SWCA®
ENVIRONMENTAL CONSULTANTS
Sound Science. Creative Solutions.®

Annual Report for the Kenai Industrial Park Round-Leaved Chaff Flower (*Achyranthes splendens* var. *rotundata*) Habitat Conservation Plan July 1, 2017–June 30, 2018

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 2018

ANNUAL REPORT FOR THE KENAI INDUSTRIAL PARK ROUND-LEAVED CHAFF FLOWER (*ACHYRANTHES SPLENDENS* VAR. *ROTUNDATA*) HABITAT CONSERVATION PLAN JULY 1, 2017–JUNE 30, 2018

Prepared for

CIRI Land Development Company
2525 C Street, Suite 500
Anchorage, Alaska 99503

and

AKC Leasing Corporation
2906 Kaihikapu Street
Honolulu, Hawai'i 96819

Submitted to

State of Hawai'i, **Division of Forestry and Wildlife**
1151 Punchbowl Street, Room 325
Honolulu, Hawai'i 96813

Prepared by

SWCA Environmental Consultants
Bishop Square ASB Tower
1001 Bishop Street, Suite 2800
Honolulu, Hawai'i 96813
(808) 548-7899
www.swca.com

SWCA Project No. 27900

Submitted August 28, 2018

CONTENTS

Appendices

Figures

Tables

1 INTRODUCTION

In February 2014, CIRI Land Development Company (CIRI) 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 federally 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 3 and moving into Year 4 of the HCP implementation at the Kalaeloa Unit (the mitigation site) from July 1, 2017, to June 30, 2018. During this time, maintenance and monitoring occurred at the mitigation site as required in the HCP, with four 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 inform the need for remedial and adaptive management measures. Monitoring was led by SWCA Project Manager Jaap Eijzenga, SWCA Botanist Danielle Frohlich, and SWCA Botanist Alex Lau. 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 was 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 square m (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 1–4 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 sixteenth 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 square meters (172 square feet).

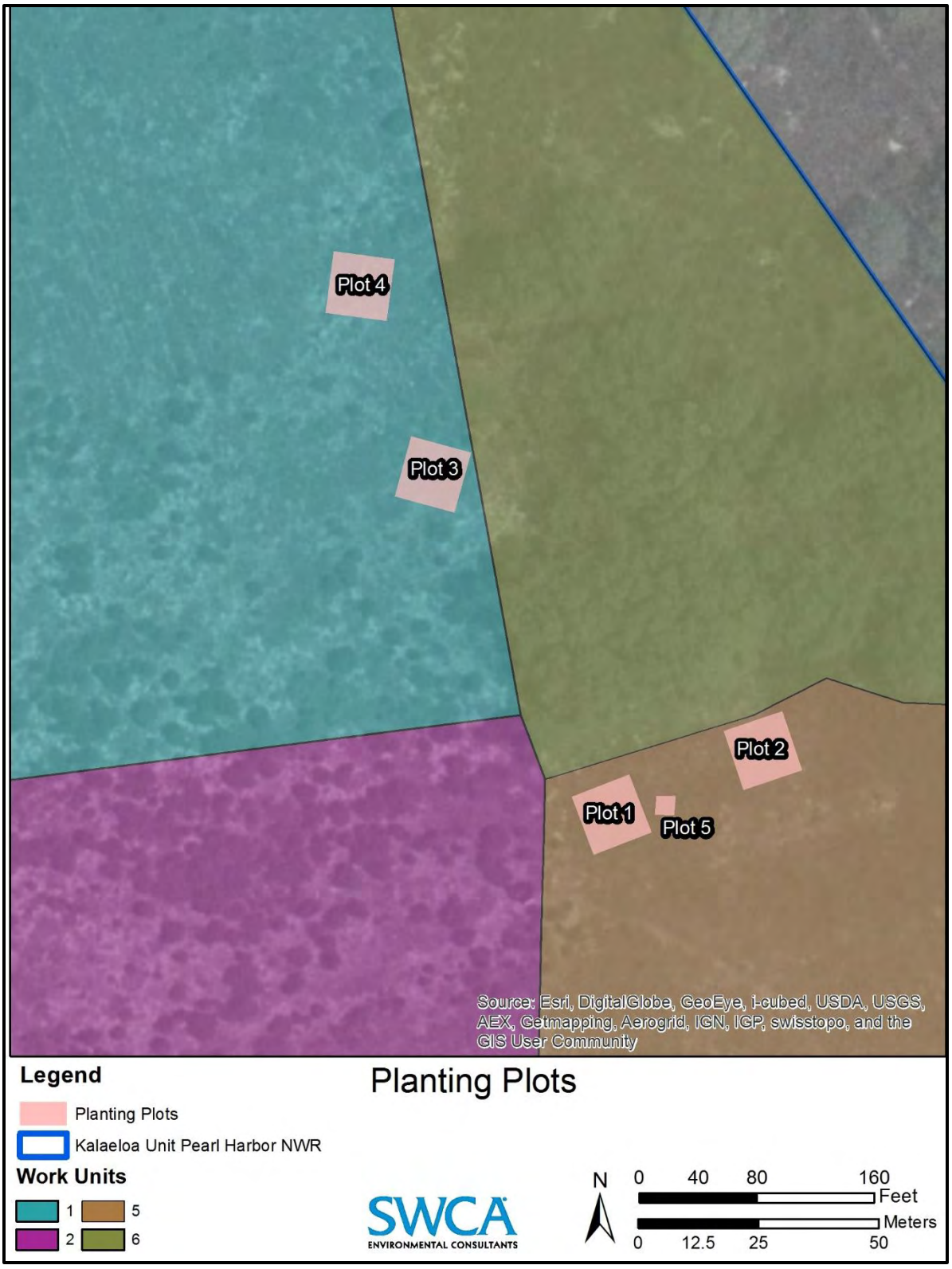

Figure 1. Planting plots in the mitigation site.

3 METHODS

Table 1 presents a timeline for activities associated with implementation of the HCP between mid-July 2017 and early June 2018.

Table 1. Timeline of Monitoring Activities

Year	Activity	Date
3	Horticultural monitoring no. 32	07/18/2017
	Horticultural monitoring no. 33	10/04/2017
	Horticultural monitoring no. 34	01/16/2018
	Botanical monitoring no. 8	02/09/2018
4	Horticultural monitoring no. 35	04/12/2018
	Botanical monitoring no. 9	06/06/2018

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 the project horticulturalist.

During the remainder of Year 3 and into Year 4, maintenance took place quarterly. If deemed necessary by the project horticulturist, maintenance will occur more frequently throughout the remainder of Years 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 quarterly during the remainder of Year 3 (July 2017–January 2018) and continued quarterly into Year 4. 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 3 (February 2018), and the second took place as part of Year 4 (June 2018). 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 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 the 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 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.

No supplemental watering has taken place during the last five maintenance visits from this reporting period. 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 continued presence of the highly destructive bostrichid beetle (*Amphicerus* sp.) identified in early 2017, have led to three chemical treatments of Safari (one of two pesticides approved by the USFWS to be used at the NWR) at the plots. Safari was applied three times in Year 3 (once in September 2017 and twice in January 2018) at a rate of 3.5 ounces over all plants.

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

4.2 Monitoring

Four horticultural monitoring events and two botanical monitoring events took place from mid-July 2017 through early June 2018 (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 1–4 on November 2014, in Plot 5. These four individuals were added to the total count on January 14, 2016 (sixteenth horticultural monitoring event). In order to allow for better data tracking, monitoring data were being reported separately for original plantings and progeny starting from the first reporting period in Year 4 on July 18, 2017.

Seventy-four of the originally outplanted individuals (47%) survived as of the most recent horticultural monitoring on April 12, 2018 (Figure 2). Plots 5 and 3 maintained the highest number of survival with 73% and 63% survival, respectively. During the same monitoring in April, a total of 47 progeny were tagged and numbered, and reported as separate individuals (Figure 3).

