CHAPTER 3: ECOSYSTEM MANAGEMENT

Notable projects from the 2016-2017 reporting year are discussed in the Project Highlights section of this chapter. This reporting year covers twelve months, from July 1, 2016 through June 30, 2017.

Threat control efforts are summarized for each Management Unit (MU) or non-MU land division. Weed control and restoration data is presented with minimal discussion. For full explanations of project prioritization and field techniques, please refer to the 2007 Status Report for the Makua and Oahu Implementation Plans (MIP and OIP; http://manoa.hawaii.edu/hpicesu/DPW/2007_YER/default.htm).

Ecosystem Restoration Management Unit Plans (ERMUP) have been written for many MUs and are available online at http://manoa.hawaii.edu/hpicesu/dpw_ermp.htm. Each ERMUP details all relevant threat control and restoration actions in each MU for the five years immediately following its finalization. The ERMUPs are working documents; OANRP modifies them as needed and can provide the most current versions on request. This year, the Ekahanui, Kaena, Kaluakauila, Koloa, Pualii and Ohikilolo (Lower Makua) ERMUPs were revised; they are included as Appendices 3-1 to 3-6.

3.1 WEED CONTROL PROGRAM SUMMARY

MIP/OIP Goals

The stated MIP/OIP goals for weed control are:

- Within 2m of rare taxa: 0% alien vegetation cover
- Within 50m of rare taxa: 25% or less alien vegetation cover
- Throughout the remainder of the MU: 50% or less alien vegetation cover

Given the wide variety of habitat types, vegetation types, and weed levels encompassed in the MUs, these IP objectives should be treated as guidelines and adapted to each MU as management begins. Please see the 2010-2011 MIP and OIP Annual Report for a discussion of adaptive changes to these goals. The Ecosystem Restoration Management Unit Plans (ERMUPs) for each MU detail specific goals and monitoring expectations for each MU.

Staff preparing for a weed control sweep at Kahanahaiki

Weed Control Effort Summary

OANRP weed control efforts are divided into three primary categories: incipient control efforts, broad ecosystem control efforts, and early detection surveys. Weed control efforts are discussed for each category separately.

This year, OANRP spent 9,309 hours controlling weeds across 594 ha. These figures include both incipient and ecosystem control efforts by staff and volunteers but do not include survey efforts or travel time. The table below lists efforts for the previous six reporting cycles. Note that all reporting periods, including this year, were 12 months in length, except 2014-2015, which covered only nine months.

Table 1. Summary Statistics for Weed Control

Report Year	Effort (hours)	Area (ha)
2016-2017	9,309	593.9
2015-2016	8,447	539.5
2014-2015 (9 months)	4,654	325.9
2013-2012	7,600	286.5
2012-2013	6,967.6	267.7
2011-2012	5,860	275.7
2010-2011	5,778	259

Complementing control efforts, OANRP staff conducted early detection surveys on all primary training range roads and military landing zones (LZs), some MU access roads, and all secondary training range roads in KTA, SBE, MMR, and SBW. Results of these surveys are discussed in section 3.5 below.

Artwork by Daniel Sailer: invasive plants form a portrait of the ultimate invasive species - humans.

Incipient Control Areas

Incipient control efforts are tracked in Incipient Control Areas (ICAs). Each ICA is drawn to include one incipient taxon; the goal of control is eradication of the taxon from the ICA. ICAs are primarily drawn in or near MUs. Those not located within or adjacent to an MU were selected for control either because they occur on an Army training range (for example, *Cenchrus setaceus* in MMR) or are particularly invasive (*Arthrostema ciliatum* in Kaluaa). Many ICAs are very small and can be checked in an hour or less, and in some MUs multiple small ICAs can be checked in one day. In contrast, a few ICAs, like those for *Sphagnum palustre* in Kaala or *Chromolaena odorata* in Kahuku, are quite large and require multiple days to sweep completely. Typically, ICAs are swept repeatedly until eradication has been achieved and staff is reasonably confident there is no remaining seed bank. In the absence of data regarding seed longevity, staff does not consider a site eradicated until ten years after the last sighting. The goal of ICA efforts is to achieve local eradication of the target species. OANRP currently controls 57 taxa in 279 ICAs, and considers eradication to have been achieved at 33 ICAs.

Of the total 590 ha swept, ICA efforts covered 467.3 ha. This year, staff spent 2,573 hours on ICA management, treated 467.3 ha, and conducted 662 visits to 233 ICAs. This is the greatest effort spent and area managed for incipient weeds in a reporting period to date; see table below. Also, this is the greatest number of ICA sites visited in one year. ICA work accounted for 79% of the total area weeded and 28% of total weeding effort. This makes sense, as incipient control generally requires less time per acre than habitat restoration weed control.

Table 2. Summary Statistics for ICAs

Report Year	# ICAs	Visits	Effort (hours)	Area (ha)
2016-2017	233	662	2,572.8	467.3
2015-2016	175	539	2,452	388.1
2014-2015 (9 months)	147	333	1,537	245.6
2013-2012	157	389	1,753.6	196.41
2012-2013	152	311	1,369.2	184.34
2011-2012	115	260	1,661	219.27
2010-2011	130	281	665.5	164

While the goals for all ICAs are the same, the rate of visitation required to achieve local eradication varies widely. Some ICAs, such as those for *Ehrharta stipoides*, must be visited at least quarterly, as this cryptic grass grows and matures very quickly. In contrast, for *Angiopteris evecta*, once initial knockdown is complete, ICAs need only be swept once every year or two as individuals are slow to mature. In general, ICA efforts are considered successful if visits are frequent enough to detect and control plants before they mature and there is a downward trend in total numbers of plants found per visit.

While the majority of ICAs require minimal amounts of effort to monitor, some require significant investment of resources. Volunteers contribute significantly to ICA control efforts at Kaala and Palikea, which enables OANRP to divert staff time to more challenging taxa and/or work sites. A good example of this are ICAs for *Sphagnum palustre, Juncus effusus*, and *Crocosmia crocosmiiflora* along the boardwalk at Kaala. All of these taxa are highly invasive, but none of these boardwalk ICAs are located in direct proximity to IP taxa. Volunteer effort here frees staff to focus on *Hedychium gardnerianum*, which directly threatens rare plants and their habitat, while maintaining pressure on the less immediate threats, posed by the boardwalk ICA taxa.

This year, there were small increases in effort for a majority of ICA taxa, and large increases in effort for a select few, including *Angiopteris evecta, Cenchrus setaceus, Chromolaena odorata, Juncus effusus, Pterolepis glomerata,* and *Schizachyrium condensatum*. These increases outweighed large declines in

effort for *Crocosmia x crocosmiifolia, Melochia umbellata, Rhodomyrtus tomentosa,* and *Sphagnum palustre*. While the true measure of success is eradication, staff hope that eventually the effort needed to treat ICAs will decline as fewer individuals are found over subsequent visits. Of the 467.3 ha treated for ICAs this year, the majority of this, 448.9 ha, was for just ten taxa: *C. odorata, Acacia mangium, R. tomentosa, S. condensatum, M. umbellata, C. setaceus, A. evecta, Miscanthus floridulus, Acacia mearnsii,* and *Erythrina poepiggiana*.

The number of ICAs managed has increased steadily over the years. Part of this is due the difficulty of determining when a site has been extirpated; ten years is a long time to monitor. Each year, staff note new locations of known priority species, for example *Pterolepis glomerata* in the Waianae Mountains, or discover entirely new taxa, such as *Chelonanthes acutangulus*. While dispersal via Army training or OANRP management accounts for some of the new ICAs, some spread is likely due to public hikers, non-native animals, and wind events. Even with improved strategies and control techniques, the time required to address ICA work grows along with the number of ICA sites. Encouragingly, this year staff were able to confidently declare eradication at 16 ICAs, for a total of 33 eradications. Among these are three *Achyranthes aspera* sites (Kahanahaiki), three *Cenchrus setaceus* sites (two at SBE, one at KTA), one *Dicliptera chinensis* site (Kahanahaiki), five *Ehrharta stipoides* sites (Pahole and Pahole No MU), one *Fraxinus uhdei* site (Ohikilolo), one *Rubus argutus* site (Pahole), one *Syzigium jambos* site (Kaluakauila), and one *Tibouchina urvilleana* site (Whitmore).

Although not included in this document, specific reports that identify dates of last mature and non-mature plants found, overall effort spent, and population trend graphs are available for each ICA. These reports may be generated in the OANRP database (supplied on CD) and are recommended for review by the IT.

The table below highlights the eleven taxa which required the most control effort in the past year. Effort from report year 2016 is presented for comparison. Note that effort hours do not include travel or trip preparation, or most time spent surveying outside of known ICA boundaries to define infestation areas. See the Invasive Species Update sections (3.7-3.8) for more detailed discussion of select priority targets.

Table 3. 2017 ICA Effort by Target Taxa

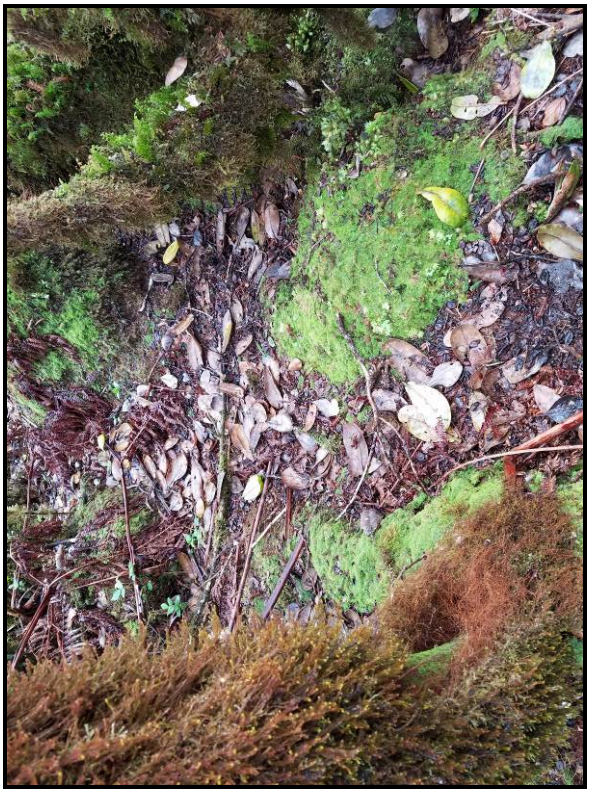
Taxa	2016 Control	2015 Control	Comments
Chromolaena odorata	1,128.75 hrs 161.28 ha 146 visits	1029.70 hrs 125.85 ha 133 visits	*Chromolaena* continues to be OANRP's top ICA priority. Staff efforts include treatments of hotspots, large sweeps, and aerial spraying; see discussion sections 3.4 and 3.7 below. OANRP continued to contract OISC to conduct work across half of the KTA infestation; see Appendices 3-7 and 3-8 for OISC's progress report. OISC efforts are not included in the totals in this table.
Schizachyrium condensatum	227.65 hrs 53.78 ha 36 visits	210.80 hrs 71.93 ha 45 visits	SBE remains the only location on Oahu with *Schizachyrium*. Last year, efforts focused on fully delimiting the infestation, which accounts in part for the high acreage swept. This year, efforts focused more on treatment of the 5 small ICAs and hotspots within the 2 large ICAs. While no new ICAs were discovered, no sustained downward trend in numbers of plants found is evident at any of the ICAs. This may be due the nature of this grass (cryptic, abundant seed production, fast-growing), complicating factors on range (regular disturbance from training and mowing), or crew related (detection ability, knowledge of sites). More frequent visits and more thorough surveys may be required to get a handle on this taxon
Crocosmia x *crocosmiiflora*	165.28 hrs 1.49 ha 27 visits	229.00 hrs 1.35 ha 23 visits	Volunteers conduct the majority of *Crocosmia* control at both Kaala and Palikea, removing the corms by hand. There was a major reduction in total effort this year, all of which came from Kaala, while Palikea efforts remained constant. However, the majority of

Taxa	2016 Control	2015 Control	Comments
			time (67%) still was spent at Kaala. There are 4 ICAs in Palikea, and two more just outside. Numbers of plants continue to decrease at all 6 sites, although one ICA was expanded greatly to include outliers on the summit slope. There are 7 ICAs at Kaala, all of which are located either on the road or directly around the FAA enclosure. While numbers of plants are decreasing at the ICAs along the boardwalk, little work has been attempted where the *Crocosmia* has formed dense banks, where hand removal is impractical. This year, staff installed a foliar spray trial based on a mix used in New Zealand; results suggest the mix is effective, although some corms do resprout. Staff will begin operational use of foliar sprays in select areas in the coming year.
Cenchrus setaceus	163.76 hrs 33.60 ha 34 visits	90.27 hrs 8.90 ha 20 visits	ICAs for this fire-prone grass are located in KTA, SBE, MMR, and Kahanahaiki. *Cenchrus* is a high priority taxon due to its association with fire and potential for negative impact to training ranges. Previous studies by the OANRP seed lab suggest seeds do not persist in the soil for longer than a year and half. Control efforts are discussed in section 3.8, below.
Juncus effusus	137.50 hrs 0.78 ha 26 visits	68.00 hrs 0.70 ha 15 visits	Volunteers conduct the majority of control on this species. Since the seeds are long-lived, control will be required for years to come. There are seven ICAs at Kaala and one East Makaleha. Most of the increase in effort this year is due to work at the two largest ICAs at Kaala, both of which were expanded to include recently found plants at the LZ, along the road, and at the shelter. Despite this, there is a downward trend in the number of plants found at all ICAs, particularly the smaller ones. Preventing further spread of this persistent rush is a priority.
Angiopteris evecta	126.25 hrs 12.13 ha 28 visits	58.41 hrs 12.21 ha 23 visits	This widespread fern has the potential to grow almost anywhere, from the wet Koolau summit to mesic Waianae forest. It is targeted for eradication in select MUs. Initial control is complete at all known sites, and the current strategy of annual maintenance checks appears to be effective. Staff continue to find large numbers of seedlings and immatures at many sites; it is unclear how long gametophytes and spores survive. Effort at all ICAs increased this year, particularly at Kapuna Upper, which accounts for 71% of all *Angiopteris* control. There are 7 ICAs in Kapuna Upper. Four are small outliers with few plants found, while the other 3 encompass large gulch areas. Plant numbers treated declined at the three largest ICAs this year, which supports the annual survey strategy. There is a large population of *Angiopteris* in neighboring West Makaleha, so continued ingress is expected. At Pahole, two new ICAs were found this year, suggesting that the full distribution of *Angiopteris* is yet to be determined in this MU. Additional effort was spent at the single ICA in Kahanahaiki, resulting in more thorough coverage. There is also a large source population to the northwest of Kahanahiki and Pahole, likely feeding spores into both MUs. There are two ICAs in Kaluaa; control efforts are going well, with no mature plants found for 10 years.
Pterolepis glomerata	108.30 hrs 1.34 ha 79 visits	77.40 hrs 0.90 ha 55 visits	This taxon is only a target in the Waianae Mountains, where it is a control priority at Kaala, Kahanahaiki, Makaha, Manuwai, Makaleha, Ohikilolo, Pahole, and Palikea. This year, 5 new sites were found: a ridge in Kahanhaiki II, the east end of the Lower Kaala NAR access road, the summit at Palikea, the east fence of Manuwai, and the Dupont Trail in Makaleha East. This continued

