/2017.

Figure D24. Plot 3, Quadrat 4 (4, 8) from botanical monitoring on 6/14/2017.

Figure D25. Plot 3, Quadrat 5 (5, 7) from botanical monitoring on 6/14/2017.

Figure D26. Plot 3, Quadrat 6 (2, 0) from botanical monitoring on 6/14/2017.

Figure D27. Plot 3, Quadrat 7 (11, 1) from botanical monitoring on 6/14/2017.

Figure D28. Plot 3, Quadrat 8 (6, 7) from botanical monitoring on 6/14/2017.

Figure D29. Plot 3, Quadrat 9 (8, 5) from botanical monitoring on 6/14/2017.

Figure D30. Plot 3, Quadrat 10 (9, 6) from botanical monitoring on 6/14/2017.

Figure D31. Plot 4, Quadrat 1 (4, 4) from botanical monitoring on 6/14/2017.

Figure D32. Plot 4, Quadrat 2 (4, 1) from botanical monitoring on 6/14/2017.

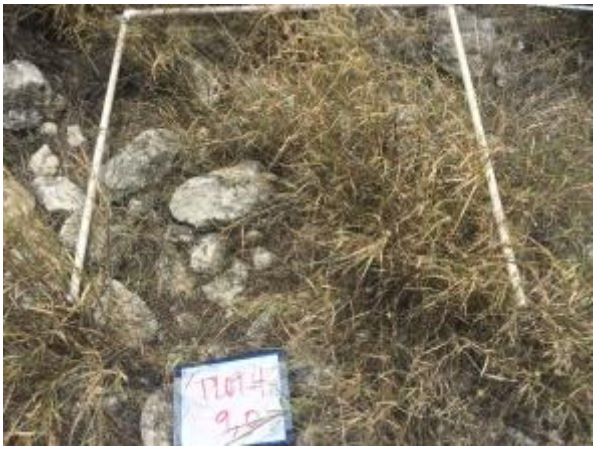

Figure D33. Plot 4, Quadrat 3 (9, 0) from botanical monitoring on 6/14/2017.

Figure D34. Plot 4, Quadrat 4 (7, 6) from botanical monitoring on 6/14/2017.

Figure D35. Plot 4, Quadrat 5 (11, 3) from botanical monitoring on 6/14/2017.

Figure D36. Plot 4, Quadrat 6 (9, 6) from botanical monitoring on 6/14/2017.

Figure D37. Plot 4, Quadrat 7 (1, 6) from botanical monitoring on 6/14/2017.

Figure D38. Plot 4, Quadrat 8 (5, 5) from botanical monitoring on 6/14/2017.

Figure D39. Plot 4, Quadrat 9 (7, 0) from botanical monitoring on 6/14/2017.

Figure D40. Plot 4, Quadrat 10 (3, 5) from botanical monitoring on 6/14/2017.

Figure D41. Plot 5, Quadrat 1 (0, 4) from botanical monitoring on 6/14/2017.

Figure D42. Plot 5, Quadrat 2 (4, 0) from botanical monitoring on 6/14/2017.

Figure D43. Plot 5, Quadrat 3 (4, 4) from botanical monitoring on 6/14/2017.