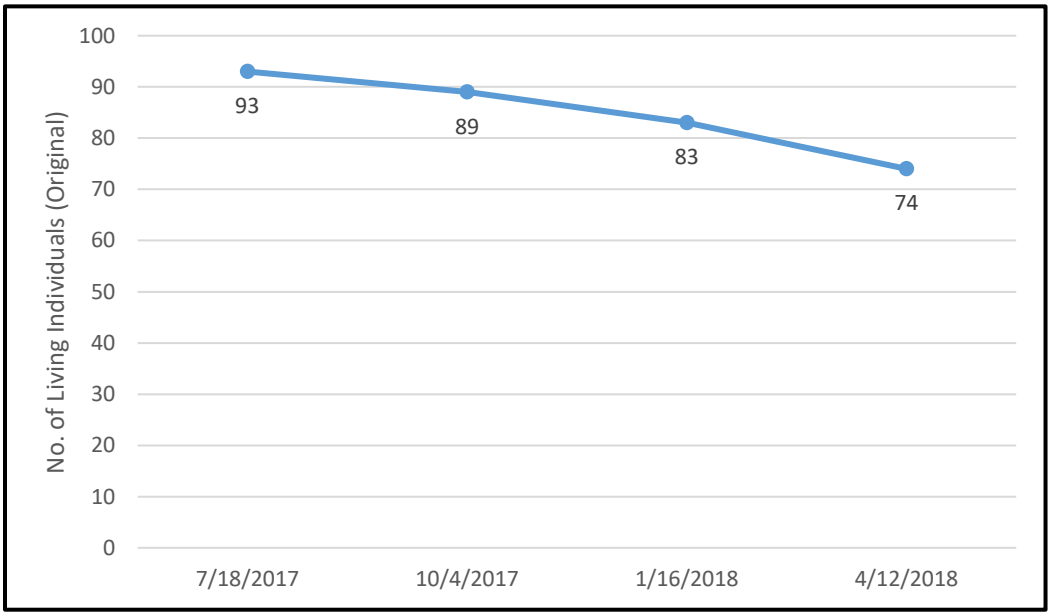

Figure 2. Survival of original plants during the horticultural monitoring events (July 18, 2017, to April 12, 2018).

Overall, the numbers of originally outplanted individuals have decreased in all plots over time since the last monitoring event in the third annual report (June 14, 2017). However, the overall total number of individuals has gone up (Table 2), as the number of new progeny recorded between July 18, 2017 and April 12, 2018 increased by 27 individuals (see Figure 3) bringing the total number of progeny to 47. Plots 3 and 1 had the highest number of progeny, 11 and 8 individuals, respectively, while plots 2 and 1 had the lowest survival numbers, with 63% and 57% survival, respectively (see Table 2).

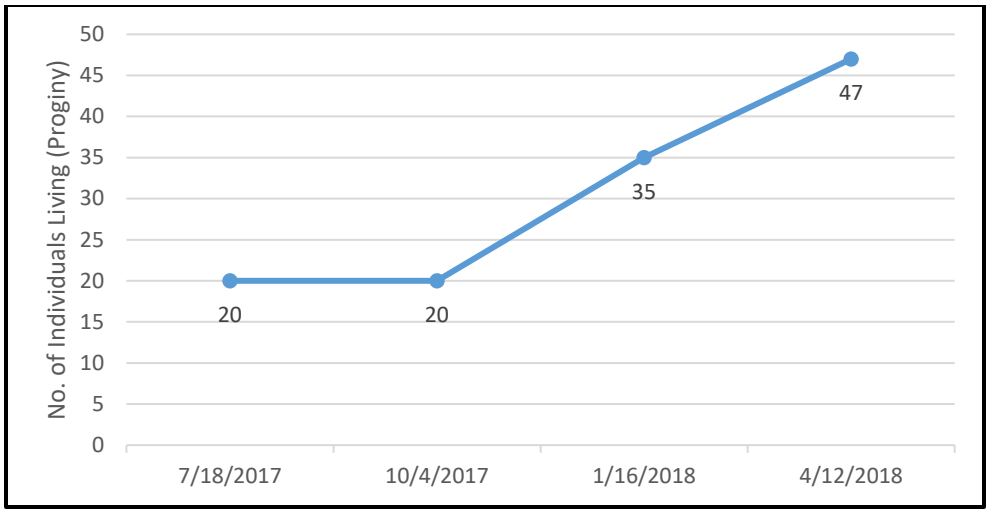

Figure 3. Survival of progeny during the horticultural monitoring events (July 18, 2017, to April 12, 2018).

Table 2. Number of Original Individuals and Progeny between the First and Last Monitoring of the Annual Reporting Period

Plot	Number of Original Individuals Living (07/18/2017)	Number of Original Individuals Living (04/12/2018)	Number of Progeny Living (07/18/2017)	Number of Progeny Individuals Living (04/12/2018)
1	25 (60%)	18 (43%)	8 (100%)	23 (100%)
2	23 (47%)	18 (37%)	1 (100%)	2 (100%)
3	22 (73%)	19 (63%)	11 (100%)	22 (98%)
4	20 (59%)	16 (47%)	-	-
5	3 (75%)	3 (75%)	-	-
Total	**93 (58%)**	**74 (47%)**	**20 (100%)**	**47 (98%)**

4.2.2 Plant Vigor

The fluctuations in vigor seen during this reporting period in the original and the progeny individuals continued to reflect those seen in previous years (Figures 4–5). These fluctuations can be attributed primarily to drought stress and hot temperatures during the dry season, as well as infestations of mealybug and bostrichid beetle that arise when plants are stressed.

Overall, vigor was low throughout the length of the annual reporting period. Healthy vigor of the original outplants was noted only on seven individuals (4%) in July 2017. It decreased even more the following monitoring period, in October 2017, when zero individuals (0%) showed healthy vigor. After two pesticide treatments, the pest infestation (consisting of mealy bugs and bostrichid beetle) was under control, and in January 2018, healthy vigor was noted on 27 individuals (17%); by April 2018, healthy vigor had increased to 52 individuals (33%). The percentage of plants considered moderately vigorous fluctuated throughout the monitoring period between 28% and 9% in July and October 2017, and then it increased up to 25% in January and decreased again to 13% in April 2018. Representative photographs depicting different vigor categories are shown in Figures 6–8.

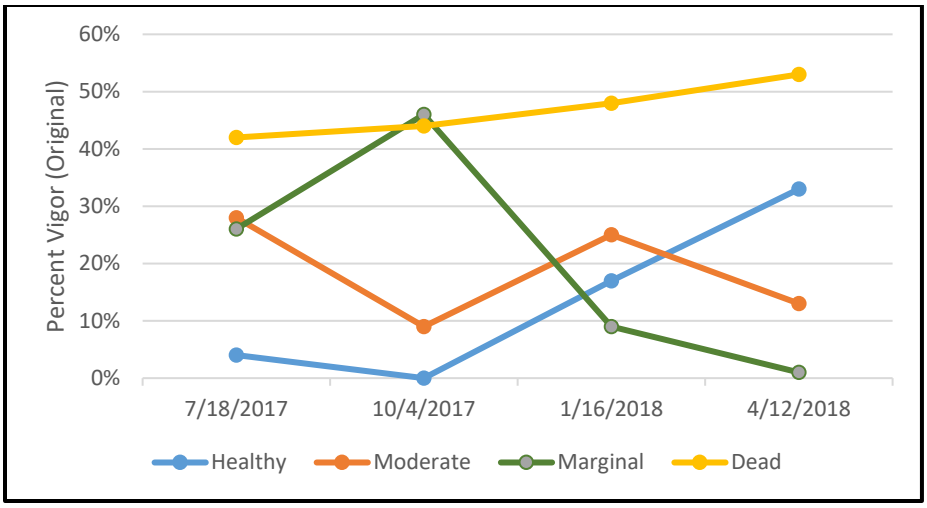

Figure 4. Percentage of original plants in the various vigor categories during the horticultural monitoring events (July 18, 2017, to April 12, 2018).

Progeny vigor also fluctuated throughout the monitoring events. No healthy individuals (0%) were recorded in July and October 2017, but they increased up to 40% in January 2018 and 75% in April 2018. Moderate vigor decreased consistently from 80% in the beginning of the reporting period in July to 23% during the last monitoring in April.

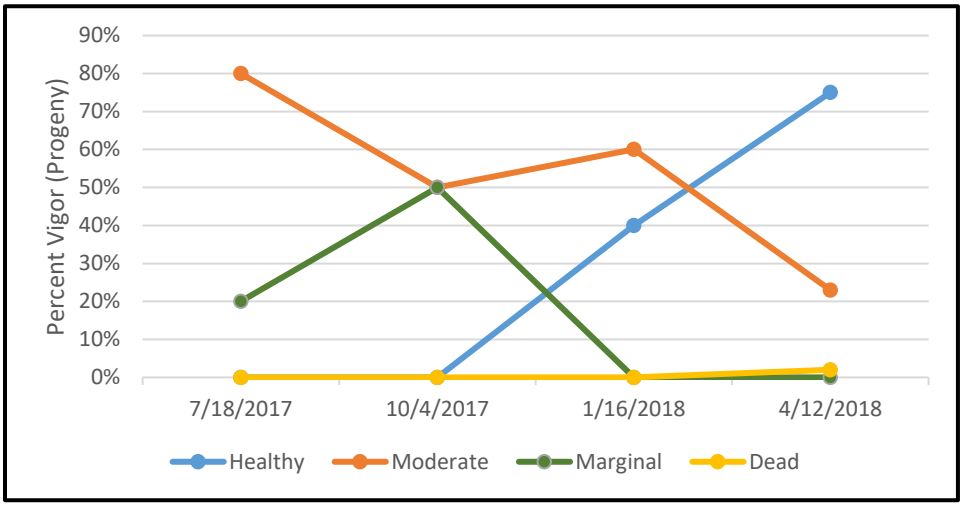

Figure 5. Percentage of progeny in the various vigor categories during the horticultural monitoring events (July 18, 2017, to April 12, 2018).