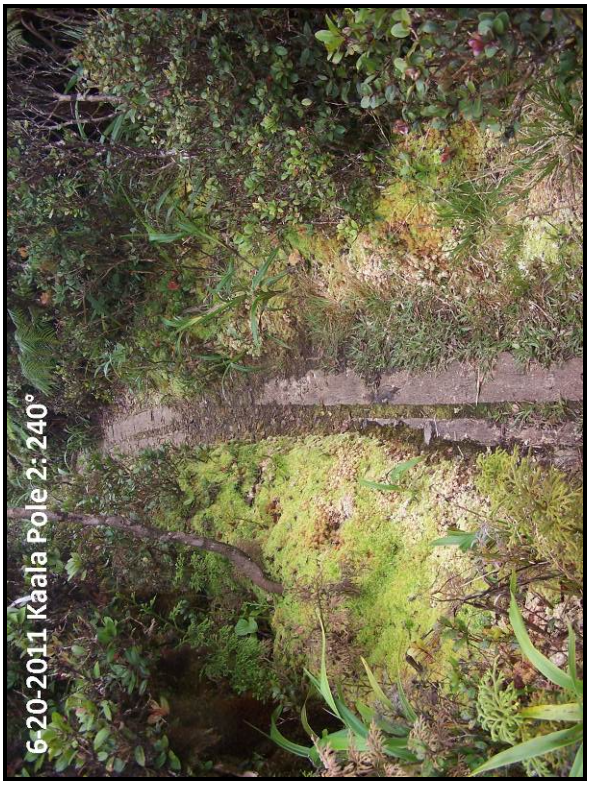
Taxa	2016 Control	2015 Control	Comments
			evidence of spread is concerning, and suggests that it may only be a matter of time before *Pterolepis* is established in the Waianaes. Several of the recent infestations are in areas not regularly accessed by OANRP, like Dupont Trail and Lower Kaala NAR road. OANRP will focus on keeping this threat out of MUs. It is thought *Pterolepis* forms a persistent seed bank. A biocontrol for a related species, *Tibouchina herbacea*, also attacks *Pterolepis* and may provide critical suppression; the biocontrol has not yet been released.
Sphagnum palustre	101.85 hrs 1.43 ha 18 visits	331.35 hrs 3.11 ha 27 visits	Control efforts have been very successful in removing the majority of the *Sphagnum* infestation on the Army side of the Kaala boardwalk; see photopoints below. This is reflected in the dramatic reduction in hours spent on *Sphagnum* control this year, although last year's numbers also included time spent on buffer surveys, which were not conducted this year. Likewise, the total amount of moss-killer used this year declined to 256 L from 460 L last year and 1,186 L in the first year of control (2012-2013). Volunteers conducted the majority of control efforts. While a few patches and small florets persist, they are so widely dispersed that this is no longer an effective project for volunteers, and staff will take over most treatment in the coming year. Unfortunately, staff did discover two new outlier ICAs this year. One is located on the transect trail, the other to the north of the FAA fence.
Rhodomyrtus tomentosa	98.00 hrs 56.93 ha 16 visits	111.70 hrs 25.58 ha 18 visits	*Rhodomyrtus*, a small tree with bird-dispersed fruit, is known from SBE and Pahole. At Pahole, only one plant was ever seen, in 2013 along the fence. Although short, the plant was mature; staff will monitor the site until 2023. The largest infestation is at SBE, where 99% of total *Rhodomyrtus* effort was spent. The *Rhodomyrtus* and *Schizachyrium* infestations overlap, and include large fields which are regularly mowed to facilitate training. This makes both taxa difficult to spot; mowed *Rhodomyrtus* can flower when they are less than a meter tall. Fortunately, staff can sweep for both taxa at the same time, which accounts for the dramatic increase in treatment area this year. In the largest ICA, *Rhodomyrtus* numbers have not declined over the past ten years, suggesting that more aggressive control is needed to reach eradication. Control efforts have been more successful at the other two ICAs. At one, only one immature was ever found, with no plants seen since 2013. This year, staff reduced *Rhodomyrtus* effort slightly, as it is a lower priority than *Schizachyrium*.
Ehrharta stipoides	50.55 hrs 2.97 ha 63 visits	49.15 hrs 1.97 ha 66 visits	This year, eradication was achieved at four ICAs in Pahole and one in Pahole No MU; all were located along the shared Pahole-Kahanahaiki ridge access trail. Previous trials suggest *E. stipoides* seeds do not persist longer than one year in soil. All 5 ICAs were monitored regularly for at least one to two years with no plants found before being declared extirpated. Frequent visits and a consistent observer were key to this success, as well as major declines in numbers of individuals found at 6 nearby ICAs in both Kahanahaiki and Pahole. Only one new ICA was identified this year, near the snail enclosure at Kahanahaiki. At Ekahanui and Huliwai, all three ICAs were monitored regularly and show declining numbers. At Kaluaa, no plants were found at the Hapapa ICA, but large numbers were found at the trail ICA, which expanded in area. Control at the four Ohikilolo ICAs continues to be challenging,

Taxa	2016 Control	2015 Control	Comments
			although regular quarterly visits and an increase in total effort (hours) have resulted in better coverage at three ICAs and declining numbers at two.
Melochia umbellata	45.00 hrs 35.56 ha 15 visits	66.50 hrs 33.56 ha 16 visits	This species, incipient to KTA, has been controlled by OANRP since 2002. It likely forms a persistent seed bank. Of the seven remaining ICAs, two have had no plants since 2011, and one has had no plants since 2013. The four remaining ICAs encompass the core of the infestation; numbers of plants found at each of these has steeply declined over the last 5 years, and may account for the decline in effort this year. Staff used aerial surveys to guide control efforts in the largest ICAs, and target control efforts around known hotspots and along roads. There are no known extant mature trees.

Top left: *Crocosmia* patch prior to treatment. Top right: Same patch four months post treatment. Bottom: Re-growth visible one year post treatment



Right: After six years of control, 07 November 2016



Left: *Sphagnum* at the beginning of control efforts, 20 June 2011

The fourteen MUs where most ICA effort was spent this report year are highlighted in the table below.

Table 4. 2017 ICA Effort in MUs

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
KTA No MU	6	*Acacia mangium* *Cenchrus setaceus* *Chromolaena odorata* *Melochia umbellata* *Miscanthus floridulus* *Senecio madagascariensis*	132	1015.75	39% of all ICA effort was spent at KTA this year. Overall effort increased by about 120 hrs over last year. KTA is a high priority for incipient control efforts because it is one of the most heavily used Ranges and hosts several ecosystem-altering weeds, including the largest population of *Chromolaena* in the State. *Chromolaena* control accounts for 94% of time spent at KTA. Hours recorded here do not include hours spent by OISC, which are included in Appendices 3-7 and 3-8. While all other ICA taxa require comparatively less effort, both *Melochia* and *A. mangium* infest large areas (35.6 ha and 82.7 ha, respectively) and have long-lived seeds. Numbers of both taxa continue to decline. Last year, *Rhodomyrtus tomentosa* was eradicated from the Range, as well as one of the two extant *Cenchrus* sites. A new *Senecio* site was found this year on the access road to KTA; this is the only known extant *Senecio* site on Army lands. Only 1 mature plant was ever found. The ICA was treated with pre-emergent herbicide, and no additional plants have been found thus far.
SBE No MU	8	*Cenchrus setaceus* *Chromolaena odorata* *Heterotheca grandiflora* *Rhodomyrtus tomentosa* *Schizachyrium condensatum* *Senecio madagascariensis* *Smilax bona-nox* *Vitex trifolia*	66	336.65	Located next to residential Wahiawa and heavily used for training, SBE is home to a diverse array of weeds not found on other Army lands. This year, 13% of all ICA effort was spent at SBE. Of this, 68% was spent on *Schizachyrium* and 29% was spent on *Rhodomyrtus*; both taxa are discussed in the table below. The one extant *Cenchrus* ICA was declared eradicated this year. No plants have been seen at the single *Senecio* ICA since 2008; this ICA will be declared eradicated in 2018 if no additional plants are found. No *Heterotheca* have been seen at any of the 3 ICAs since 2014-03, and much of the sand the plants were found in has been replaced. Staff will monitor these sites annually until 2024. Happily, no plants have been seen at the *Chromolaena* ICA since 2015-02, suggesting the infestation was removed before creating a seed bank. The *Smilax* ICA continues to persist, but has increased in area. While the plants do not appear to set seed, they can spread clonally. To eradicate this small ICA, staff may need to dig out roots, or use herbicides with better translocation. The two *Vitex* ICAs continue to be low priority, with few plants found this year
Kaala Army	8	*Anthoxanthum odoratum* *Crocosmia* x *crocosmiiflora* *Diplazium esculentum*	62	222.65	About 140 hrs less ICA effort was spent at Kaala Army this year compared to last year. This primarily was due to a reduction in effort on *Crocosmia* and *Sphagnum* ICAs due to reduced need. The bulk of effort (42%) was spent on 5 *Sphagnum* ICAs, including 2 new outliers, one on the transect trail and another north of the FAA exclosure. Diligent and detail-oriented volunteers have reduced *Sphagnum* levels in the core dramatically. Almost an equal amount of effort (40%) was spent controlling 6 *Juncus* ICAs. Four of these are outliers, with only a few plants ever seen.

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
		Festuca arundinacea *Juncus effusus* *Pterolepis glomerata* *Setaria palmifolia* *Sphagnum palustre*			Since OARNP trials suggest *Juncus* seeds are very long-lived, these outliers may be monitored longer than 10 years to be sure they have been extirpated. *Juncus* continues to persist in moderate-low numbers at the larger 2 ICAs. Volunteers conduct much of the work on both *Juncus* and *Crocosmia*. There are 4 *Crocosmia* ICAs in the MU. Numbers continue to decline within the bog fence, but the other ICAs include dense banks of corms and will require more aggressive control. One of the most difficult species to detect is *Festuca* (4 ICAs). This grass may be well-established within the FAA fence; further surveys and discussion is needed to determine if further control is worthwhile. Staff continue to find low numbers of *Anthoxanthum* and *Diplazium* (1 ICA each), both of which have cryptic immatures. No plants were seen at either of the *Pterolepis* ICAs this year. While mature plants were found at both in the past, no plants have been seen at the boardwalk site since 2014 or the transect trail site since 2015. There is one old *Setaria* ICA along the spur fence. No plants have been seen since 2009, and barring future finds, hopefully can be declared eradicated in 2019.
Kaala NAR	5	*Crocosmia* x *crocosmiifolia* *Diplazium esculentum* *Juncus effusus* *Pterolepis glomerata* *Sphagnum palustre*	31	149.85	Almost 100 hrs less ICA effort was spent at Kaala NAR this year compared to last year. Last year, staff assisted NEPM with *Sphagnum* control on the State side of the boardwalk as part of a work swap. This work swap has not yet happened this year, and accounts for the drop in time. However, staff and volunteers did treat the *Sphagnum* ICA along the radio tower road; the moss spray is less effective at this infestation, as it is often submerged in water. Staff handpull it when possible and time treatment for dry conditions. The majority of effort (60%) was spent on the 3 *Crocosmia* ICAs. Staff and volunteers focused on plants along the forest edge, and saw a decline in numbers of plants found within the boardwalk fence. Work on 3 *Juncus* ICAs account for 29% of ICA effort. Again, volunteers performed much of this work. While the largest ICAs near the trailhead continue to persist at moderate numbers, no plants have been seen at the single outlier ICA since 2014. Staff continue to monitor the *Diplazium* ICA along the road and the *Pterolepis* ICA at the Kaala shelter. Both taxa are persistent and require regular monitoring.
SBW No MU	2	*Erythrina poepiggiana* *Chromolaena odorata*	30	140.50	*Chromolaena* control accounts for 93% of ICA efforts at SBW. There are 2 small, outlier ICAs and 2 large, densely infested ICAs. Regular efforts at the outlier ICAs were effective in keeping plant numbers low, although a patch of seedlings was found in an area that had been missed at one ICA. This highlighted the value of thorough sweeps to staff. Control efforts in the core continued to be a combination of ground and aerial treatment. Last year, 213 hrs were spent at this MU; the reduction is entirely due to fewer aerial sprays of *Chromolaena* needed. There are two *Erythrina* ICAs at SBW, an outlier, and a more established patch along Trimble road. The outlier contained an immature sapling, and no additional plants have been found since 2016-04. Staff began delimiting the Trimble road ICA.

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
Ohikilolo Lower	1	*Cenchrus setaceus*	11	120.16	Both ground control and aerial sprays were conducted at the *Cenchrus* infestation. Last year, 78.52 hrs were spent at this site; the increase is due to additional ground surveys. New hotpsots within the ICA were found during a valley-wide survey effort. While progress at the core is encouraging, cliff-dwelling plants continue to be challenging to reach with spray gear, timing sprays for optimal grass conditions is difficult (*Cenchrus* is most susceptible to herbicide when it is green, ie, soon after rain), and the continued spread of plants indicates more consistent visits are needed.
Kahanahaiki	11	*Acacia mearnsii* *Achyranthes aspera* *Angiopteris evecta* *Casuarina glauca* *Cenchrus setaceus* *Dicliptera chinensis* *Ehrharta stipoides* *Elephantopus mollis* *Pterolepis glomerata* *Setaria palmifolia* *Sphaeropteris cooperi*	58	99.45	Last year, ICA effort was limited to 3 taxa and 16.30 hrs. Efforts were renewed this year, with the full suite of ICAs receiving treatment. All 3 *Achyranthes* ICAs and 1 *Dicliptera* ICA were eradicated this year. Staff continued to make *Ehrharta* treatment a high priority. Although one new ICA was found near the Kahanahaiki Snail Enclosure, all 5 ICAs saw sharp declines in numbers of individuals, and may achieve eradication next year. Control has been effective at both *Elephantopus* ICAs, with no plants seen for more than a year. No plants have been seen at the *Pterolepis* ICA at the Chipper Site since 2012, when the ICA was buried by mulch. Staff hope any seeds were killed by the heat of the mulch. Staff found a new *Pterolepis* ICA on a ridge in Kahanahaiki II this year; control is on-going. Efforts resumed at both *Acacia* ICAs this year. No plants have been seen at the Schweppes site since 2014, but mature plants were found at the Black Wattle site. Staff plan regular annual sweeps to prevent this in future. For the first time, staff performed focused sweeps for both *Angiopteris* and *Sphaeropteris* in the main gulch, as opposed to treating plants opportunistically during other work. This resulted in more plants than ever controlled for both species. No plants were found at the Ethan's outlier *Angiopteris* ICA. Some control was done at the single *Casuarina* ICA, but rope work is needed to reach the remaining plants. A new *Setaria* ICA was found in Maile Flats; this grass likely was spread to the MU via contaminated staff or partner agency gear. OANRP asked collaborators to ensure gear was clean before entering the MU. Lastly, in August 2016, staff found an immature *Cenchrus* on the gulch fenceline. Bishop Museum confirmed it was a vegetative match for *Cenchrus*, but couldn't make a definitive identification given the lack of inflorescence. This discovery is discussed further in section 3.8.
Kapuna Upper	4	*Angiopteris evecta* *Ehrharta stipoides* *Rubus argutus* *Sphaeropteris cooperi*	18	93.25	ICA effort at Kapuna Upper doubled this year over last year; most of this is due to *Angiopteris*, which accounts for 96% of effort. Staff revised the *Angiopteris* ICA boundaries this year, expanding them to cover 20.9 ha (12.6 ha last year) and reshaping them to facilitate more streamlined, thorough surveys. Mature plants were found at only 2 of the 7 ICAs. Staff will continue to conduct annual surveys of all ICAs, which is sufficient to prevent the majority of plants from maturing. There are 2 *Rubus* ICAs, and no plants have been seen at either since 2010. One new *Sphaeropteris* site was discovered this year, adjacent to Subunit I. Additional delimiting surveys are needed at this site. Staff continue to find low numbers of plants are the other *Sphaeropteris* ICA in Subunit III. State staff lead *Ehrharta* control efforts.

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
Manuwai	4	*Caesalpinia decapetala* *Chromolaena odorata* *Dietes iridioides* *Pterolepis glomerata*	31	82.80	ICA effort more than doubled at Manuwai this year (from 33.21 hrs). While effort at all ICAs increased, the biggest change was at the largest *Pterolepis* ICA, on the ridge dividing Manuwai and Alaiheihe. This effort resulted in more thorough surveys conducted and a reduction in plants found. One new ICAs was found on the east fence this, for a total of 4 ICAs. At the smallest ICA, no plants have been seen since 2015-12. Given the persistence of *Pterolepis* seed, all ICAs will require years of management. This year, staff noted a decline in numbers of plants at the single *Dietes* ICA. No plants have been found at the lone *Caesalpinia* ICA since 2013. Unfortunately, staff discovered *Chromolaena* in 2017-02, likely spread via contaminated staff gear. While all three plants found were vegetative, one was large enough to have matured. Staff monitor the ICA quarterly and have begun delimiting surveys.
Palikea	4	*Crocosmia* x *crocosmiiflora* *Dicliptera chinensis* *Pterolepis glomerata* *Setaria palmifolia*	28	51.18	Effort spent at this MU increased by a third (from 39.25 hrs last year). The majority of time (85%) was spent on *Crocosmia* control and utilized volunteer labor. While plant numbers have declined dramatically since control began, in recent years they have plateaued at all 4 ICAs. This reflects the difficulty of removing each corm by hand. Foliar sprays may help push this taxon closer to eradication. There are 2 *Dicliptera* ICAs. No plants have been seen at the gulch ICA since 2009, and it will be monitored until 2019. Numbers of plants continued to decline at the slope ICA. One new *Pterolepis* site was discovered on the summit fence trail this year. Only one immature plant has been found at this location, suggesting there is no seed bank. One new *Setaria* ICA was discovered along the eastern fenceline, for a total of 4 *Setaria* ICAs. Two ICAs are approaching eradication, with no plants seen at one since 2013 and at the other since 2014. Heavy traffic across the MU due to expanded management may be a factor in new ICAs at Palikea; the importance of sanitation has been reiterated to staff and partners.
Ohikilolo	4	*Ehrharta stipoides* *Fraxinus uhdei* *Pterolepis glomerata* *Rubus argutus*	32	38.95	Last year, a range closure of MMR limited staff access to Ohikilolo. This year, staff were able to almost double ICA effort. 50% of this time was spent on *Ehrharta* control. While 1 of the 4 ICAs was not monitored due to its remote location, quarterly surveys of the other 3 were effective in achieving more thorough coverage than ever before. The single ICA of *Fraxinus* was declared eradicated. While no new *Pterolepis* sites were discovered, plants are consistently found at both ICAs, suggesting seed banks exist at both sites. Plants also continue to persist at all 3 *Rubus* ICAs. More consistent monitoring and use of more aggressive control techniques are needed for this taxon.
Kaluaa and Waieli	5	*Angiopteris evecta* *Casuarina equisetifolia* *Dovyalis hebecarpa*	10	24	ICA effort at Kaluaa increased slightly from last year, but fortunately, there are relatively few ICA in this large MU. No plants have been seen at the *Casuarina* ICA since 2014, and none have been seen at the *Dovyalis* ICA since 2013. These sites will be monitored annually until 2023/24. There are 2 *Ehrharta* ICAs. No plants have been seen at the Hapapa ICA since 2015-02. If no plants are seen by the end of 2017, it will be considered eradicated. Unfortunately, the ridge trail

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
		Ehrharta stipoides			ICA expanded, and will require additional surveys. Staff continue to find low numbers of plants at the *Solanum* ICA; annual surveys appear to be sufficient at this site. Almost half the ICA effort at Kaluaa was for *Angiopteris* (2 ICAs). At the steps ICA, only 1 immature has ever been found. At the large south gulch ICA, no mature plants have been found since 2007 and annual surveys are sufficient to control immatures before they produce spores.
		Solanum capsicoides			
Pahole	10	*Angiopteris evecta*	37	22.95	ICA effort did not change much from last year. Most of the ICAs at Pahole, with the exception of those for *Angiopteris* and *Dicliptera*, are found along the Makua/Pahole fenceline. This year, consistent effort on *Ehrharta* paid off, with 3 of 4 ICAs deemed eradicated. The remaining ICA (at the Pahole Snail Enclosure) will require at least another year of monitoring. The *Rubus* ICA was eradicated this year, with no plants seen since 2004. Both the *Dicliptera* and *Rhodomyrtus* ICAs are on the path to eradication, with no plants seen since 2013. More thorough surveys are needed at the *Tecoma* ICA; although no plants have been seen since 2013, part of the ICA is difficult to survey due to thick vegetation. Plants are regularly seen at both the *Axonopus* and *Pterolepis* ICAs; more consistent checks are needed at both sites. Two new ICAs were found along the Pahole/Kahanahaiki trail this year: 1 immature *Elephantopus* and 1 immature *Setaria*. In addition, a new *Angiopteris* ICA was identified in the gulch, for a total of 5 *Angiopteris* ICAs. While numbers of *Angiopteris* remain low, the wide distribution of ICA sites is suggests additional plants may be present elsewhere in the valley. Staff will continue to control and track *Angiopteris* wherever it is found.
		Axonopus compressus			
		Dicliptera chinensis			
		Ehrharta stipoides			
		Elephantopus mollis			
		Pterolepis glomerata			
		Rhodomyrtus tomentosa			
		Rubus argutus			
		Setaria palmifolia			
		Tecoma capensis			
Kaleleiki	1	*Chromolaena odorata*	4	22.00	*Chromolaena* was discovered at the small *Eugenia koolauensis* fence in 2016-09. Only small numbers of plants have been found. This site is a high priority for control.

Weed Control Areas

Ecosystem control efforts are tracked in Weed Control Areas (WCAs). WCAs generally track all control efforts which are not single-species based. Note that WCAs are not necessarily drawn to encompass all of a MU, although in some MUs, like Makaha and Manuwai, the entire MU has been divided into WCAs. Each WCA is prioritized and goals are set based on a variety of factors including: presence of MIP/OIP rare taxa, potential for future rare taxa reintroductions, integrity of native forest, level of invasive species presence, and fire threat. Some WCAs simply track trail and fenceline vegetation maintenance. WCAs drawn outside of MUs typically provide a way of tracking weed control effort at genetic storage rare plant sites, removal of a widespread weed not yet prevalent in an MU (for example *Sphaeropteris cooperi* just outside Palikea), or along access trails and roads. The goals and priorities for weeding in a particular WCA are detailed in the appropriate ERMUP and translated into actions in the OANRP database. Visitation rates are scheduled for each action. OANRP does not necessarily plan to control 100% of the acreage in a WCA every year. Some WCAs are not intended to be visited annually, particularly those in sensitive habitats. Others, like the ones in Ohikilolo Lower which facilitate fuel break maintenance, are monitored quarterly and are swept in their entirety. For some low-priority WCAs, no control may be planned for many years. Via the ERMUPs, staff hopes to more accurately show how priorities are set for different WCAs over a multi-year time period. See the 2009 Status Update for the MIP and OIP, Appendix 1-2, for information on control techniques.

Table 5. Summary Statistics for WCAs

Report Year	Visits	Effort (hours)	Area (ha)
2016-2017	727	6,736	126.6
2015-2016	713	5,995	151.3
2014-2015 (9 months)	352	3,117	80.4
2013-2014	526	5,846	90
2012-2013	532	5,620	83.4
2011-2012	443	4,199	57
2010-2011	409	5,123	
2009-2010	353	3,256	
2008-2009	267	2,652	

This year, WCA efforts covered 126.6 ha. Staff spent 6,736 hours over 727 visits at 183 WCAs. WCA work accounted for 21% of the total area controlled and 72% of total effort. Much WCA control involves intensively working in small areas around rare taxa locations, and thus requires higher inputs of time per acre than for ICA management. The table above compares this report year's efforts to previous report years. The 2015-2016 reporting period covered only nine months, but all other reporting periods cover twelve months each. Area data from 2008 through 2011 was not collected as accurately as current practices and is not presented for comparison.

Table 6. Changes in Area Weeded between Report Year 2017 and 2016

IP Management Unit	Increase in Area (ha)	IP Management Unit	Decrease in Area (ha)
Kaala Army	+5.78	Makaha I	-15.77
Ekahanui	+3.97	Poamoho North	-6.32
Ohikilolo	+3.40	Makaha II	-6.05
Pahole	+2.13	Kahanahaiki	-3.72
Koloa	+2.02	Palikea	-3.28
		Makaha No MU	-2.81
		Kaena	-2.52
		Kaluaa and Waieli	-2.03

While overall area weeded decreased from last year, area weeded increased at 31 MUs and decreased at 24 MUs. Changes of 2 ha or more are summarized in Table 6. Most of the decrease is due to reductions in targeted canopy or single-species sweeps; this includes Makaha I and II, Kahanahaiki, Palikea, and Kaluaa and Waieli. Last year, all of Makaha I and II and Kahanahaiki were swept for *Grevillea robusta*. Similarly, selective thinning of *Morella faya* and *Cryptomeria japonica* occurred at Palikea. These actions do not need to be repeated annually. Staff continue to conduct canopy weed sweeps in new areas of Kaluaa and Waieli. The reductions in area seen at Poamoho North and Makaha No MU are due to infrequent events that occurred last year: assisting with State aerial sprays of *Angiopteris evecta* at Poamoho, and clearing the Makaha road. The Kaena MU contains one IP taxa and extensive weeding in the past has improved habitat; it was not a high priority this year. At the MUs which had large increases in area weeded, field teams prioritized work at Ekahanui, Ohikilolo, and Pahole. Increases at Kaala Army and Koloa are due to single-species sweeps by the Ecosystem Restoration (EcoRest) team.

Table 7. Changes in Weeding Effort between Report Year 2017 and 2016

IP Management Unit	Increase in Effort (hrs)	IP Management Unit	Decrease in Effort (hrs)
Kaala Army	+194.2	Kaluaa and Waieli	-174.0
Pahole	+184.75	SBW No MU	-151.9
Ekahanui	+167.0	Ohikilolo Lower	-56.5
Makaha I	+146.25	Manuwai	-55.25
Kahanahaiki	+125.6	Makaleha West	-51.75
Ohikilolo	+91.85	Makaha No MU	-49.0
Palikea	+56.25	Poamoho No MU	-41.0
Pualii North	+54.25	Waimea No MU	-40.0
Koloa	+50.5	Koko Crater No MU	-34.5
Kapuna Upper	+43.8	Opaeula Lower	-34.0
Makaha II	+43.7	Kamaili	-34.0
Kaluakauila	+43.0		
Keaau Hibiscus	+41.0		

Total effort spent weeding again increased this year. Effort increased at 32 MUs, but decreased at 24 MUs. Changes of 30 person hours or more are summarized in Table 7. At many of the MUs, the increase in effort is due to a renewed emphasis on weed control by field teams. This includes Pahole, Ekahanui, Kahanahaiki, Ohikilolo, Koloa, Kapuna Upper, Keaau Hibiscus, and Kaluakauila. At Ekahanui, efforts were boosted by an extensive trail clearing project to facilitate rodent control. Ohikilolo was closed by Range Control for part of last year; regaining access allowed staff to resume more management. Restoration projects contributed to the increases in effort at Kahanahaiki and Makaha I. High-priority target sweeps conducted by the EcoRest team contributed to much of the increase at Kaala Army and Koloa. Efforts expanded at Makaha II to include new rare plant reintroductions. Increased effort at Pualii North is due primarily to volunteer work in the gulch. At Palikea, huge amounts of effort were spent clearing weeds for a new snail enclosure. As a result, effort in other parts of Palikea declined, although there was a net gain. At the MUs which had a decrease in effort, some of this was due to decreased field team staffing or a decreased emphasis on the MU; this includes Kamaili, Opaeula Lower, Makaleha West, and Kaluaa and Waieli. In addition, there was a slight decrease in volunteer effort at Makaleha West, and a large volunteer decrease at Kaluaa and Waieli. At Manuwai, much of the decrease is due to less time spent on targeted canopy sweeps this year. At Ohikilolo Lower, the decrease suggests good news; a range closure last year severely limited access to the MU, and staff spent a lot of effort reestablishing fuel reduction zones. Less maintenance was required this year. Work at Waimea and Koko Crater is focused on rare plant living collections, and occurs only as necessary. Lastly, decreased effort at SBW No MU (West Base volunteer garden weeding), Makaha No MU (road clearing) and Poamoho No MU (State lead road-clearing) are due to one-time events which occurred last year.

In the OANRP database, specific reports can be generated which detail the amount of time spent in each WCA, the weeds controlled, the techniques used, and the rare taxa managed. These database reports, as well as the ERMUPs, provide a more detailed look into each MU and each WCA, and are recommended to the IT/USFWS for review. It can be difficult to compare effort spent between WCAs or MUs and to judge whether the effort spent was sufficient. Since goals for each site vary, estimating the effort needed for each WCA is very challenging. Staff continue to work towards creating meaningful estimates of effort needed per WCA.

Native plant recovery at the Palikea 'Banyan Bowl' site

The twenty MUs where the most effort was spent this reporting year are summarized in Table 8. Most of these MUs are large, host multiple rare IP taxa, contain large swaths of native forest, and are readily accessible; these include Kahanahaiki, Palikea, Kaala Army, Makaha I, Kaluaa and Waieli, Pahole, Ohikilolo, Lihue, Ekahanui, Manuwai, and Kapuna Upper. Koloa would fall in this group, but is more difficult to access due to its location in the northern Koolaus. Several of other MUs in the table are significantly smaller, but support several IP taxa and include patches of native forest; these include Makaha II, Makaleha West, Pualii North, Kaluakauila, and Opaeula Lower. Two MUs on the list are located in severely degraded habitat and host one or two IP taxa. Ohikilolo Lower is completely dominated by alien grasses. Maintaining the fuel reduction areas around the rare taxa is a high priority and requires consistent, large inputs of time. Similar habitat is found in Keaau Hibiscus. While there are no plans to create Ohikilolo Lower style fuel breaks here, this grass habitat requires regular maintenance. Lastly, Pahole No MU includes all weed maintenance along the Pahole Road and around the Nike greenhouse and LZ. Weed maintenance at the Nike Site helps to minimize the risk of accidental weed dispersal via staff activity. Roadside maintenance is required of OANRP by the State.