Figure 6. Representative plants showing healthy vigor.

Figure 7. Representative plants showing moderate vigor.

Figure 8. Representative plants showing marginal vigor (left) and dead plant (right).

4.2.3 Pests

Pest presence was similar for both the original and the progeny individuals throughout the reporting period.

Consistent with the previous monitoring reports, pests (mainly mealybug, bostrichid beetle, and ants) continue to be a significant issue for all plots as the seasons change from wet to dry. Pests were noted on all original plants (100%) in July and on 99% of individuals in October 2017 (Figure 9). After three pesticide treatments, the severity of the infestation decreased by over a half to 58% in April 2018.

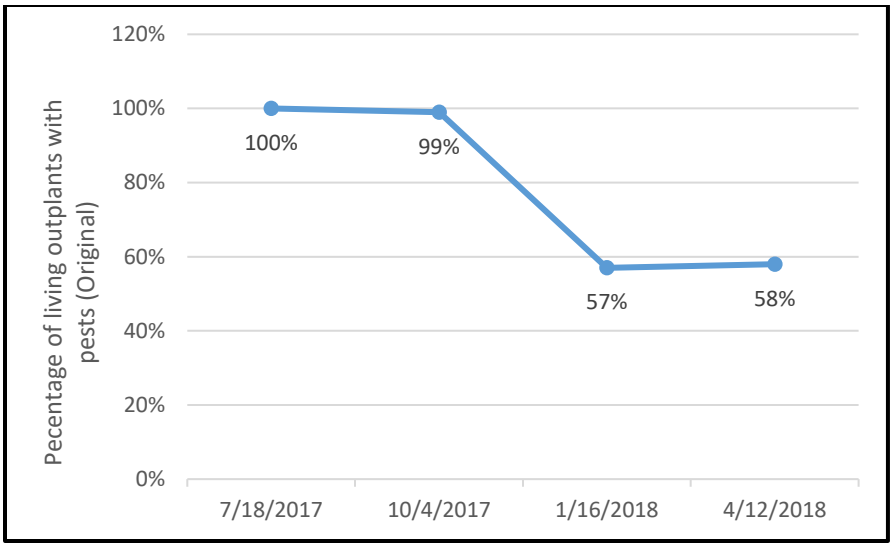

Figure 9. Percentage of all live original plants with pests during the horticultural monitoring events (July 18, 2017, to April 12, 2018).

Similar to the original outplantings, all progeny were infested (100%) in July and October 2017 (Figure 10). As they are generally stronger and healthier than the original outplantings, they weathered the infestation better than the original individuals, and only 26% were showing pest presence at the end of the reporting period in April.

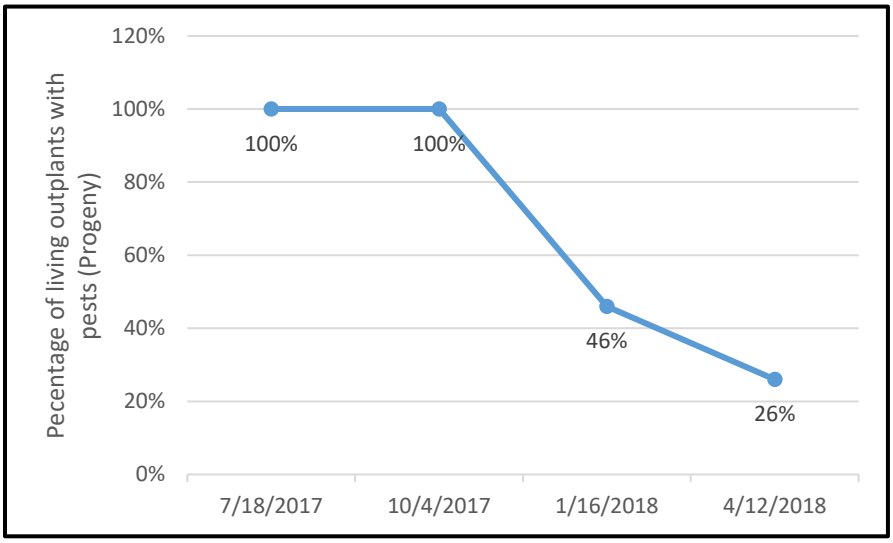

Figure 10. Percentage of all live progeny plants with pests during the horticultural monitoring events (July 18, 2017, to April 12, 2018).

Presence of the bostrichid beetle continues to be noted throughout the plots, and it continues to contribute to mortality in outplants. It is possible that the plants are dying because they are at the end of their lives and are weakened. The beetle is likely attacking dead or dying branches and introducing a fungus that weakens the plant further (K. Magnacca, pers comm). Some plants have been noted deteriorating from moderate or healthy vigor to dead within a matter of months after being colonized by this beetle. Mortality related beetle presence was significant during this reporting period, and pesticide

continues to be applied as a control measure wherever beetles are found. No rodent or other vertebrate damage has been seen in any of the plots.

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 27% in Plot 4 in July 2017, to 70% in Plot 3 at the end of the reporting year in April 2018 (Figure 11). Native cover was generally consistent between and within all plots, decreasing during dry periods (July 2017) between 27% and 40% within the plots, and ranging between 32% and 70% in April 2018 with increased rainfall. Plots were regularly weeded, although horticultural monitoring no. 35 (April 2018) took place before the maintenance crew was out at the site and after a heavy rainfall period, which consequently resulted in non-native cover reaching over 25% in nearly all plots for the reported data (Figure 12). The maintenance crew was notified immediately and weeding took place to address the overgrowth. For the remaining horticultural monitoring events, non-native cover stayed low, never reaching above 25% in all plots during the horticultural monitoring events (July 2017 to April 2018).

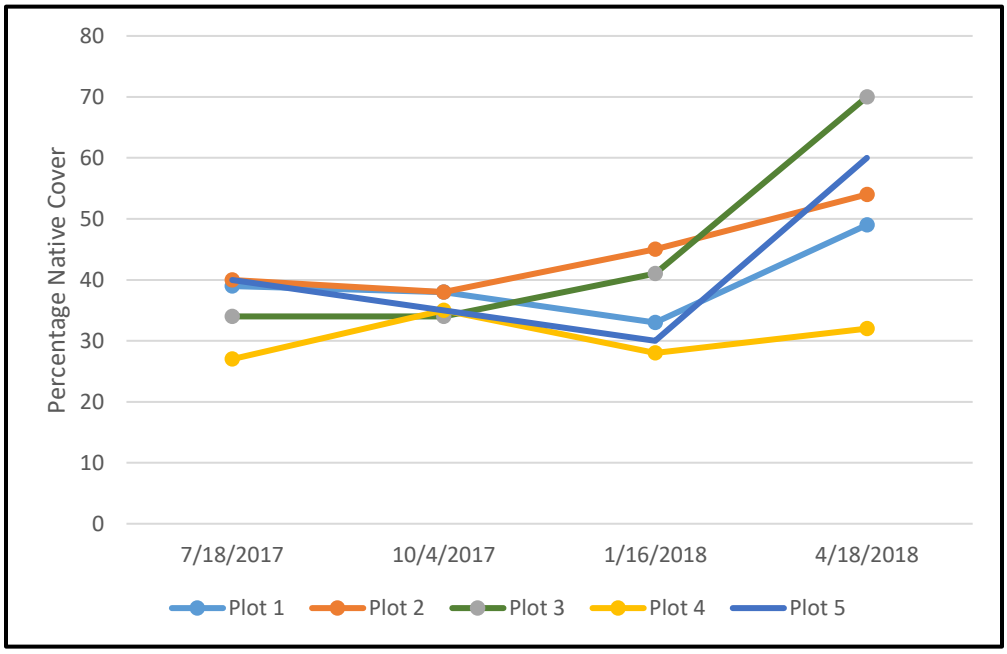

Figure 11. Estimated native plant cover in Plots 1–4 during the horticultural monitoring events (July 18, 2017, to April 12, 2018).

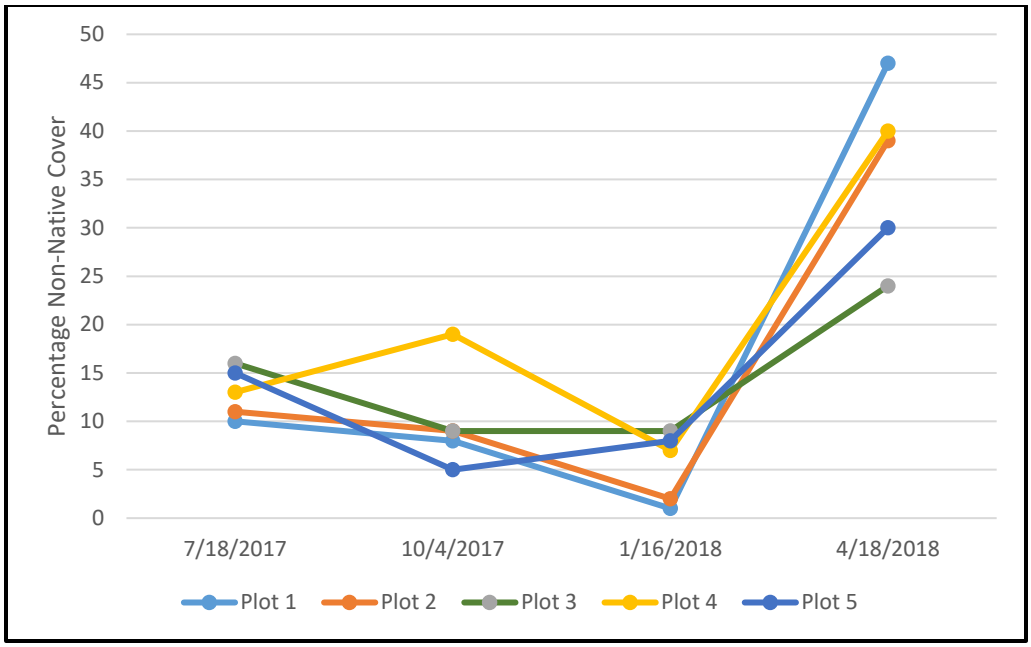

Figure 12. Estimated non-native plant cover in Plots 1–4 during the horticultural monitoring events (July 18, 2017, to April 12, 2018).

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).

Native cover was higher in all plots during the two botanical events, with the exception of Plot 4; in the past, some of its non-native cover was reported to be higher than the native cover. With maintenance activities now taking place quarterly, weeding does not take place as often as it did in the previous reporting periods, which may lead to higher amounts of non-native cover.

Table 3. Mean Cover of Native and Non-Native Species in Plots 1–4 during the Two Botanical Monitoring Events (February 9, 2018, and June 6, 2018)

Plot	Mean Native Cover (%)		Mean Non-Native Cover (%)	
	February 9, 2018	June 6, 2018	February 9, 2018	June 6, 2018
1	26.30	16.50	17.00	9.70
2	52.60	44.10	11.00	0.70
3	33.60	22.00	22.70	4.10
4	13.80	8.50	17.20	17.40

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.* Where most of the round-leaved chaff flower individuals were planted, some seedling regeneration occurred below planted individuals. Plots 1 and 3 have had the highest cover percentage of round-leaved chaff flower. In addition, ʻilima and ʻilima pua kea *(Abutilon incanum)* were the predominant native cover for Plot 2 during the two botanical monitoring periods, while naio had the highest percent native cover in Plot 4 in June 2018. The non-native plants scarlet spiderling (*Boerhavia coccinea*) and buffel grass *(Cenchrus ciliaris)* had the highest overall cover for non-native species.

Total average non-native cover varied in the quadrats between 0.70% and 22.70% in February and June 2018.

Photographs of each quadrat assessed for cover during the botanical monitoring in February and June 2018 are provided in Appendices 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-leaved chaff flower phenology (USFWS 1994). Nearly all individuals were reproductive (100%) during most of the horticultural events. October 2017 saw the lowest percentage of reproductive individuals, with Plots 4 and 5 having no reproductive plants (0%) (Figures 13 and 14).

Nearly all progeny were reproductive during all monitoring events, although not all plots had reproductive individuals. Plot 2 had all of its progeny individuals reproductive in July and October 2017 and April 2018. The lowest percentage of reproductive progeny was noted in Plot 1 in July and October 2017 at 0%, and in January 2018 at 9%. No progeny have been noted in Plots 4 and 5 and thus no reproductive progeny have been noted for these plots. New seedlings were monitored, individuals reaching a height of 6 inches were tagged and numbered, and their growth, pest presence, and vigor were tracked. In all, 27 new progeny were tagged and tracked during this reporting year, bringing the total number of progeny to 47.

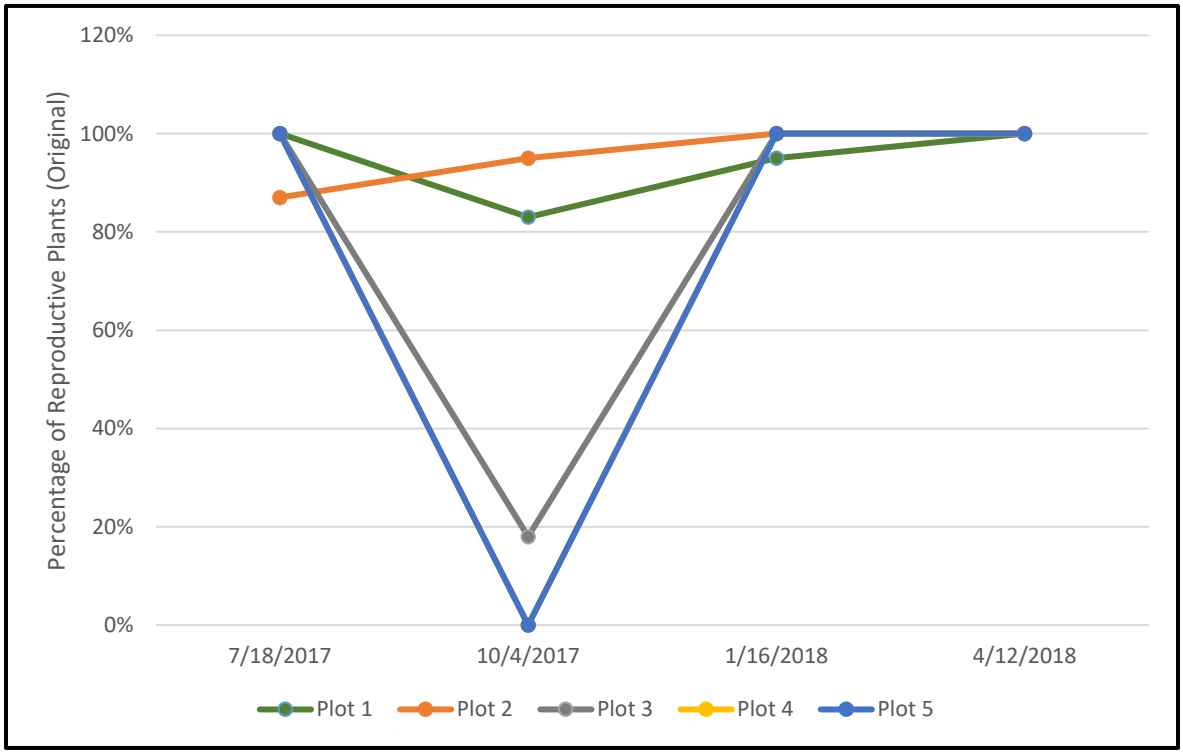

Figure 13. Percentage of reproductive living plants in Plots 1–5 during the horticultural monitoring events (July 18, 2017, to April 12, 2018).