All MUs are managed by an assigned field team which is responsible for the bulk of weed control efforts, particularly any weed control at rare taxa sites. Other factors which contribute to overall effort in an MU include: targeted canopy or single species sweeps not focused around IP taxa (carried out by the assigned field team or roaming EcoRest team), active volunteer projects (led by the Outreach team), and active restoration projects incorporating aggressive weed control coupled with native taxa restoration (often

implemented by the EcoRest team). These three factors are included in the table below, and provide some insight into the levels of effort spent various MUs. Team weeding efforts at Kahanahaiki, for example, are bolstered by targeted sweeps for two priority weeds, volunteer work at two different sites, and four separate restoration projects. In contrast, management of Makaha II this year focused solely on rare taxa sites and was carried out by the field team.

Table 8. Top Twenty MUs with Highest WCA Control Effort

IP Management Unit	Effort (person hours)	# Visits	Area Weeded (ha)	Targeted Canopy or Single Taxa Sweeps Conducted?	Volunteer Projects Present?	Restoration Project On-going?
Kahanahaiki	1,232.13	124	6.35	Yes (*Montanoa hibiscifolia, Triumfetta semitriloba*)	Yes	Yes
Palikea	995.65	83	2.85	No	Yes	Yes
Kaala Army	614.85	51	20.73	Yes (*Hedychium gardnerianum, Psidium cattleianum, Toona ciliata*)	Yes	No
Makaha I	451.50	38	1.25	No	Yes	Yes
Kaluaa and Waieli	376.50	48	13.08	Yes (*Aleurites moluccana, Grevillea robusta, Spathodea campanulata, Toona ciliata, Trema orientalis*)	Yes	No
Pahole	344.75	40	4.79	No	No	No
Ohikilolo Lower	327.50	35	3.84	No	No	Yes
Ohikilolo	244.00	24	4.39	No	No	No
Lihue	230.55	32	10.50	No	No	No
Ekahanui	223.25	35	4.77	No	No	No
Makaha II	189.70	18	0.59	No	No	No
Makaleha West	186.25	16	0.64	No	Yes	No
Manuwai	185.00	24	13.43	Yes (*Coffea arabica, Grevillea robusta, Leucaena leucocephala, Psidium cattleianum, Schefflera actinophylla, Spathodea campanulata, Syzigium cumini, Toona ciliata, Trema orientalis*)	No	No
Kapuna Upper	157.50	19	1.23	No	No	No
Pualii North	117.75	14	1.53	No	Yes	No
Kaluakauila	76.00	16	2.01	No	No	No
Opaeula Lower	67.75	10	0.50	No	No	No
Keaau Hibiscus	61.00	6	0.21	No	No	No
Koloa	59.50	5	2.15	Yes (*Psidium cattleianum, Angiopteris evecta*)	No	No
Pahole No MU	47.00	7	8.05	No	No	No

Control efforts for all MU are summarized in Table 9. The table lists all MUs where WCA control was conducted in the past year. Data from the 2016 report is included for reference. This year's data is shaded and in bold. For each year, the total actual area weeded is reported; for example, if a one acre rare plant site was swept on three separate occasions, the area weeded is reported as one acre, not three acres. The number of separate weeding trips is recorded as number of visits, and the effort is recorded in person hours spent weeding (travel and set-up time is not included). While these statistics are not a replacement for vegetation monitoring, they detail the investment OANRP has made over the years.

Table 9. MU WCA Weed Control Summary, Report Years 2017 and 2016

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Alaiheihe No MU	N/A	9.99	**3.72**	**2**	**6.00**	9.99	1	8.50	This area includes the Lower Kaala NAR access road. Staff sprayed roadside weeds, focusing on *Urochloa maxima* and *Caesalpinia decapetala*. Due to the poor condition of the road, only the portion closest to Manuwai was sprayed.
Ekahanui	87.5	91.66	**4.77**	**35**	**223.25**	0.80	13	56.25	Control efforts were split almost equally between clearing trails to facilitate rat control, and weeding around rare species sites, particularly reintroduction zones.
Ekahanui No MU	N/A	10.09	**0.01** ***(133 m²)***	**1**	**1.15**	0	0	0	While monitoring a Genetic Storage *Delissea waianaensis* site, staff also conducted weed control.
Haili to Kealia I	7.91	0.75	**0.10**	**4**	**22.50**	0.05 *(518 m²)*	3	21.00	Weed control targeted woody weeds and grasses around the *Hibiscus brackenridgii* subsp *mokuleianus* reintroduction along the Kealia trail.
Haili to Kealia No MU	N/A	3.37	**2.50**	**2**	**11.00**	0.43	1	1.00	This area encompasses the Kuaokala access road. Staff scoped a *Sphaeropteris cooperii* hotspot along the road; no plants were found. The crew also cleared fallen trees off the road in August 2016.
Helemano	60.63	61.86	**0.37**	**7**	**12.50**	0.21	1	2.00	Helemano is a low priority MU due to the small number of Tier 1 taxa, and is challenging to access due to weather. Staff monitored for *Setaria palmifolia* (a highly invasive grass that spreads easily along trails) along the fenceline, but none was found.
Huliwai	0.12	0.20	**0.12**	**3**	**6.00**	0	0	0	This small MU is centered at an *Abutilon sandwicensis* population. Weed control was targeted directly around the rare plants.
Huliwai No MU	N/A	9.44	**0.08** ***(801 m²)***	**1**	**3**	0.02 *(151 m²)*	1	6.00	While monitoring a *Cenchrus agrimonioides* var. *agrimonioides* site, staff also conducted weed control around it.

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kaala Army	49.02	51.53	**20.73**	**51**	**614.85**	14.94	47	420.66	*Hedychium gardnerianum* continues to be the primary weed target at Kaala, along with *Psidium cattleianum*. This year, the majority of area swept (79% of MU total) and effort (53%) were spent in Kaala-01, the largest WCA. Most of the remaining effort and area swept was in Kaala-05, on the eastern slopes. The remainder of weeding effort focused around rare taxa sites and reintroductions.
Kaala NAR	20.03	11.19	**0.01** ***(69 m²)***	**1**	**0.50**	0.70	3	4.00	Last year, staff assisted NEPM in multi-species sweeps across part of the bog. This year, efforts were limited to mowing and maintenance around the shelter/campsite area.
Kaena	10.06	3.28	**0.02** ***(190 m²)***	**3**	**11.50**	2.54	3	30	The vegetation matrix at Kaena appears to be relatively stable and requires little effort to maintain. Last year, staff swept across most of the WCAs. Efforts this year focused on the far western *Euphorbia celastroides* var. *kaenana* site, as well as the site within the exclosure.
Kaena East of Alau	14.51	0.89	**0.17**	**4**	**23.75**	0.89	4	39	Weed control efforts this year focused directly around the small *Euphorbia celastroides* var. *kaenana* site. Last year, additional time was spent on reducing fuels in the surrounding area.
Kahanahaiki	37.7	42.04	**6.35**	**124**	**1232.13**	10.07	125	1,106.5	Effort spent weeding again increased at this MU. This is due to continued emphasis on intensive restoration sites. 37% of effort was spent on three restoration sites in the gulch. 42% was spent on projects in Maile Flats, large grass sprays and follow-up control at the chipper site. Other weeding focused around rare taxa sites. No sweeps for *Grevillea robusta* were conducted this year, which accounts for the large drop in area treated.

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kaleleiki	0.12	0.80	**0.14**	**1**	**9.00**	0	0	0	This *E. koolauensis* population has been heavily impacted by the *Puccinia* rust. Staff swept the entire enclosure once, targeting woody weeds and *Urochloa maxima*. Weed control efforts are a low priority until new options for *Eugenia* management are discovered.
Kaluaa and Waieli	80.97	83.00	**13.10**	**48**	**376.50**	15.11	56	550.5	This year, targeted canopy sweeps using IPA continued across the MU, and account for much of the area treated. Staff continued to focus other weed control efforts around rare taxa sites, reintroductions, and the Hapapa Snail Enclosure.
Kaluaa No MU	N/A	14.23	**0.32**	**5**	**12.50**	2.26	5	30	Staff effort outside the MU is limited to trail, road, parking site and LZ maintenance, as well as management in a small TNC exclosure home to several rare taxa. This year, no work along the access road was required.
Kaluakauila	42.73	11.36	**2.01**	**16**	**76.00**	1.14	6	33	Staff expanded efforts from last year, focusing on grass control across the WCAs, general habitat sweeps, and weeding at reintroduction sites. Staff also controlled grass along the fence.
Kamaileunu No MU	N/A	0.96	**0.04** ***(428 m²)***	**1**	**7.00**	0.06 *(643 m²)*	2	6	All control was conducted at the LZ and campsite. In particular, the LZ requires regular maintenance as it quickly becomes overgrown.
Kamaili	2.57	3.92	**0.85**	**4**	**38.00**	0.71	12	72	This MU is divided into mauka and makai fences. Native dominated ridges were swept in the mauka fence, while weed control focused on rare taxa reintroductions in the makai one. Fence vegetation maintenance was conducted at both.
Kapuna Upper	172.35	179.20	**1.23**	**19**	**157.50**	2.59	21	113.7	Both this year and last year, control efforts were focused around wild and reintroduced rare taxa. In addition, weeds were removed from select portions of the fence.

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kaunala	1.98	2.24	**0**	**0**	**0**	0	0	0	Until effective techniques to combat *Puccinia* rust in the field are found, OANRP is hesitant to commit resources to habitat restoration at any *E. koolauensis* sites.
Kawainui No MU	N/A	38.36	**0**	**0**	**0**	0.08 *(823 m²)*	1	0.5	Last year, staff opportunistically controlled *Leptospermum scoparium* on the summit trail. There is a large infestation of *L. scoparium* in the northern Kooalu mountains, although it is not established in Koloa.
Keaau Hibiscus	3.64	3.67	**0.21**	**6**	**61.00**	0.04 *(362 m²)*	1	20	All weeding effort focused around wild and reintroduced *H. brackenridgei*. Both herbaceous weeds and grasses were controlled as a priority. Future weeding will be conducted in concert with restoration plantings.
Koko Crater No MU	N/A	1.85	**0.90**	**1**	**9.00**	0.23	3	43.5	Weed control was conducted around rare plant living collections at Koko Crater Botanical Garden.
Koloa	71.54	73.16	**2.15**	**5**	**59.50**	0.12	1	9	Located at the summit of the Koolau Mountains, weather poses a major challenge to conducting effective weed control. This year, staff conducted several sweeps targeting *Psidium cattleianum*, which accounts for the majority of effort and area. In addition, staff also maintained weeds at a rare plant reintroduction site.
Lihue	711.92	714.91	**10.50**	**32**	**230.55**	12.14	35	227.75	This year, trail clearing and fenceline maintenance accounted for 68% of effort and 89% of area treated in the MU. Other effort focused around wild and reintroduced rare taxa sites, in particular reintroductions of *Gardenia mannii*, *Hesperomannia oahuensis*, and *Stenogyne kanehoana*.

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Makaha I	34.2	35.59	**1.25**	**38**	**451.50**	17.02	38	305.25	Last year, most of Makaha I was swept for *G. robusta*, and select gulches were swept for *Toona ciliata*; this accounts for the large area weeded. This year, efforts focused on wild and reintroduced rare taxa sites, as well as restoration projects. The increase in effort is primarily due to clearing and maintenance of two restoration sites on Camp Ridge. Volunteers continue to contribute greatly to *Coffea arabica* removal on Flag City Ridge.
Makaha II	26.69	6.85	**0.59**	**18**	**189.70**	6.64	23	146	Last year, all of Makaha II was swept for *G. robusta*, which accounts for the large area weeded. This year, efforts focused primarily around wild and reintroduced rare taxa sites. Efforts expanded to include several brand new reintroductions. In addition, some fenceline maintenance was performed.
Makaha No MU	N/A	16.65	**0**	**0**	**0**	2.81	3	49	Last year, staff cleared grass off the BWS access road.
Makaleha Central No MU	N/A	0.1	**0**	**0**	**0**	0.01 *(144 m²)*	1	5	Last year, staff weeded while monitoring a *Kadua degeneri* subsp. *degeneri* site. This MFS site is not within an MU, and is not a high priority for weed control at this time.
Makaleha East	111.99	3.59	**0.01 (133 *m²*)**	**1**	**0.60**	0	0	0	Staff controlled high priority weeds *Angiopteris evecta* and *Ehrharta stipoides* opportunistically while monitoring rare taxa.
Makaleha East West Branch	1.14	1.23	**0.00 (28 *m²*)**	**1**	**1.00**	0	0	0	Some weed control was conducted around *K. degneri* this year. In future, staff will work to incorporate weed control into the schedule while monitoring this rare taxa site.

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Makaleha West	38.04	1.50	**0.64**	**16**	**186.25**	0.59	20	238	This MU has two widely separated WCAs. No control was conducted at the northern WCA this year. At the 3-Points WCA, staff focused around rare taxa locations and on grass control, while volunteers focused on the fenceline and in a patch of *Psidium cattleianum*. The reduction in effort does not mean that less weed control is needed here, but that the team prioritized other MUs for extra effort this year.
Makaleha West No MU	N/A	0.52	**0.11**	**2**	**7.00**	0.17	2	1	Staff performed weed control as needed to maintain the access trail.
Manuwai	122.49	127.44	**13.43**	**24**	**185.00**	11.74	30	239.25	Effort at Manuwai was split equally between large landscape sweeps for canopy weeds and focused control around rare taxa sites, particularly those in the northwestern corner of the MU (42% each). Fenceline maintenance accounts for the remaining effort. Landscape sweeps account for most of the area treated.
Manuwai No MU	N/A	4.17	**3.90**	**5**	**25.00**	2.65	6	34.5	Staff cleared vegetation, primarily *Urochloa maxima*, along the western road and trail to facilitate access.
MMR No MU	N/A	19.49	**1.03**	**4**	**35.00**	1.8	4	32.5	This year, the majority of time was spent maintaining grasses along the Makua-Kuaokala fenceline. Staff also did some fenceline maintenance along the east rim of Makua. The *H. brackenridgei* living collection at Makua Range Control is not thriving, and staff spent minimal effort controlling weeds across it.
Moanalua No MU	N/A	86.33	**0.37**	**1**	**15.00**	0	0	0	Staff cleared trails in Moanalua to facilitate rodent control and elepaio monitoring.

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Nanakuli No MU	N/A	5.35	**2.16**	**2**	**32.00**	0.49	2	2.5	This leeward facing bowl stretches between the Palikea and Palikea IV MUs. Staff swept it for *Sphaeropteris cooperi* and *Angiopteris evecta*; both ferns are a priority to keep out of the MUs.
Napepeiaoolelo	0.75	0.48	**0.13**	**2**	**5.00**	0.07 *(724 m²)*	1	4	The *Hesperomannia oahuensis* protected by this fence has been dead since 2013. Staff continue to monitor and maintain the fenceline.
Ohikilolo	232.79	138.41	**4.39**	**24**	**244.00**	0.99	19	152.15	In the Lower Makua portion of the MU (31% of effort), staff weeded around rare taxa sites, but most effort was dedicated to sweeps of native-forest dominated ridges. In the Ohikilolo Ridge portion of the MU (69% of effort), staff focused efforts in native forest patches and rare taxa sites, and also performed grass control. Last year, MMR was closed for part of the year due to a safety incident, limiting weed control effort.
Ohikilolo Lower	28.75	4.54	**3.84**	**35**	**327.50**	3.72	27	382	The 3 WCAs surrounding rare taxa were completely swept multiple times this year. Effort decreased from last year, major clearing was needed to open the WCAs after a range closure. Outplantings of common native species are surviving, and hopefully will reduce weed control effort required in future.
Oio	1.33	1.39	**0**	**0**	**0**	0	0	0	Until effective techniques to combat *Puccinia* rust in the field are found, OANRP is hesitant to commit resources to habitat restoration at any *E. koolauensis* sites.
Opaeula	50.93	50.42	**0.01 *(61 m²)***	**1**	**6**	0	0	0	This MU hosts primarily Tier 2 taxa, and thus is a low priority for weed control. Staff weeded around a new reintroduction of *Labordia cyrtandrae* this year.

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Opaeula Lower	10.15	6.80	**0.50**	**10**	**67.75**	0.9	8	101.75	Effort decreased this year. The field team has some staffing shortages, and since this MU has few IP rare taxa, it was deemed a lower priority than other areas. Staff weeding efforts focused around wild and reintroduced rare taxa sites, understory control in native forest patches, sweeps for *A. evecta*, and fenceline maintenance.
Pahipahialua	0.6	0.80	**0**	**0**	**0**	0	0	0	Until an effective strategy to combat *Puccinia* rust is created, OANRP is hesitant to commit resources to habitat restoration at any *E. koolauensis* sites.
Pahole	88.02	32.46	**4.79**	**40**	**344.75**	2.67	29	160	This year's large increases in effort and area treated cannot be attributed to one specific project, but represent an across the board improvement at almost all WCAs. Efforts continue to focus on rare taxa sites and surrounding habitat, and along the Kahanahaiki-Pahole ridge access trail.
Pahole No MU	N/A	13.00	**8.05**	**7**	**47.00**	6.61	11	57.25	Staff continues to control weeds along the Pahole road, around the Nike greenhouse and LZ, and on the access trail to the main gulch.
Palawai No MU	N/A	4.76	**0.02** ***(187 m²)***	**2**	**4.25**	0.48	4	13	This area immediately abuts the Palikea MU. This year, staff cleared vegetation to create a new LZ just below the fence. In previous years, control efforts here targeted *Sphaeropteris cooperi*. This project was not a priority this year, due to work on a new snail enclosure.

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Palikea	9.95	11.47	**2.85**	**83**	**995.65**	6.13	103	939.4	Work on the new Palikea North Snail Enclosure began in earnest this year. Clearing for the new snail enclosure accounts for 45% (450.5 hrs) of MU effort. As a result, weeding effort dropped at several of the other WCAs, although volunteer efforts and restoration projects led by the 'EcoRest' team contributed to an increase at some WCAs. Staff also continued to weed around rare taxa sites. Last year, large sweeps targeting gradual removal of *Morella faya* and *Cryptomeria japonica* were conducted; they account for the large area treated.
Poamoho No MU	N/A	119.78	**0**	**0**	**0**	1.38	3	41	Last year, OANRP participated in a State-led interagency road clearing effort at Poamoho.
Poamoho North	257.77	202.77	**3.99**	**3**	**192**	6.32	1	15	Last year, staff assisted NEPM with aerial spraying of *A. evecta*. One planned spray trip this year was cancelled due to weather. As resources allow, OANRP will continue to support this project. This MU is of moderate priority, as it contains few MFS IP taxa and is actively managed by two other agencies. OANRP assisted on one weed control camp trip this year; the high effort is due to partner collaboration.
Puaakanoa	10.7	1.07	**0.21**	**3**	**17.00**	0	0	0	Weed control efforts were hampered by the closure of MMR last year. Staff were able to resume management this year, and focused on grass and herbaceous weed control around *C. celastroides* sites.
Pualii North	7.99	10.98	**1.53**	**14**	**117.75**	0.66	10	63.5	This year, staff weeded at wild and reintroduced rare taxa sites, around native forest patches, and along the fenceline. Most of the increase in effort from last year is due to volunteer work in the lower part of the gulch. This gulch area contains patches of native forest, but few rare taxa.

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
SBE No MU	N/A	4.16	**0.06** ***(602 m²)***	**2**	**5.00**	0.09 *(901 m²)*	3	3	Weeds were cleared at the sediment disposal site, to keep it open for future use by DPW.
SBW No MU	N/A	2.61	**1.33**	**10**	**14.50**	0.84	15	166.45	This year, staff began controlling weeds at the Kahua Living Collection site; this accounts for the increase in area weeded. Staff continue to regularly maintain weeds at West Base to reduce the potential for staff to act as vectors. Last year's effort was high due to 142 hours of volunteer effort in the West Base interpretive garden.
Waianae Kai	3.66	1.14	**0.06** ***(580 m²)***	**2**	**2.50**	0	0	0	Staff conducted limited weed control in this small MU, focusing around rare taxa sites and along fencelines.
Waimanalo to Kaaikukai No MU	N/A	2.35	**0.98**	**2**	**2.50**	0.83	1	3	This area encompasses the Palikea access trail. Staff controlled alien grasses along the trail to reduce the potential for weed spread.
Waimea No MU	N/A	0.37	**0**	**0**	**0**	0.34	4	40	Last year, weed control was conducted around living collections of *Nototrichium humile* at Waimea Valley botanical garden. Staff conduct weed management as needed.
TOTAL	N/A	2,528.5	**126.64**	**727**	**6,735.9**	151.3	713	5,995	Total effort and visits increased, while area treated decreased from last year. The decrease in area can be attributed to fewer single-species targeted sweeps, while the increase in effort can be attributed to a combination of more restoration projects and greater priority given to weed control projects by field teams.

3.2 INTER-AGENCY INVASIVE PLANT COLLABORATION

Invasive species management can be incredibly daunting, as the number of weeds rarely diminishes and new species discoveries add to an ever-mounting list of challenges. Collaboration is critical in achieving progress. OANRP supports, and is supported by, a variety of partner agencies in addressing weed control issues. They include, but are not limited to:

- Oahu Invasive Species Committee (OISC). OANRP serves on the OISC steering committee and the OANRP Ecosystem Restoration Program Manager recently completed two years as the OISC Chair. In the past year, joint projects have included *Cenchrus setaceus* and *Chromolaena odorata* control efforts. In addition, OARNP facilitated OISC access to SBE for *Miconia calvescens* surveys and SBW for Rapid Ohia Death early detection surveys.
- Bishop Museum. Plant samples were submitted to and identified by the Bishop Museum Herbarium staff. Noteworthy finds are discussed in section 3.5.
- College of Tropical Agriculture and Human Resources (CTAHR). OANRP continues to collaborate with Dr. James Leary on research into novel weed control techniques, in particular, Incision Point Application (IPA) and Herbicide Ballistic Technology (HBT). For a complete description of IPA and HBT, and a history of these projects, please see the 2009–2014 and 2016 MIP and OIP Status Reports. This year, staff installed two new IPA trials on *Citharexylum caudatum* and *Psidium cattleianum* var. *lucidum*. These trials are designed to run for two years. A previous trial on *C. caudatum* was unsuccessful, and the new trial tests a higher rate of herbicide per basal diameter. This is the first OANRP trial for *P. cattleianum* var. *lucidum*; this variety is prevalent in certain MUs, has yellow-fruit, and tends to form large trunked trees as opposed to trees with a cluster of small trunks. In the coming year, staff hope to install additional trials on *Syzygium cumini* and very large *Grevillea robusta*.

Psidium cattleianum var. *lucidum* tagged for IPA trial

- State of Hawaii, Dept. of Land and Natural Resources (DLNR), Natural Area Reserve System (NARS), Forest Reserves (FS), and Native Ecosystems Protection and Management (NEPM). OANRP staff continue to collaborate with NEPM on discoveries of new invasive weed sites and management actions. This year, OANRP assisted NEPM with disposal of contaminated media.
- Dr. Cliff Morden, University of Hawaii. Dr. Morden provided genetic analysis of an unknown Melastomaceae found in the OANRP greenhouse; see Section 3.6.
- Board of Water Supply (BWS). BWS reviews OANRP weed control actions in Makaha Valley.
- Koolau Mountains Watershed Partnership (KMWP). OANRP is a member of the partnership. The EcoRest Team joins one KMWP camp trip per year, targeting priority weeds in Poamoho.
- Puu Ohulehule Conservancy. Staff share and discuss weed control and restoration techniques with the Conservancy.
- Waianae Mountains Watershed Partnership (WMWP). OANRP is a member of the partnership.
- Waimea Valley. OANRP manages two rare taxa living collection sites at Waimea.
- Coordinating Group on Alien Pest Species (CGAPS). The Federal Biologist participates in the CGAPs working groups on mosquitoes and coconut rhinoceros beetle.

OANRP participates in Priority Oahu Native Ecosystems (ONE, formerly the Oahu Weed Working Group) meetings organized by NEPM. As part of a Priority ONE subcommittee, OANRP helped to plan the fourth Oahu Weed Workshop, hosted by Waimea Valley. OANRP staff also presented at the workshop. Both the workshop and Priority ONE meetings provide a valuable way to share information, data, and control techniques among local agencies conducting active weed control management work. OANRP staff also attended the Hawaii Conservation Conference, held in Honolulu, July 2016.

Sharing new gear at the Tool Tailgate at the Oahu Weed Workshop

3.3 VEGETATION MONITORING

This year, vegetation monitoring was conducted and analyzed for the Ohikilolo (Upper) MU (Appendix 3-9), Palikea *Morella faya* Incision Point Application trial (Appendix 3-10), and Makaha 'Giant Ohia' Restoration Area (Appendix 3-11). The results of these studies will be used to modify weed control plans at these MUs. Vegetation monitoring was also conducted across the Palikea MU and at the North Palikea Snail Enclosure; results will be analyzed and presented next year. In the coming year, staff plan to conduct belt transect monitoring at Kapuna Upper and Kahanahaiki MUs, as well as continue on-going monitoring of the Makaha Giant Ohia site, the Palikea *M. faya* trial, and the North Palikea Snail Enclosure.

3.4 INVASIVE SPECIES SPREAD PREVENTION ON ARMY TRAINING RANGES

The Army's potential to move weeds from one training area to another has been amply demonstrated. This year, OANRP continued to coordinate with Range Division, DPW, and contractors to increase the Army's awareness of alien weed threats and improve sanitation-related protocols, practices, and policies.

Soldier Training

- OANRP and the Federal Natural Resource Manager updated the Officer in Charge/Range Safety Officer (OIC/RSO) brief this year. The OICs and RSOs for each unit are required to attend this brief before they can schedule or conduct any training on Army lands. This is the most direct way for staff to highlight natural resources concerns to soldiers, particularly the need to clean vehicles and gear and report fires.
- The Natural Resources Office hosted high level unit commanders at the OANRP baseyard to provide an overview of environmental concerns/topics. One of the stations during this tour was an overview of invasive species concerns and how to prevent spread. Gear, vehicle and equipment cleaning were emphasized.

Integrated Training Area Management (ITAM), Range Division, DPW, and Contractors

- Following the discovery of two new outlier *C. setaceus* sites in mowed areas in MMR at the end of last report year, staff contacted the contract lead and provided her with a map and plant identification photos. She stated that she would brief her staff regarding this new threat.
- OANRP staff shared techniques for effective control of *Falcataria moluccana* and *Spathodea campanulata* with the facilities manager and pest control shops on Base.
- The Federal Natural Resource Manager reviewed a request to use sand from Loko Ea fishpond on range. There were no invasive species concerns, and if this project proceeds, staff will survey the sand as a preventative measure.

Wash Rack Status

- Use at the Central Vehicle Wash Facility (CVWF) continued this year with regular hours of operation: 0800-1600. Of the three wash rack facilities, CVWF was the most dependably functional this year.
- The SBE Wash Rack continues to suffer repair and maintenance issues. This year, it was not usable in July-August 2016, and was officially closed for repairs from September to November 2016. Repairs took longer than expected, and it eventually reopened April 2017. Range utilization reports suggest it was not used or scheduled once this year, which is not surprising given that it was not operational much of time. The SBE Wash Rack was similarly afflicted in 2014 and 2015. With the recent repairs and more consistent oversight by the DPW Engineering Division, staff hope that the SBE facility will be open for more consistent use in the coming year.
- For much of the year, the KTA Wash Rack suffered from problems which shut down part, but not all of the facility; such issues occurred off and on in July, August, September and October of 2016 and March of 2017. Fortunately, the facility was partially usable for much of this time. On a positive note, in July 2016, the Range Scheduling office made it mandatory for units to schedule the wash rack on the last day of a KTA mission. In addition, language reminding all users to use the wash rack was posted on the Range Control scheduling database (RFMSS). This is another important way to reach KTA users. Unfortunately, the log book which all users of the wash rack are required to sign does not appear to be maintained/enforced by KTA Range Control staff. In

addition, the process for scheduling and using the facility changed several times over the year. This led to challenges for OANRP staff, who are motivated to use the wash rack; it is unknown if the issues discouraged troops from using it.

- OANRP facilitated discussions between contractors and Range personnel to ensure staffing of the KTA Wash Rack during Rim of the Pacific (RIMPAC) training when high numbers of troops were expected on the range.
- Staff at the DPW Cultural Resources (CR) office have provided great support to OANRP in pushing for more consistent oversight and accountability of the wash rack facilities. CR staff drafted an in-house guide to wash rack use. OANRP also updated in-house wash rack info and vehicle washing guides (Appendices 3-12 and 3-13).
- The DPW Engineering Department submitted a work order signs reminding troops to use the wash racks to be placed on all exit gates at KTA (2 gates), SBE (3 gates), SBS (1) and SBW (2). The signs were reviewed by OANRP, but have not yet been installed. This proactive measure is greatly appreciated. DPW Engineering has been very responsive to requests from the Natural and Cultural Resources offices.

Landing Zones

- While reviewing the list of approved military LZs, staff noted that two LZs on Dole land (Nixon and Elephant's Foot) and one LZ on Kamehameha Schools land (Kainapuaa/Nixon) were on RFMSS, where they were visible to units scheduling training ranges. Both LZs are off-limits, as there is no lease in place for their use. Upon OANRP request, the Range Scheduling office noted these as 'dormant' in RFMSS, such that units are no longer able to view them.
- Staff surveyed the large Basilian LZ for the first time this year. This site is leased to the Army periodically and is located west of Drum Road on private land. No concerning invasive species were found.