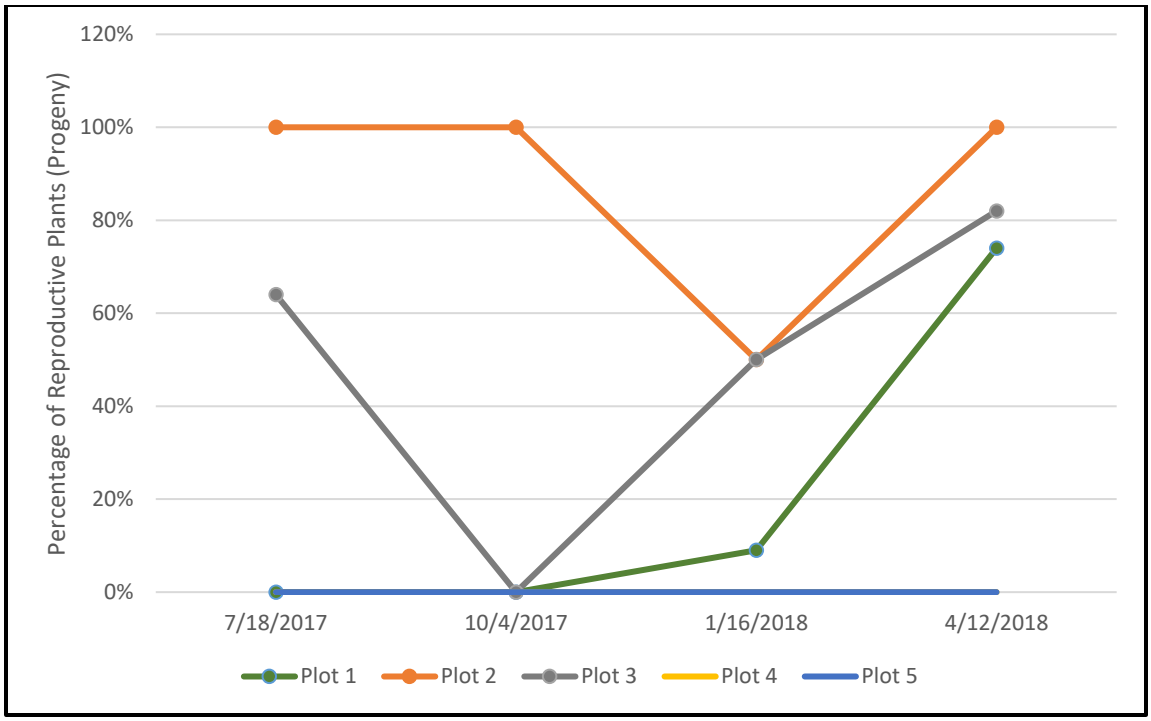

Figure 14. Percentage of reproductive living progeny in Plots 1–5 during the horticultural monitoring events (July 18, 2017, to April 12, 2018).

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 grandifolium	Hairy Indian mallow	X
Abutilon incanum	Maʻo, hoary abutilon	I
Achyranthes splendens var. *rotundata*	Round-leaved chaff flower	E
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
Desmanthus pernambucanus	Slender mimosa	X
Eragrostis amabilis	Japanese lovegrass	X
Euphorbia hirta	Hairy spurge	X
Euphorbia hypericifolia	Graceful spurge	X
Gossypium tomentosum	Maʻo	E
Leucaena leucocephala	Koa haole	X

Scientific Name	Hawaiian, Common Name(s)	Status*
Solanum lycopersicum var. cerasiforme	Tomato	X
Malva parviflora	Cheeseweed	X
Myoporum sandwicense	Naio, bastard sandalwood	I
Setaria verticillata	Bristly foxtail	X
Sicyos sp.	‘Anunu	E
Sida fallax	‘Ilima	I
Sonchus oleraceus	Common sowthistle	X
Tridax procumbens.	Coat buttons	X
Verbesina encelioides	Golden crownbeard	X
Waltheria indica	‘Uhaloa	I
Total		**24**

* 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 in the Immediate Vicinity during the Botanical Monitoring Events

Scientific Name	Common Name	Status*
Invertebrates		
Agraulis vanillae	Gulf fritillary	X
Amphicerus sp.	Bostrichid beetle	X
Apis mellifera	Honey bee	X
Pantala flavescens	Wandering glider	X
Paratrechina longicornis	Longhorn crazy ant	X
Phenacoccus solenopsis	Cotton mealybug	X
Pieris rapae	Cabbage butterfly	X
Avifauna		
Columba livia	Rock dove	X
Cardinalis cardinalis	Northern cardinal	X
Haemorhous mexicanus	House finch	X
Mimus polyglottos	Northern mockingbird	X
Paroaria coronata	Red-crested cardinal	X
Pycnonotus cafer	Red-vented bulbul	X
Pycnonotus jocosus	Red-whiskered bulbul	X
Mammalian Fauna		
Herpestes javanicus	Small Indian mongoose	X
Felis catus	Domestic cat	X
Total		**16**

* 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 the soil chemical analysis have been relatively constant throughout the monitoring period and across plots (Figures 15–20).

After receiving stable soil data during the monitoring period covered in the first annual report, consulting with soils specialists at the University of Hawai'i, and further discussing the data with DOFAW (personal communication, Afsheen Siddiqi, DOFAW, September 22, 2015), it was decided that only semiannual 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 February 9, 2018, and one on June 6, 2018. A soil analysis was done for pH, nitrogen, phosphorus, potassium, calcium, magnesium. In addition to the four original plots, soil data was collected and analyzed for Plot 5 as well.

The results of these soil analyses were consistent with previous reporting years. The pH levels in the plots remain between 7.2 and 7.7, which is naturally more alkaline compared to other Hawaiian soils because of the dominant presence of coral substrate. Nitrogen and phosphorous levels remain relatively high (see Figures 16 and 17) and are consistent with previous reporting of between 0.30 and 1.80 parts per million (ppm) microgram/gram (ug/g) for nitrogen and between 46 and 269 ppm ug/g for phosphorus. Potassium levels were between 39 and 207 ppm ug/g (see Figure 18). Calcium levels continued to be high at the site (see Figure 19) due to the presence of limestone, especially in Plot 4, which has the highest levels of limestone. Magnesium levels were between 421 and 1886 ppm ug/g (see Figure 20). The results for Plot 5 are consistent with the data from the other four plots.

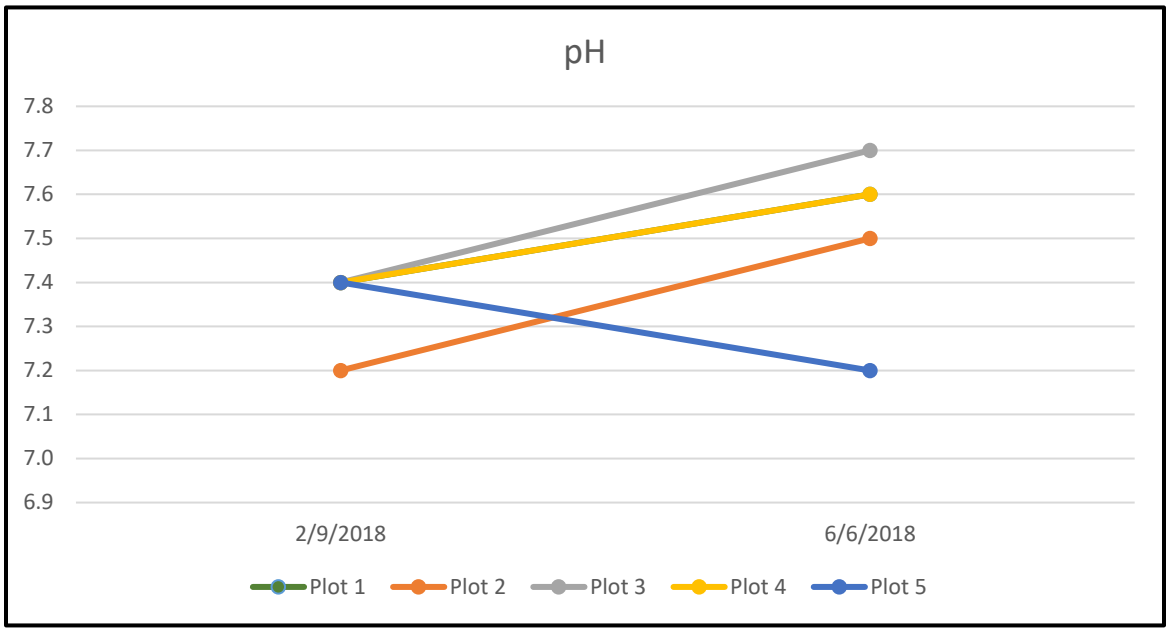

Figure 15. pH values recorded from soil samples taken during the botanical monitoring events.