KTA

- In preparation for the 2016 Lightning Forge training event, staff reviewed a request to conduct digging and excavation activities around the Combined Arms Collective Training Facility. While there are few native and no rare taxa in the region, *Chromolaena odorata* is present. Staff requested that no digging occur within a 20m buffer around any known *C. odorata* location.
- Range Division contacted the Natural Resources office in April regarding upcoming clearing work scheduled for several roads and trails in the Bravo 1 training range. This area is adjacent to the *C. odorata* infestation. Staff surveyed the area prior to the first stage of work in May, and no *C. odorata* were found along any of the trails and roads. The second stage of work is scheduled for August 2017.
- While conducting *C. odorata* surveys in the Delta 1 and 2 training ranges this year, staff noted unauthorized activity in area, including people driving ATVs on a jeep trail, tire tracks on other trails, and a large zipline tower. In 2015, staff noted unauthorized bulldozed trails in the same region and reported the incident to Range Control; while some follow-up occurred, OANRP do not know the extent of the military's investigation in 2015. The area directly abuts private land, and the property line is not clearly demarcated in the field. The tower belongs to Climbworks at Keana Farms, a business which runs zipline and ATV tours. OANRP reported the activity seen this year to Range Control and ITAM. A site visit by ITAM revealed three separate zipline towers on the Installation. The situation was turned over to the Department of Emergency Services for resolution. Unfortunately, staff also found *C. odorata* in the region. There is great potential for *C.*

odorata to be spread via ATVs and tours. OANRP shared the find with the Oahu Invasive Species Committee, and they plan to conduct surveys at Keana Farms in the coming year. OISC already has shared information about *C. odorata* with Climbworks.

SBW

- Staff conducted a site visit with a unit planning to train at Firing Point 212, which is on the edge of the *C. odorata* infestation. The area north of the FP is marked off-limits for training. Staff discussed the situation with the unit representatives and approved their use of the area. This is the second time in two years the Range Scheduling office referred a unit hoping to train north of the FP to OANRP and shows that Range staff understood the importance of the restrictions placed on the area by the Natural Resources office.
- A private contractor was hired to spray herbicide across much of the area within the firebreak road at SBW this year. OANRP staff worked with this contractor in the past and stored some of their gear at West Base. Staff provided the contractor with maps of sensitive habitat and 'no-spray' buffer areas, and ensured the contractor's gear was accounted for.

Pohakuloa Training Area (PTA)

- PTA Natural Resources staff shared a weed list titled "Primary, Secondary, and Invasive Species Proposed for Management at Pohakuloa Training Area, Hawaii" with the OANRP office. While some of these species are widespread on Oahu, others are unfamiliar to OANRP staff. Staff created a reference based on the list as an identification tool (Appendix 3-14), as there is a real possibility for a weed common at PTA to show up on Oahu. In fact, this year, staff found *Senecio madagascariensis* near Range Control at KTA; this herb is widespread across PTA. OANRP and PTA staff will share weed lists annually; this help both programs anticipate potential new weed introductions.
- Another PTA weed, *Parthenium hysterophorus*, was found on the Wheeler road survey this year. It was found in a pile of soil and debris at a stockpile location within Lyman gate. The source of the soil could not be determined. Bishop Museum records indicate it is already know from Oahu, but this is the first time it has shown up on any OANRP road survey. *Parthenium. hysterophorus* is a pasture weed, toxic to horses, which produces copious seed and colonizes bare soil.

Parthenium hysterophorus at Wheeler soil stockpile

- The Federal Natural Resource Manager asked the PTA office to reiterate the importance of cleaning vehicles to units departing for Oahu. PTA staff confirmed that this is a part of existing briefs and SOPs. In addition, OANRP reviewed a draft invasive species prevention SOP geared towards reducing the risk of invasive species spread on to PTA ranges.

Marine Corps Training Area Bellows (MCTAB)

- OANRP staff assisted MCTAB with a weed road survey at MCTAB and Bellows Air Force Station this year. OANRP was concerned about the potential of *C. odorata* to disperse to Bellows, given the large numbers of Marines who train at KTA and the recent discovery of a single *C. odorata* plant in nearby Lanikai. Fortunately, no plants were found. OANRP also assisted MCTAB staff with follow-up weed species identifications. Only one concerning species was seen on the survey: a small population of *Cenchrus setaceus*, which likely dispersed to the area from the infested Lanikai pillbox trail via wind or hikers. Due to the remote location and low number of plants found (four), it is unlikely *C. setaceus* will spread from Bellows to Army lands via training exercises.

Above: courtesy of MCBH staff, this map shows the northern portion of the Bellows survey area (outlined in yellow) and the *C. setaceus* site. Below: mature *C. setaceus*, with the training range in spread out beyond.

3.5 WEED SURVEY UPDATES: NEW FINDS

OANRP conducted surveys along Roads and Landing Zones (LZs) used by both natural resource staff and the Army. New surveys were conducted this year along roads on Tripler Army Medical Center and Fort Shafter. These surveys were conducted to look for targeted species such as *Chromolaena odorata* and *Cenchrus setaceus,* and to note other potentially invasive weeds. Staff were unable to drive several side-roads on Schofield Barracks East Range due to downed trees after heavy rain and wind events, and one road on Schofield Barracks West Range due to a range control blockade. All surveys where drivable roads may vary year to year are tracked and stored in Geographic Information Systems (GIS).

Three new OANRP LZs were surveyed for the first time this year. There was an overall increase in OANRP LZ surveys this year, likely due to a reminder alert when filling out helicopter plans in the OANRP database that was instituted this past year.

Staff also surveyed locations of potential introduction such as OANRP camp sites, Army washrack sediment disposal sites and MU access trails. This year the survey at the Schofield Barracks Quarry was not completed due to as the quarry has not been in use. Unusual and noteworthy plants found during the course of other field work are referenced as incidental in the Summary of Alien Taxa on Surveys table below. OANRP received support from the Bishop Museum to identify unknown species. This year a total of 21 submissions were sent to Bishop Museum for identification or to document new locales for select taxa.

Table 10. Summary of Surveys Conducted

Survey Type	Description	# Surveys Conducted this Year
Road Survey	All drivable roads on Army Training Ranges were surveyed. Access roads to OANRP Management Units are surveyed annually or every other year; this year most were on the schedule.	34 road surveys
LZ Survey	Actively used Army LZs are surveyed once per year. This year two Army LZs were discontinued due to inactivity and change of lease: LZ Elephant's Foot and LZ Nixon. OANRP LZs were surveyed if used within a quarter.	62 surveys on 35 LZs
Transect Survey	Surveys are conducted annually along high use access trails to OANRP MUs, and along selected MU fencelines and transects inside MUs.	9 weed transect surveys
Camp/Other Survey	Surveys are conducted at OANRP campsites and other potential locations of introduction such as washrack sediment disposal sites. Survey frequency varies based on location and use.	14 surveys at 8 sites

Locations of LZ and camp/other survey sites surveyed this year are depicted in the map below as points. The line features are locations of roads and transects surveyed.

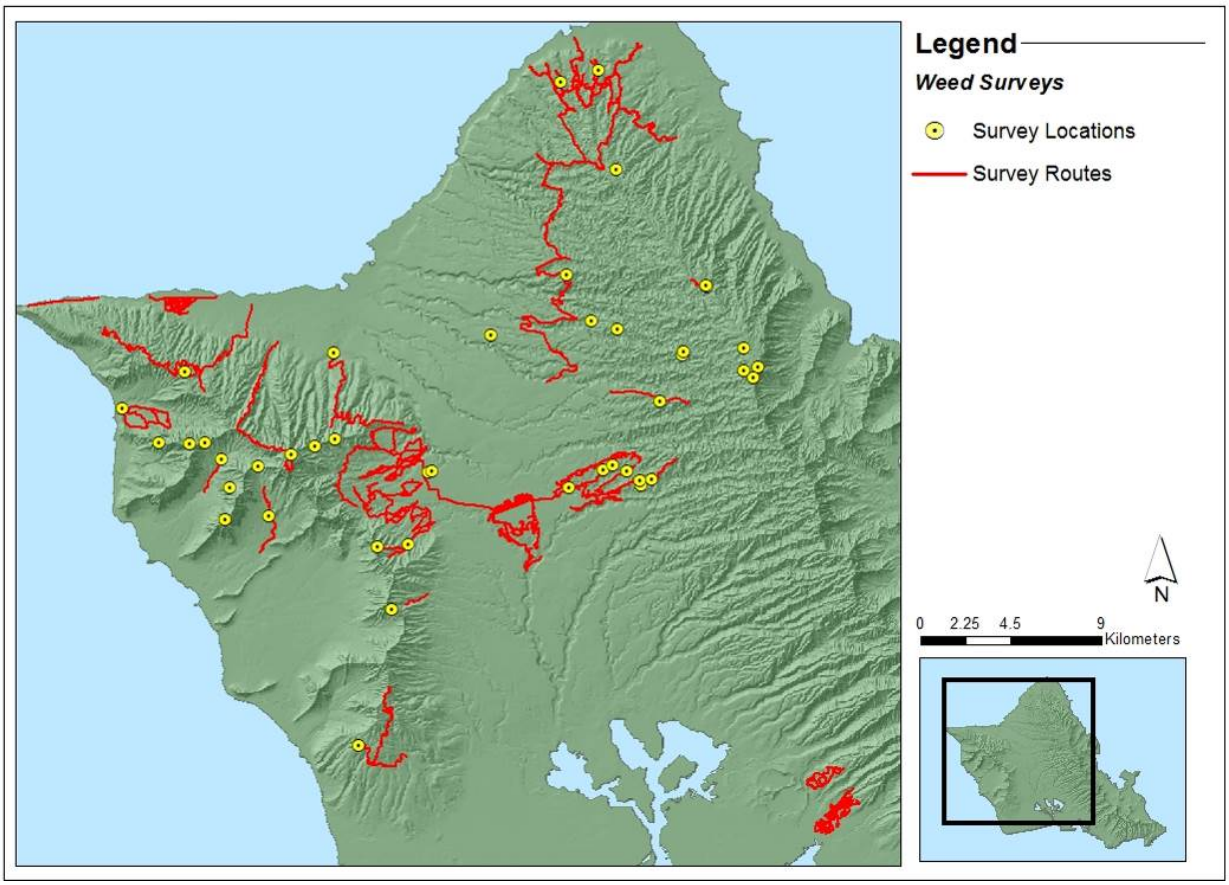


Figure 1. Map of Surveys Conducted in 2017

Survey data are tracked in the OANRP database and each year the list of new finds on each of those surveys is reviewed. Unidentifiable, or noteworthy species from surveys or incidental observations during regular work are submitted to Bishop Museum and are summarized below.

Table 11. Summary of Alien Taxa on Surveys

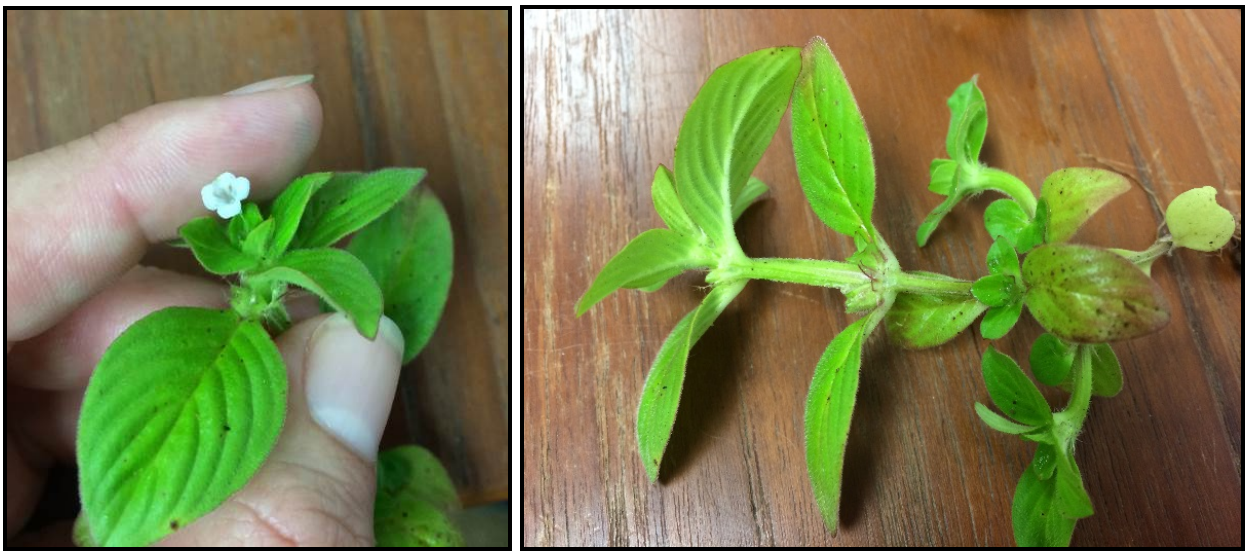
Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
Road	**RS-KLOA-01**	*Cyperus involucratus*	This taxa is widespread on Oahu, and would be a priority for control if found at Poamoho LZ or trailhead to keep away from reaching the Koolau summit. Will monitor new distributions.
		Plantago debilis	Not widely established on Oahu. Not habitat altering and no control planned.
Road	**RS-KTA-07**	*Hedychium flavescens*	Staff will note where this taxon was seen on next year's survey (less surprising if found closer to residential side of road) to ensure that this taxa is not naturalizing close to the Koolau summit in natural areas.

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
		Pimenta dioica	It is a surprise that this is the first sighting of this taxa on this survey given that *P. dioica* is known in high abundances elsewhere in KTA. This road does occur at a higher elevation on the range which could mean that there is potential for this taxon to continue to spread at higher elevations. No control is planned.
Road	**RS-KTA-08**	*Santalum album*	This taxon has been noted by staff to have naturalized in local populations across the range. There could be a possibility of hybridization with native *Santalum*. Staff will not control it, but will continue to document new locations of this species, and investigate its potential as an ecosystem altering taxa.
Road	**RS-KTA-09**	*Senecio madagascariensis*	A single mature plant was identified (and destroyed) 1 m from the Rd at the entrance to Kahuku Training Area. An ICA was created at this location and it will be treated for eradication. This taxon is treated for eradication in a few locations in the northern Koolaus on or near Drum Road by OISC.
		Chromolaena odorata	Several outlier immature plants were also found near the entrance to KTA on this Rd survey. An ICA was created around these and is regularly monitored. *C. odorata* continues to show up in new locations throughout KTA, often on roadsides, despite intensive control efforts in the larger infestation areas.
Road	**RS-LKN-01**	*Falcataria moluccana*	Much of the previously burned and fallow ranch lands below Lower Kaala NAR are prime habitat for *F. moluccana*. As this species increases at lower elevations, it will be important to keep it out of the NAR and Manuwai MU. New higher elevation sightings should be documented. This tree will be targeted when seen in Manuwai.
Road	**RS-MMR-01**	*Kalanchoe tubiflora*	This species should be tracked and noted if seen within the managed areas in Makua. Both *K. crenata* and *K. pinnata* are invasive on the dry, rocky, open areas, and compete with recruiting *Euphorbia celastroides* var. *kaenana* in this type of habitat. Control of this species will be conducted during regular weed control efforts if found.
		Hylocereus undatus	This ornamental plant, also farmed for its edible fruit, can tolerate dry, open areas. It may not be quick to naturalize, but it would be appropriate to document its location and monitor over time.
Road	**RS-Shafter-01**	*Citharexylum spinosum* *Coccinia grandis* *Filicium decipiens* *Jasminum fluminense* *Ochna sp.* *Santalum album*	This was the first year a survey was conducted at Fort Shafter. This survey was initiated to search for *Chromolaena odorata* and *Cenchrus setaceus* that occur on other military lands. Additionally, staff were looking to identify plants that may be naturalizing across the base, or to identify populations of invasive plants. The taxon listed here are worth noting for their establishment across the facility, but no control is warranted.
Road	**RS-Tripler-01**	*Antigonon leptopus* *Citharexylum spinosum* *Filicium decipiens* *Ochna sp.*	For the same reasons as the survey above, this was the first time a survey was conducted across roads around Tripler Army Medical Center. The species listed here were naturalized around the facility (most often in the wild areas surrounding the facility). No control will be conducted.
Road	**RS-WaiKai-01**	*Verbesina encelioides*	It is disappointing that this invasive aster continues to show up in locations across the leeward side of the Waianae Range. There is lots of suitable habitat there, and it is likely to become a permanent part of the ecosystem. It will be targeted during regular control efforts in leeward managed areas, but not targeted for eradication.

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
Road	**RS-Wheeler-01** Roads throughout Wheeler Army Airfield (WAA)	*Atriplex muelleri* *Datura stramonium* *Parthenium hysterophorus* *Portulaca oleracea* *Portulaca pilosa* *Trianthema portulacastrum*	During the road survey, particular attention was paid to a location on Wheeler Army Airfield where street sweeper biomass, and dirt and rubble piles are staged before pickup for removal. These taxa were found growing out of a dirt pile and are not believed to be invasive, but are not known from Wheeler/Schofield. *P. hysterophorus* is however known from PTA and is controlled in 2 satellite locations where it occurs in natural areas. No control will be conducted unless this taxa shows up closer to natural areas. *Atriplex muelleri*, was submitted to Bishop Museum for identification and is a New State Record. No control is planned. Surveys will continue at this site annually during the road survey to monitor spread to surrounding areas, or for presence of new species. Additional sightings of any of these species elsewhere on military lands will be documented. Sediment containment plans for the dirt piles was initiated by DPW after these new taxa were identified.
		Verbesina encelioides	This taxon was observed growing out of the remnants of a sandpile along a Wheeler Road near the airfield. Live plants were handpulled, but the sand had most likely been dispersed and no additional actions will be conducted.
Road	**RS-SBS-01**	*Spermacoce alata*	This species was determined to be a New State Record after it was found at Kumaipo on the ridge above Makaha Valley. The same staff that worked to identify *S. alata* there later noted it on this road survey. They remarked that it was possibly mis-identified in the past as *S. assurgens*. Staff will continue to hone in their identification skills and to submit additional vouchers of this species as it may be more widespread than previously thought.
Road	**RS-SBS-02**	*Hedypnois rhagadioloides*	This dandelion-like species was first submitted to Bishop Museum following a road survey at SBW in 2015 where it was seen in somewhat high abundance in the training areas around range control. At the time it was noted as a New State Record. It is not surprising that it is now being identified from SBS, but noteworthy to document its spread to new areas.
Road	**RS-SBW-04**	*Elephantopus mollis*	This weed is known to occur in disturbed habitats along trails and roadsides. It is targeted as an ICA in Kahanahaiki, and may be naturalizing in more locations. No control is planned unless found inside a MU.
		Sonchus asper	*S. asper* is not common on Oahu, and may not be documented from this island. If seen again, staff will collect a sample to document range extension for Bishop Museum. No control is planned.
LZ	**LZ-CHERRY-155**	*Plantago debilis*	This uncommon species is known also from the Pahole Road. No invasive threat record. No control planned.
LZ	**LZ-HON-215**	*Schefflera actinophylla*	This LZ was created this year to replace the LZ adjacent to the existing Palikea snail enclosure, and to facilitate access to both the old and new (Palikea North) snail enclosures. Several *S. actinophylla* individuals were also found while clearing vegetation for the Palikea North enclosure. There is anecdotal evidence for increasing frequencies of this taxon across Honouliuli Forest Reserve. It should be targeted when observed anywhere in Palikea MU, and is a high priority target during weed control sweeps.
LZ	**LZ-Kamaili-199**	*Montanoa hibiscifolia*	Dense patches of *M. hibiscifolia* are known from Kamaili, and efforts are made to keep this weed out of ungulate exclosures around rare resources. Targeted control of stands of this taxon are recommended as time permits.

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
LZ	**LZ-KLOA-022**	*Setaria palmifolia*	There is already one ICA for this species in the Lower Opaeula MU. This newest find around the LZ needs to be evaluated as it is an extension of a population that occurs outside the fence. All plants will be controlled, either as ICAs or during WCA control after population size outside the fence is evaluated. *S. palmifolia* is a high priority target for this MU.
LZ	**LZ-MAK-096**	*Coccinia grandis*	*C. grandis* is widespread on Oahu, although not usually found in highly native habitats. This LZ occurs at the end of the road in Makaha valley surrounded by alien forest. It is a high priority to keep out of Makaha MU and will be controlled there if seen.
		Dicliptera chinensis	*D. chinensis* is known from one other location in Makaha MU. No control is planned, but staff will continue to document distribution.
Other	**OS-SBE-01**	*Solanum torvum*	Known elsewhere from SBW training areas, *S. torvum* was identified on a survey where sediment from the Central Vehicle Wash facility is deposited. This serves as a good example that vehicles do indeed pick up seed on the ranges and would otherwise spread them from range to range if not washed after use. Vegetation growing out of the sediment piles is treated quarterly.
Other	**OS-SBW-03**	*Datura stramonium*	This survey is conducted around a staging area for sand/gravel at SBW. Both these taxa were also found growing out of a dirt pile on Wheeler this year. It appears that the same suite of weeds is often found in the same type of source material (ie. sand, dirt, etc.) for range maintenance. It would be prudent to ensure that the source of these materials run through a more rigorous sterilization or inspection process. At the very least OANRP is tracking locations of these staging piles so that regular inspections and treatment can be made as needed.
		Portulaca oleracea	
Incidental		*Cenchrus setaceus*	A single clump of grass looking like *C. setaceus* was found on the northeastern Kahanahaiki fence and submitted to Bishop Museum for identification. The sample was dried out, but looked to be a vegetative match for *C. setaceus.* While known from the southeastern rim of Makua valley, no plants have been found this distant from the known infestation area. Targeted surveys were conducted in the valley this year, along with helicopter surveys around the location of this plant on cliffs below, inaccessible on foot. For additional discussion, see section 3.8.
Incidental		*Spermacoce alata*	This herb was found growing in the burn site at Kumaipo Ridge above Makaha. It is a new state record. No invasive threat record. No control planned.
Incidental		*Tibouchina longifolia*	Greenhouse staff noted an unknown Melastomataceae growing out of several planted pots in the greenhouse. Plants were submitted to Bishop Museum and Dr. Cliff Morden at UH Manoa for DNA testing to verify the species. This species is not known to occur anywhere on Oahu. The plants in the pots resulted from contaminated cinder imported from the Big Island. Thousands of valuable plants in the greenhouse potted with the contaminated cinder lot were bare rooted, and re-potted. It was a massive staff effort to decontaminate plants, and dispose of the contaminated media. See Section 3.6 for further discussion.

Above: Photos of New State Record *Atriplex muelleri*, found growing out of soil staging area on Wheeler



Above: Photos of New State Record *Spermacoce alata* found on Kumaipo ridge and the Makaha access road.

3.6 EARLY DETECTION: *TIBOUCHINA LONGIFOLIA*, WHITE FLOWER TIBOUCHINA

In August-September 2016, OANRP staff discovered seedlings in the Melastomaceae family growing out of potting media at both the Schofield Barracks Nursery and OANRP Nike Nursery. Unable to identify the seedlings, horticultural staff potted several up to grow them large enough for a positive identification. In the meantime, Dr. Cliff Morden, UH, offered to run genetic sequencing on a leaf sample at his lab; he determined the plant was *Tibouchina longifolia*. The plants flowered in December, producing small white flowers. Specimens submitted to the Bishop Museum Herbarium likewise were identified as *T. longifolia*. This represents the first time this taxon has been documented from Oahu. Previously, *T. longifolia* was only known from the Hilo and Puna regions of the Big Island, and from nowhere else in the State. The entire *Tibouchina* genus is on the Hawaii Noxious Weed list. The Hawaii-Pacific Weed Risk Assessment score for *T. longifolia* is 8, giving it a 'High Risk' rating. Other taxa in the same family are known to have long-lived seeds. The very fact that it spread to Oahu confirms the invasive potential of this taxon. In all, staff found approximately thirty to fifty seedlings.

Left to right: *T. longifolia* seedling growing out of a potted pilo; 3-4 month old plant; blooms at 6 months.

Staff strongly suspect that cinder in the potting media mix is the source of the *T. longifolia* contamination. There are several reasons for this. Firstly, there is no *T. longifolia* source population on Oahu. The greenhouses are fully enclosed with shade cloth, minimizing any possible likelihood of dispersal from the surrounding environment and potential unknown *T. longifolia* populations via birds or wind. All pots used were brand new, and all potting media was stored in covered containers in the greenhouses. The potting media was a mix of cinder (Hawaii Island), Sunshine Mix #4 (Canada), Perlite (Oregon, extreme heat used in manufacturing), and Vermiculite (purchased in 2014, unlikely source). *Tibouchina longifolia* is a tropical species, not known from North America, according to the Centre for Agriculture and Biosciences International (www.cabi.org), which maintains the online Invasive Species Compendium. *Tibouchina longifolia* is well established on Hawaii Island, in the same Puna/Hilo region where cinder production companies are located. Lastly, the only feature universal to all pots in which *T. longifolia* was found was a transplant date on or after May 17, 2016. OANRP purchased cinder in May and September of 2016, and it is possible that one or both of these orders were contaminated.

In October 2016, OANRP drafted a letter to HDOA regarding *T. longifolia*, and notified the cinder vendor of the find. After talking with the vendor, HDOA informed OANRP that the cinder is transported in open top containers from Puna to Honolulu, and is not guaranteed to be free of vegetative debris or weed seeds. While transporting a noxious pest is prohibited, HDOA inspection of previously unopened bags of OANRP cinder did not identify any *T. longifolia* seeds and further action could not be pursued. OANRP staff monitored several trays of cinder in the greenhouse, but did not find any *T. longifolia* seedlings. It is worth noting that the unopened bags inspected were from the September 2016 purchase only, as the May 2016 cinder already had been mixed into media.

OANRP horticultural staff follow Hawaii Rare Plant Restoration Group (HRPRG) phytosanitation guidelines, available online at http://laukahi.org/hrprg. Staff work to promote a sanitary culture in the greenhouses and communicate about pests found. Prior to outplanting, the top half inch of media is removed, and plants are visually inspected. If pests are found, plants are treated. Plants that cannot be cleaned are not planted. In addition, independent experts inspect the greenhouses twice during reintroduction season. These protocols were effective in identifying *T. longifolia* before any outplanting occurred. This is the first instance of contamination by a Melastomaceae seen by OANRP in almost 15 years of operation. Cinder is no longer used in OANRP horticultural operations.

Left: experts inspecting plants prior to outplanting. Right: *T. longifolia*, 4-5 months old

The discovery of *T. longifolia* and the threat posed by local cinder as a potential vector was shared directly with OANRP partners, as it directly impacted reintroduction plans. Staff also publicized the find to the larger conservation community via notices posted to listservs in October 2016 and February 2017 (Appendices 3-15 and 3-16), and a presentation at the March 2017 Oahu Weed Workshop. Partners in the State NEPM program discovered suspicious seedlings at their field nursery at Kaala. While the seedlings were too small to identify positively, they were very similar to those found by OANRP, and were also grown in media containing local cinder.

To avoid spreading this noxious pest, particularly to native forest work sites, staff cleaned approximately 2,400 plants destined for outplanting, setting back outplanting schedules about 6 weeks. Media was carefully washed from each plant, which was then re-planted into sterile media. This replacement media cost about $2,000. The process of bare-rooting is stressful to plants and some did not survive. In some cases, cuttings were taken instead and the original plant discarded. In all, cleaning took about 420 person hours and created 2,200-2,800 lbs of contaminated media and plant material. Disposing of this material was difficult. Unopened bags of cinder were donated to the Bishop Museum for consumption in a lava exhibit. After investigating options ranging from H-Power (media inflammable), to the landfill (high potential for dispersal), to autoclaving (prohibitively expensive, small capacity), to the Navy's air curtain

burner (small capacity, media would need to be mixed with organic matter), OANRP eventually decided to bury the contaminated material in a little used corner of West Base. The material was placed in a deep pit, covered with ground cloth, then buried under several feet of dirt. The location was marked with a pole and can easily be monitored in future. OANRP disposed of potentially contaminated media from the NEPM field nursery in the same pit.

While staff are confident that the *T. longifolia* is unlikely to show up again in the greenhouses, mitigating this threat required significant time, effort, money, and logistical creativity. If *T. longiofolia* was present in cinder purchased prior to 2016, there is a chance it could be found at older outplanting sites. Staff will monitor reintroductions for *T. longifolia* and other pests in the coming years.

Left to right: contaminated media drying in pots; dumping media into West Base pit; weed mat covering media.

Left: washing media off plants prior to re-potting. Right: burying media under several feet of soil.

3.7 INVASIVE SPECIES UPDATE: *CHROMOLAENA ODORATA*, DEVIL WEED

Control of *C. odorata* is a high priority for OANRP. Please see the 2011 Year End Report, Appendix 1-2 to view the draft management plan for *C. odorata* control. This year, *C. odorata* control efforts alone accounted for 44% (1,129 hours) of the time spent on ICA work, and 12% of the total time spent conducting all weed control. Although high, these statistics under-represent the resources required to combat *C. odorata*, as they do not include time spent conducting surveys outside of ICAs, developing and maintaining spray equipment, managing detailed data sheets, ordering dedicated gear, coordinating with Range and DPW staff, or OISC contract effort.

The status of *C. odorata* management is mixed. The KTA infestation expanded in size this year, both on and off-range. A small infestation expansion was seen at SBW. A new infestation was found at Manuwai, and off-duty staff discovered an outlier plant in Lanikai. There continues to be no effective way to restrict motocross riders to the official State Motocross Park in Kahuku, and no progress in working with the State to build wash facilities for park users. In better news, no plants were seen at SBE, surveys were negative for *C. odorata* at Bellows, and staff assisted OISC in aerially spraying the Kahana infestation for the first time. No plants have been found at a handful of small KTA outlier ICAs for several years. Area treated via aerial spray at KTA increased dramatically over previous years and includes both the primary core in Pahipahialua gulch and a secondary core in Kaunala gulch. Aerial spray acreage did not increase at SBW, but the core was fully treated once this year before the 2016-2017 flowering season. While control efforts at outlier infestations and designated hotspots are going well, with declining numbers of plants found, OANRP has not succeeded in stemming the spread of *C. odorata* into adjacent and new areas.

OISC continues to manage infestations at Kahana, Keamanea/Haleiwa, and Aiea/Camp Smith; see Appendices 3-7 and 3-8. No *C. odorata* surveys have been conducted outside of known infestation areas on Oahu, so it is possible that new infestations may be found in the future. To date, all discoveries off of Army training ranges have been opportunistic. In order to better understand the scope of *C. odorata* invasion on Oahu and set realistic goals for control, island-wide surveys are needed.