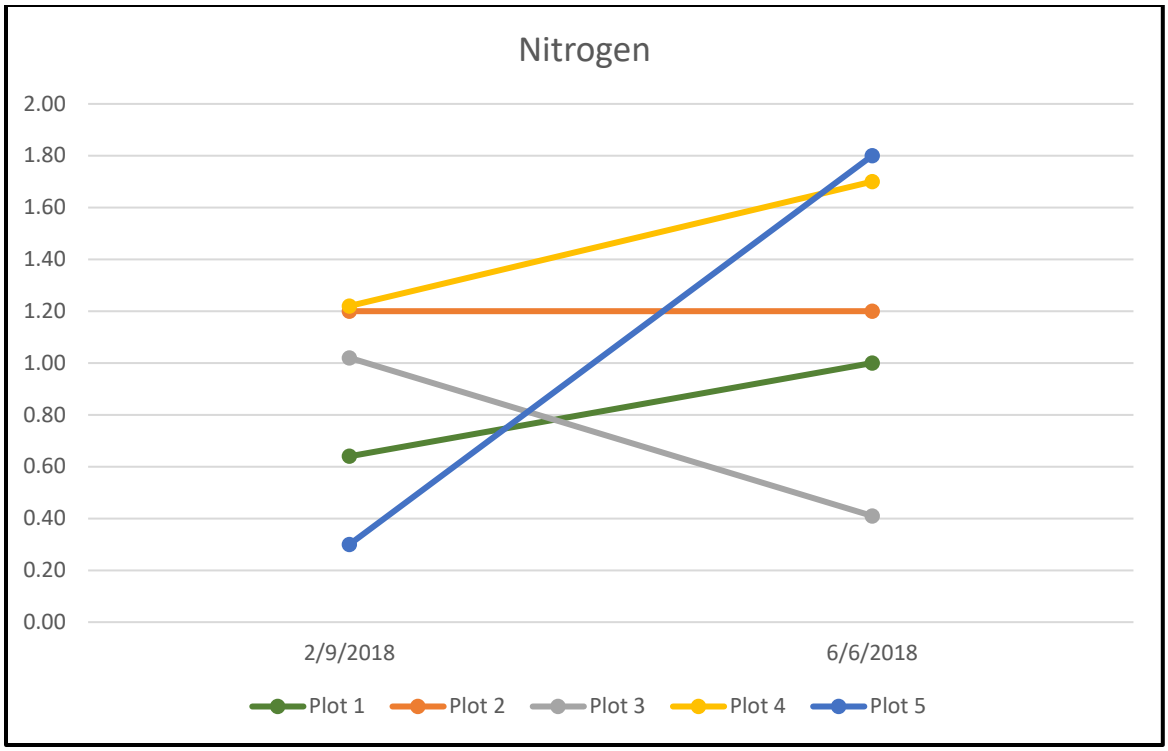

Figure 16. Nitrogen values recorded from soil samples taken during the botanical monitoring events.

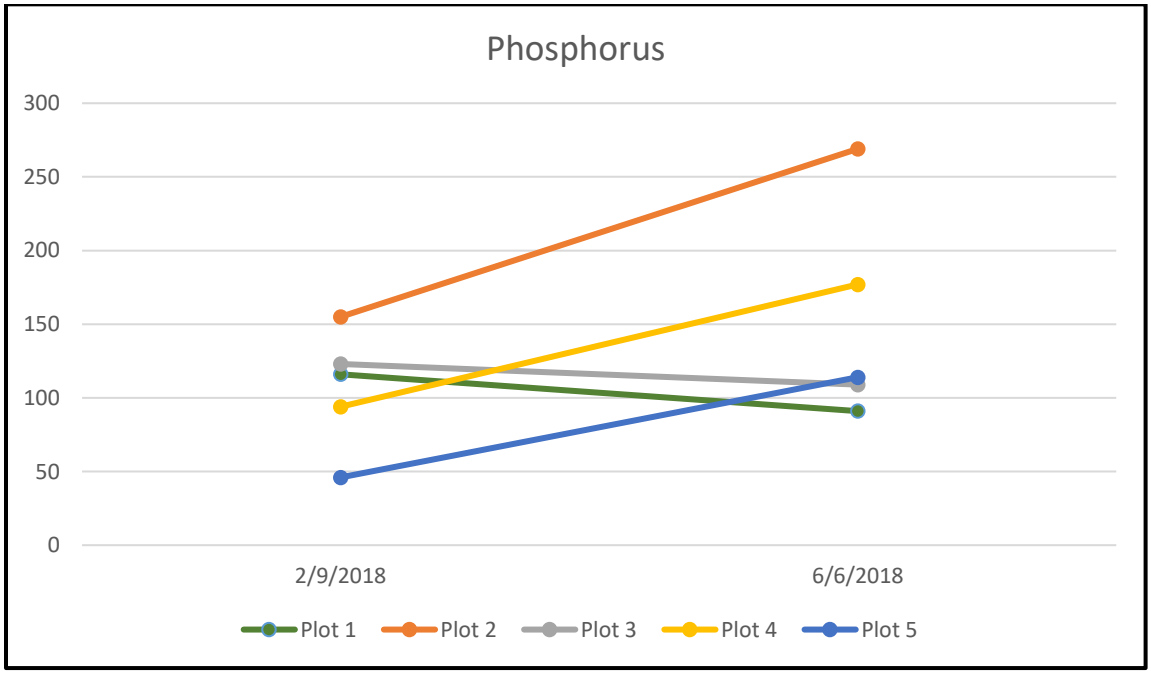

Figure 17. Phosphorous values recorded from soil samples taken during the botanical monitoring events.

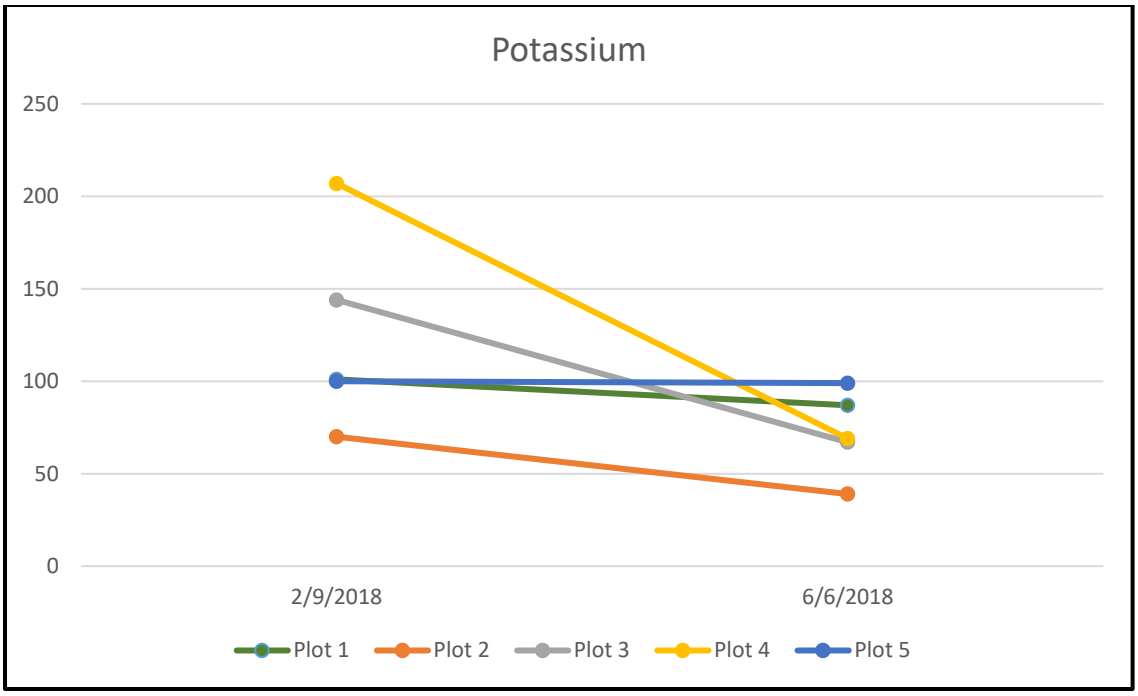

Figure 18. Potassium values recorded from soil samples taken during the botanical monitoring events.

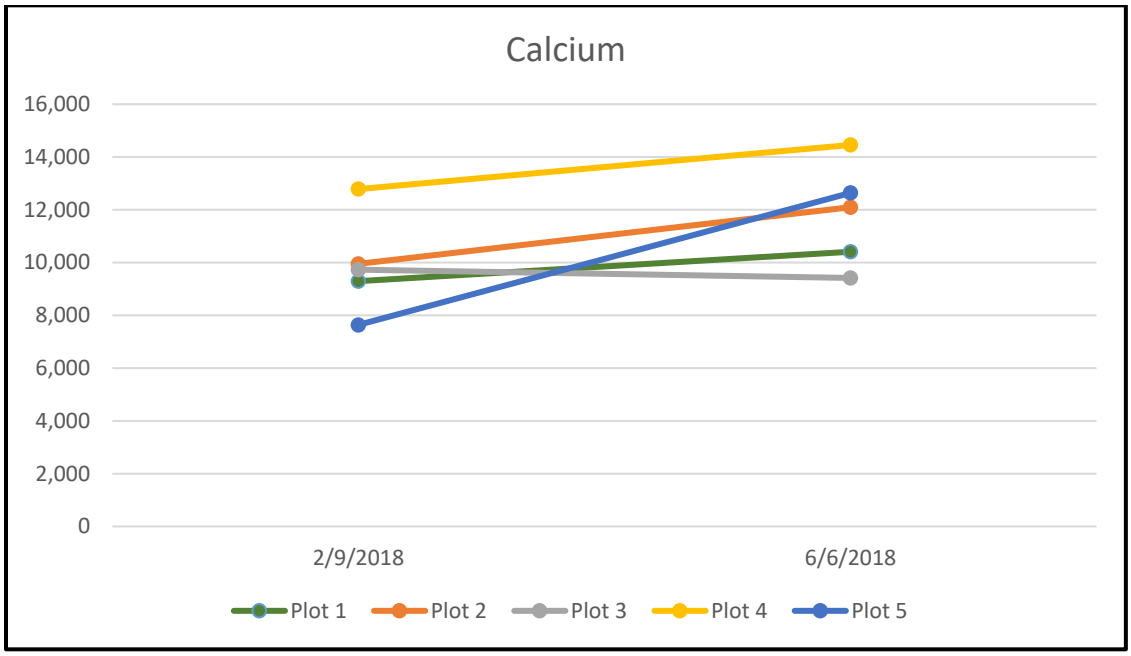

Figure 19. Calcium values recorded from soil samples taken during the botanical monitoring events.

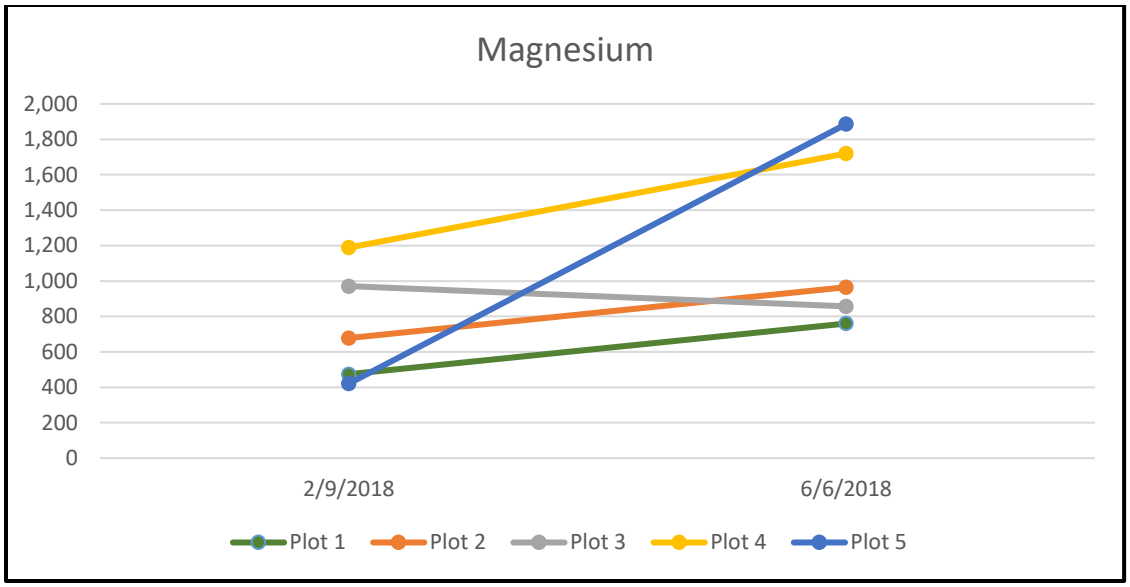

Figure 20. Magnesium values recorded from soil samples taken during the botanical monitoring events.

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 Pearl Harbor 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 criteria:

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. The 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. The 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 (July 1, 2016–June 30, 2017) with the exception of Criterion 1, which requires that 75% of the original outplants remain at the end of the reporting year. During the last horticultural monitoring on April 12, 2018, 74 of the originally outplanted individuals (47%) were alive,; 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, Hui Kū Maoli Ola, July 25, 2017). After survivorship of the original outplants dipped below the level specified in Criterion 1, SWCA and DOFAW agreed to discuss adjusting the survivorship criterion in the HCP to reflect the realities of this species' life history with the Endangered Species Recovery Committee (ESRC) (personal communication, Glenn Metzler, DOFAW, August 17, 2017). In response to this discussion in a meeting with ESRC and DOFAW on April 26, 2018 SWCA suggested 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, which is to ensure that round-leaved chaff flower becomes established at the mitigation site and has a stable and viable self-producing population. ESRC has agreed with the proposed changes to the success criteria and is working with DOFAW on processing an administrative approval to the HCP.

6 REMEDIAL MEASURES

Remedial measures 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

A Native Hawaiian Garden. 2017. *Achyranthes splendens* var. *rotundata* (*'Ewa hinahina*) – The power of volunteers. Available at: http://www.nativehawaiiangarden.org/flowering-plants/achyranthes. Accessed August 28, 2017.

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.

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

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

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 the U.S. Fish and Wildlife Service. 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.

Appendix A

Summary of Maintenance Activities

Table A-1. Summary of Maintenance Activities

Maintenance and Monitoring Period	Date of Visit	Comments
Year 3 (once every 3 months of monitoring)		
September	9/14/2017	The crew performed general maintenance activities: weeding and pesticide application. Approximately 3.5 oz of Safari was sprayed on infected plants to treat mealy bugs.
January	01/10/2018	Yes our guys were out there on 1/10/18 and 1/18/18. They weeded all plots and buffers. Safari was applied a total of 2 times on January 10th and January 18th. Each time we used 3.5 oz over the 6400 sqft. Yes we noticed the reduction in bugs on the second round so hopefully the bugs are getting under control to manageable levels.
January	01/18/2018	Yes our guys were out there on 1/10/18 and 1/18/18. They weeded all plots and buffers. Safari was applied a total of 2 times on January 10th and January 18th. Each time we used 3.5 oz over the 6400 sqft. Yes we noticed the reduction in bugs on the second round so hopefully the bugs are getting under control to manageable levels.
Year 4 (once every 3 months of monitoring)		
April	04/25/2018	The site is totally weeded and looks great! I was out there with them and there were some seedlings but not as many as I would've expected. Likely due to how dense the weed cover was. We thinned out some of the Ilima too to open it up a bit. No need at this point [in reference to pesticide application]. The plants look healthy without too many bug issues.
April	04/26/2018	The site is totally weeded and looks great! I was out there with them and there were some seedlings but not as many as I would've expected. Likely due to how dense the weed cover was. We thinned out some of the Ilima too to open it up a bit. No need at this point [in reference to pesticide application]. The plants look healthy without too many bug issues.

This page intentionally left blank.

Appendix B

Select Permanent Photo Points

Figure B-1. Plot 1 conditions during horticultural monitoring no. 32, 07/18/2017.

Figure B-2. Plot 1 conditions during horticultural monitoring no. 33, 10/04/2017.

Figure B-3. Plot 1 conditions during horticultural monitoring no. 34, 01/16/2018, is not available. Photograph was taken during a site visit on 12/21/2018 to assess plant conditions.

Figure B-4. Plot 1 conditions during horticultural monitoring no. 35, 04/12/2018.

Figure B-5. Plot 2 conditions during horticultural monitoring no. 32, 07/18/2017.

Figure B-6. Plot 2 conditions during horticultural monitoring no. 33, 10/04/2017.

Figure B-7. Plot 2 conditions during horticultural monitoring no. 34, 01/16/2018.

Figure B-8. Plot 2 conditions during horticultural monitoring no. 35, 04/12/2018.

Figure B-9. Plot 3 conditions during horticultural monitoring no. 32, 07/18/2017.

Figure B-10. Plot 3 conditions during horticultural monitoring no. 33, 10/04/2017.

Figure B-11. Plot 3 conditions during horticultural monitoring no. 34, 01/16/2018.

Figure B-12. Plot 3 conditions during horticultural monitoring no. 35, 04/12/2018.

Figure B-13. Plot 4 conditions during horticultural monitoring no. 32, 07/18/2017.

Figure B-14. Plot 4 conditions during horticultural monitoring no. 33, 10/04/2017.

Figure B-15. Plot 4 conditions during horticultural monitoring no. 34, 01/16/2018.

Figure B-16. Plot 4 conditions during horticultural monitoring no. 35, 04/12/2018.

Figure B-17. Plot 5 conditions during horticultural monitoring no. 32, 07/18/2017.

Figure B-18. Plot 5 conditions during horticultural monitoring no. 33, 08/16/2016.

Figure B-19. Plot 5 conditions during horticultural monitoring no. 34, 01/16/2018.

Figure B-20. Plot 5 conditions during horticultural monitoring no. 35, 04/12/2018.

This page intentionally left blank.

Appendix C

Photographs of Quadrat Assessment from Botanical Monitoring on February 9, 2018

Figure C1. Plot 1, Quadrat 1 (10, 10) from botanical monitoring on 02/09/2018.

Figure C2. Plot 1, Quadrat 2 (1, 10) from botanical monitoring on 02/09/2018.

Figure C3. Plot 1, Quadrat 3 (5, 6) from botanical monitoring on 02/09/2018.

Figure C4. Plot 1, Quadrat 4 (3, 6) from botanical monitoring on 02/09/2018.

Figure C5. Plot 1, Quadrat 5 (11, 9) from botanical monitoring on 02/09/2018.

Figure C6. Plot 1, Quadrat 6 (9, 0) from botanical monitoring on 02/09/2018.

Figure C7. Plot 1, Quadrat 7 (1, 2) from botanical monitoring on 02/09/2018.

Figure C8. Plot 1, Quadrat 8 (3, 9) from botanical monitoring on 02/09/2018.

Figure C9. Plot 1, Quadrat 9 (3, 11) from botanical monitoring on 02/09/2018.

Figure C10. Plot 1, Quadrat 10 (10, 1) from botanical monitoring on 02/09/2018.

Figure C11. Plot 2, Quadrat 1 (4, 11) from botanical monitoring on 02/09/2018.

Figure C12. Plot 2, Quadrat 2 (8, 3) from botanical monitoring on 02/09/2018.

Figure C13. Plot 2, Quadrat 3 (8, 11) from botanical monitoring on 02/09/2018.

Figure C14. Plot 2, Quadrat 4 (0, 0) from botanical monitoring on 02/09/2018.

Figure C15. Plot 2, Quadrat 5 (2, 5) from botanical monitoring on 02/09/2018.

Figure C16. Plot 2, Quadrat 6 (4, 1) from botanical monitoring on 02/09/2018.

Figure C17. Plot 2, Quadrat 7 (9, 0) from botanical monitoring on 02/09/2018.

Figure C18. Plot 2, Quadrat 8 (6, 8) from botanical monitoring on 02/09/2018.

Figure C19. Plot 2, Quadrat 9 (1, 11) from botanical monitoring on 02/09/2018.

Figure C20. Plot 2, Quadrat 10 (6, 4) from botanical monitoring on 02/09/2018.

Figure C21. Plot 3, Quadrat 1 (4, 7) from botanical monitoring on 02/09/2018.

Figure C22. Plot 3, Quadrat 2 (4, 0) from botanical monitoring on 02/09/2018.

Figure C23. Plot 3, Quadrat 3 (8, 6) from botanical monitoring on 02/09/2018.

Figure C24. Plot 3, Quadrat 4 (4, 8) from botanical monitoring on 02/09/2018.

Figure C25. Plot 3, Quadrat 5 (5, 7) from botanical monitoring on 02/09/2018.

Figure C26. Plot 3, Quadrat 6 (2, 0) from botanical monitoring on 02/09/2018.

Figure C27. Plot 3, Quadrat 7 (11, 1) from botanical monitoring on 02/09/2018.

Figure C28. Plot 3, Quadrat 8 (6, 7) from botanical monitoring on 02/09/2018.

Figure C29. Plot 3, Quadrat 9 (8, 5) from botanical monitoring on 02/09/2018.

Figure C30. Plot 3, Quadrat 10 (9, 6) from botanical monitoring on 02/09/2018.

Figure C31. Plot 4, Quadrat 1 (4, 4) from botanical monitoring on 02/09/2018.

Figure C32. Plot 4, Quadrat 2 (4, 1) from botanical monitoring on 02/09/2018.

Figure C33. Plot 4, Quadrat 3 (9, 0) from botanical monitoring on 02/09/2018.

Figure C34. Plot 4, Quadrat 4 (7, 6) from botanical monitoring on 02/09/2018.

Figure C35. Plot 4, Quadrat 5 (11, 3) from botanical monitoring on 02/09/2018.

Figure C36. Plot 4, Quadrat 6 (9, 6) from botanical monitoring on 02/09/2018.

Figure C37. Plot 4, Quadrat 7 (1, 6) from botanical monitoring on 02/09/2018.

Figure C38. Plot 4, Quadrat 8 (5, 5) from botanical monitoring on 02/09/2018.

Figure C39. Plot 4, Quadrat 9 (7, 0) from botanical monitoring on 02/09/2018.

Figure C40. Plot 4, Quadrat 10 (3, 5) from botanical monitoring on 02/09/2018.

Figure C41. Plot 5, Quadrat (4, 4) from botanical monitoring on 02/09/2018.

Figure C42. Plot 5, Quadrat (4, 0) from botanical monitoring on 02/09/2018.

Figure C43. Plot 5, Quadrat (0, 4) from botanical monitoring on 02/09/2018.

Appendix D

Photographs of Quadrat Assessment from Botanical Monitoring on June 6, 2018

Figure D1. Plot 1, Quadrat 1 (10, 10) from botanical monitoring on 06/06/2018.

Figure D2. Plot 1, Quadrat 2 (1, 10) from botanical monitoring on 06/06/2018.

Figure D3. Plot 1, Quadrat 3 (5, 6) from botanical monitoring on 06/06/2018.

Figure D4. Plot 1, Quadrat 4 (3, 6) from botanical monitoring on 06/06/2018.

Figure D5. Plot 1, Quadrat 5 (11, 9) from botanical monitoring on 06/06/2018.

Figure D6. Plot 1, Quadrat 6 (9, 0) from botanical monitoring on 06/06/2018.

Figure D7. Plot 1, Quadrat 7 (1, 2) from botanical monitoring on 06/06/2018.

Figure D8. Plot 1, Quadrat 8 (3, 9) from botanical monitoring on 06/06/2018.

Figure D9. Plot 1, Quadrat 9 (3, 11) from botanical monitoring on 06/06/2018.

Figure D10. Plot 1, Quadrat 10 (10, 1) from botanical monitoring on 06/06/2018.

Figure D11. Plot 2, Quadrat 1 (4, 11) from botanical monitoring on 06/06/2018.

Figure D12. Plot 2, Quadrat 2 (8, 3) from botanical monitoring on 06/06/2018.

Figure D13. Plot 2, Quadrat 3 (8, 11) from botanical monitoring on 06/06/2018.

Figure D14. Plot 2, Quadrat 4 (0, 0) from botanical monitoring on 06/06/2018.

Figure D15. Plot 2, Quadrat 5 (2, 5) from botanical monitoring on 06/06/2018.

Figure D16. Plot 2, Quadrat 6 (4, 1) from botanical monitoring on 06/06/2018.

Figure D17. Plot 2, Quadrat 7 (9, 0) from botanical monitoring on 06/06/2018.

Figure D18. Plot 2, Quadrat 8 (6, 8) from botanical monitoring on 06/06/2018.

Figure D19. Plot 2, Quadrat 9 (1, 11) from botanical monitoring on 06/06/2018.

Figure D20. Plot 2, Quadrat 10 (6, 4) from botanical monitoring on 06/06/2018.

Figure D21. Plot 3, Quadrat 1 (4, 7) from botanical monitoring on 06/06/2018.

Figure D22. Plot 3, Quadrat 2 (4, 0) from botanical monitoring on 06/06/2018.

Figure D23. Plot 3, Quadrat 3 (8, 6) from botanical monitoring on 06/06/2018.

Figure D24. Plot 3, Quadrat 4 (4, 8) from botanical monitoring on 06/06/2018.

Figure D25. Plot 3, Quadrat 5 (5, 7) from botanical monitoring on 06/06/2018.

Figure D26. Plot 3, Quadrat 6 (2, 0) from botanical monitoring on 06/06/2018.

Figure D27. Plot 3, Quadrat 7 (11, 1) from botanical monitoring on 06/06/2018.

Figure D28. Plot 3, Quadrat 8 (6, 7) from botanical monitoring on 06/06/2018.

Figure D29. Plot 3, Quadrat 9 (8, 5) from botanical monitoring on 06/06/2018.

Figure D30. Plot 3, Quadrat 10 (9, 6) from botanical monitoring on 06/06/2018.

Figure D31. Plot 4, Quadrat 1 (4, 4) from botanical monitoring on 06/06/2018.

Figure D32. Plot 4, Quadrat 2 (4, 1) from botanical monitoring on 06/06/2018.

Figure D33. Plot 4, Quadrat 3 (9, 0) from botanical monitoring on 06/06/2018.

Figure D34. Plot 4, Quadrat 4 (7, 6) from botanical monitoring on 06/06/2018.

Figure D35. Plot 4, Quadrat 5 (11, 3) from botanical monitoring on 06/06/2018.

Figure D36. Plot 4, Quadrat 6 (9, 6) from botanical monitoring on 06/06/2018.

Figure D37. Plot 4, Quadrat 7 (1, 6) from botanical monitoring on 06/06/2018.

Figure D38. Plot 4, Quadrat 8 (5, 5) from botanical monitoring on 06/06/2018.

Figure D39. Plot 4, Quadrat 9 (7, 0) from botanical monitoring on 06/06/2018.

Figure D40. Plot 4, Quadrat 10 (3, 5) from botanical monitoring on 06/06/2018.

Figure D41. Plot 5, Quadrat (4, 4) from botanical monitoring on 06/06/2018.

Figure D42. Plot 5, Quadrat (4, 0) from botanical monitoring on 06/06/2018.

Figure D43. Plot 5, Quadrat (0, 4) from botanical monitoring on 06/06/2018.