Current resources are insufficient to conduct planned treatment at all known infestations, much less survey potentially infested lands, and more aggressive tools are needed. OANRP is investigating biocontrol options for *C. odorata* which have been successful in other parts of the world. OANRP has begun discussions with OISC and other members of the Chromolaena odorata Working Group (COWG) to figure out the steps necessary to release one of the most promising biocontrols: *Cecidochares connexa*, a gall-forming fly. Staff hoped to obtain funding for biocontrol work this year, but need to wait until the OANRP contract renews in order secure monies for this important project.

Seed Longevity Trial Update

In 2011, staff installed a five-year trial at KTA to determine how long *C. odorata* seeds persist in soil. See the 2016 Year End Report for a description of the trial and partial results. The last two buried seed packets were scheduled to be dug up in July 2016, but staff were unable to locate them at the time. Fortunately, the seed packets were found in May 2017; this seed is currently undergoing testing in the seed lab. The fourth year seed could not be used to assess overall seedbank persistence, due to low numbers (7 seeds remaining of 2,500 buried). Fortunately, there were no similar problems with the seed recovered in 2017 (sixth year). Currently, it appears that *C. odorata* forms a short-term, persistent seed bank, with 36% germination at three years. Two of the seven seeds recovered from the four-year packets germinated. Full results of this trial will be presented in next year's report. A second buried seed trial was installed at SBW in May of 2016. Staff continue to monitor this trial, which is set up to run as long as ten

years, if needed. Between the two trials, staff hope to gain greater insight into the longevity of the *C. odorata* seed bank and any differences in seed persistence between sites.

The last seed packets from the KTA trial, after six years in the ground.

Sanitation

As a result of the discovery of *C. odorata* in Manuwai, OANRP invested in gear dedicated solely to *C. odorata* control. This greatly improves OANRP sanitation procedures. In spring of 2017, all staff assigned to control *C. odorata* were issued separate tabis. In addition, staff share a stash of small day packs, wire and nylon brushes, and gloves. All dedicated gear is clearly labeled. The brushes are not just for cleaning *C. odorata* gear at the end of a field day, but also for cleaning in the field when moving out of an area with a high density of plants. Staff will avoid work in dense infestations during fruiting season (March-May). The need for a stronger culture of sanitation was reinforced, embarrassingly, by the discovery of a *C. odorata* seedling growing in a planter at West Base. The planter, along a busy walkway, is right next to the H-Power bin where staff dispose of material from all of the highly invasive taxa OANRP controls. Seed may have been dropped near the planter when someone tossed a bag of vegetation into the bin, or when someone decontaminated field gear nearby.

OANRP staff Emily Long contemplating the *C. odorata* seedling she found at West Base.

KTA Update

Control efforts at KTA account for 38% of all incipient control effort this report year. In addition, OANRP continues to contract OISC to conduct control across almost half of the primary infestation. See Appendices 3-7 and 3-8 for a summary of OISC's work, including maps of areas treated this year.

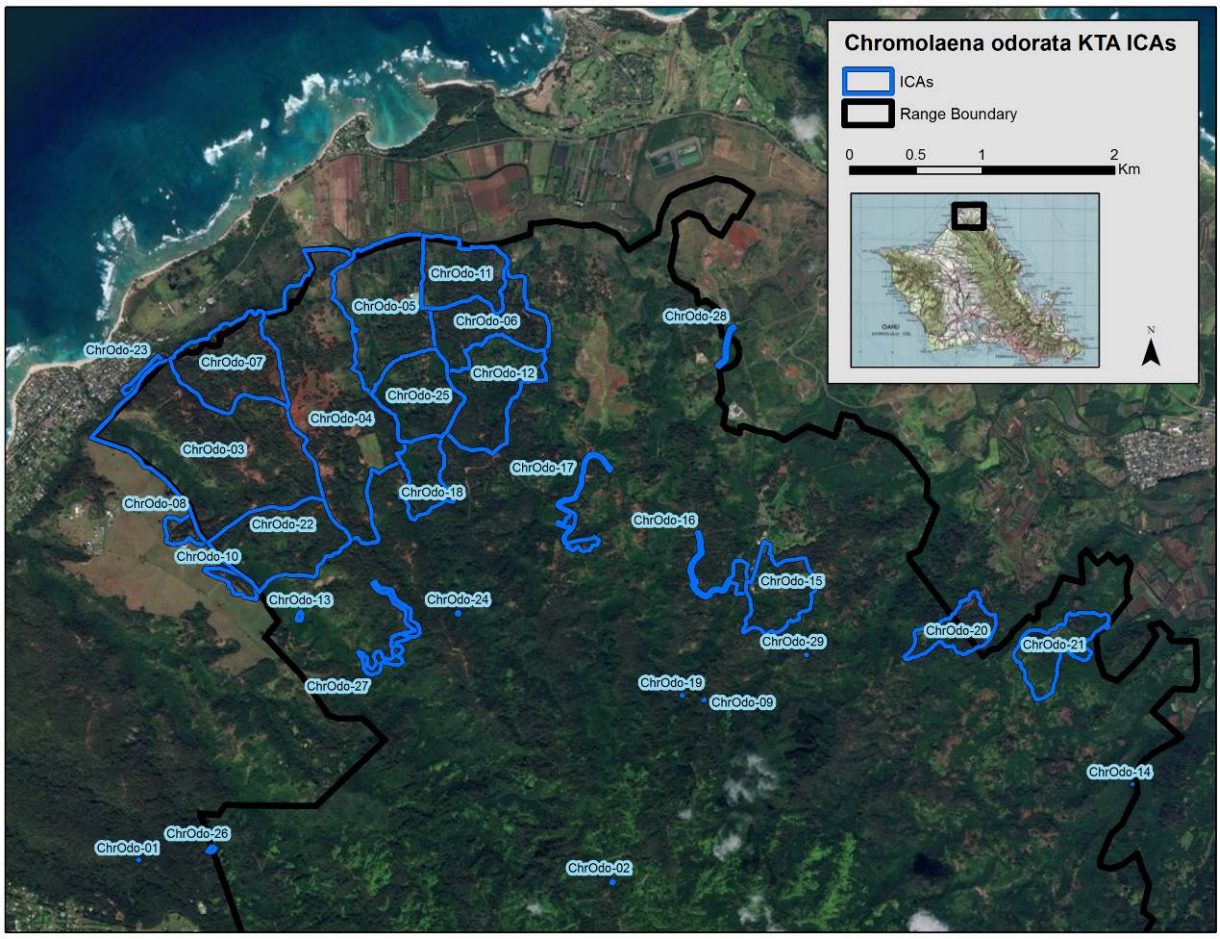


Figure 2. *C. odorata* Incipient Control Areas at KTA

- New ICAs. Four new ICAs were created this year, numbers 26-29.
    - ICA #26, Kaleleiki: In September 2016, staff found a single mature *C. odorata* at a small fence protecting a *Eugenia koolauensis* site. Unluckily, the plant had already dropped its seeds. This find prompted a full sweep of the exclosure, but only one additional plant, a seedling, was found. In all, only three plants have been found at Kaleleiki. In 2011, staff surveyed much of the surrounding area for *E. koolauensis*; although *C. odorata* was not part of that mission, if a large infestation were present, it is probable staff would have noted it. The likely source of the Kaleleiki infestation was contaminated OANRP gear.
    - ICA #27, Kaunala Road: One immature *C. odorata* was found along the Kaunala road during annual road surveys in March 2017. This is the first time *C. odorata* has been found along this particular road. On subsequent surveys, four additional immature plants were found. Although not in the State motocross park, this road is just mauka of it and is an irresistible draw for many riders. While occasionally used for military training, motocross use is much more frequent.

- ICA #28, Charlie Road: This ICA was also found during road surveys in March 2017. One mature and seven immature plants were found along the KTA access road, just below Range Control, between the Charlie 2 gate and engineer's union driveway. This road is heavily used by the military, the most likely vector. The road is also used by neighboring landowners and motocross riders.
- ICA #29, Delta Road: A single immature plant was found along the road leading from the CACTF to the Delta ranges during March road surveys. The surrounding area is heavily forested, not ideal *C. odorata* habitat, and it seems likely this plant was spread by a contaminated vehicle or road maintenance equipment.

- ICA Changes. Five ICAs were expanded to include new patches of *C. odorata* just outside their borders: ICAs 06, 12, 16, 21, and 23. The very large ICA 05, which encompassed the core of the infestation in Pahipahialua gulch, was split into two: ICA 05 is the northern end of the gulch, and contains the bulk of the infestation, including most of the aerial spray zone; ICA 25 is the less heavily infested area just to the south. This split assists with scheduling and logistics of control efforts.
- Control Summary. All control efforts are summarized in Table 12. Area, effort and number of visits are reported for the 2017 and 2016 report years. The dates of the most recently removed mature and immature plants are included. The *C. odorata* infestation now covers 606.5 ha in KTA. This is a huge area, and staff are unable to sweep every inch of it, despite contracting OISC to work in the motocross park, the highest priority area. Different strategies are employed in different ICAs as a means of stretching limited resources. The core of the infestation is divided between ICAs 03, 04, 05, 07, and 25. The other ICAs are either on the fringes of the core, represent separate infestations, or are outliers. The strategies used at each ICA are detailed in the 2016 Year End Report, and the "Type/ Strategy" column provides a quick reference to management approach at each ICA:
    - Outlier. These are geographically small sites, usually with very few individual plants found. After discovery, these ICAs are monitored quarterly. After several years with no plants found, the monitoring interval decreases to once or twice a year.
    - OISC contract + OANRP hotspot. OISC is contracted to sweep several ICAs fully twice a year. The ICAs covered by the contract are numbers 03, 04, and 07; they span the western end of the primary infestation and include the State Motocross Park. Hotspots are drawn around high densities of plants. OANRP sprays the hotspots 1-4 times per year with pre-emergent herbicide.
    - Sweep + Hotspot. Strategy at these ICAs includes rigorous sweeps across the whole ICA, in addition to more intensive monitoring and treatment with pre-emergent herbicides at Hotspots. Hotspots are tracked and monitored within ICAs. Whenever possible, staff use highly effective power sprayer equipment at Hotspots.
    - Sweep + Hotspot + Aerial Spray. As above, except aerial sprays are used to treat large, remote patches of plants which are either inaccessible to the power sprayer or located on steep cliffs.
    - Trails + Roads + Hotspots. Management at these ICAs is limited to surveys of all trails and roads 1-2 times per year, rather than landscape-wide sweeps. Staff observed that *C. odorata* spreads easily into new areas along trails and roads. Hotspots are tracked and aggressively treated. This approach is used only in ICAs with low plant density.
    - Trails + Roads + Hotspots + Sweep. As above, except portions of these ICAs are fully swept. This approach is used when *C. odorata* density is high in select areas of an ICA.
    - Private Land. OANRP does not have permission to work on infestations on private land, but OISC does. Staff assist OISC at these ICAs as feasible.

Table 12. KTA Control Efforts

ICA Code	ICA Area (ha)	2017 Report Year			2016 Report Year			Date Last Mature Plant Found	Date Last Immature Plant Found	Type/Strategy
		Area Weeded (ha)	Effort	# Visits	Area Weeded (ha)	Effort	# Visits			
WaimeaNoMU-ChrOdo-01	64 m²	64 m²	1.0	2	63 m²	2.5	2	none	2011-04-05	Outlier
KTA-ChrOdo-02	328 m²	328 m²	0.5	1	328 m²	0.5	1	none	2011-08-22	Outlier
KTA-ChrOdo-03	118.43	7.71	214.0	16	7.06	216.5	15	2017-06-29	2017-06-29	OISC Contract + OANRP hotspot
KTA-ChrOdo-04	111.63	10.40	94.0	10	6.77	107	12	2017-03-22	2017-06-28	OISC Contract + OANRP hotspot
KTA-ChrOdo-05	57.96	40.82	258.5	21	25.62	228	17	2017-06-14	2017-06-14	Sweep + Hotspot + Aerial spray
KTA-ChrOdo-06	32.62	31.68	103.5	7	1.9	32.5	2	2016-10-12	2016-10-12	Sweep + Hotspot
KTA-ChrOdo-07	41.26	4.18	33.0	6	4.72	59.35	6	2017-06-28	2017-06-28	OISC Contract + OANRP hotspot
AimuuNoMU-ChrOdo-08	4.59	0.59	1.0	1	0	0	0	N/A	2016-08-16	Private Land. OISC.
KTA-ChrOdo-09	78 m²	78 m²	0.5	1	78 m²	1.5	2	2013-01-09	2013-09-10	Outlier
AimuuNoMU-ChrOdo-10	3.73	0	0	0	0.36	1	1	N/A	2016-01-21	Private Land. OISC.
KTA-ChrOdo-11	28.74	18.64	41.5	5	17.98	40	2	2016-07-28	2016-08-03	Sweep + Hotspot
KTA-ChrOdo-12	39.29	4.23	19.0	2	6.02	37	3	2017-04-04	2017-05-17	Trails + Roads + Hotspots + Sweep
KTA-ChrOdo-13	0.23	457 m²	1.0	1	3 m²	0.25	1	2015-12-23	none	Outlier
KTA-ChrOdo-14	6 m²	6 m²	0.5	1	6 m²	1	2	2014-01-07	none	Outlier
KTA-ChrOdo-15	23.51	3.96	18.5	2	3.58	11.25	4	2016-12-06	2017-03-07	Trails + Roads + Hotspots + Sweep
KTA-ChrOdo-16	4.04	1.44	3.5	3	0.79	0.75	1	2016-12-06	2016-12-06	Trails + Roads + Hotspots
KTA-ChrOdo-17	3.73	1.98	4.0	3	2.67	4.75	2	2014-01-14	2017-05-17	Trails + Roads + Hotspots
KTA-ChrOdo-18	16.43	2.34	23.5	2	0.23	2.5	2	2014-10-29	2016-08-11	Trails + Roads + Hotspots
KTA-ChrOdo-19	78 m²	78 m²	0.5	1	0	0	0	none	2014-09-24	Outlier
KTA-ChrOdo-20	15.74	4.87	42.0	3	3.07	10.25	4	2016-12-06	2017-06-20	Trails + Roads + Hotspots + Sweep

ICA Code	ICA Area (ha)	2017 Report Year			2016 Report Year			Date Last Mature Plant Found	Date Last Immature Plant Found	Type/Strategy
		Area Weeded (ha)	Effort	# Visits	Area Weeded (ha)	Effort	# Visits			
KTA-ChrOdo-21	21.31	4.48	35.0	3	11.38	23	4	2017-06-20	2017-06-20	Trails + Roads + Hotspots
KTA-ChrOdo-22	43.8	0.94	20.5	3	4.8	24.5	4	2017-03-21	2017-03-21	Roads + Trails + Hotspots + Sweep
KahukuLaie-ChrOdo-23	1.52	0.13	1.25	1	0.48	2.75	2	2016-04-27	2016-09-27	Private Land. OISC manage?
KTA-ChrOdo-24	316 m²	316 m²	3.0	3	18 m²	0.1	1	2016-03-02	none	Outlier
KTA-ChrOdo-25	31.28	5.78	35.0	6	N/A	N/A	N/A	2017-06-27	2017-06-27	Sweep + Hotspot + Aerial spray
KTA-ChrOdo-26	0.18	0.18	22.00	4	N/A	N/A	N/A	2016-09-08	2017-02-21	Outlier
KTA-ChrOdo-27	5.73	1.54	3.5	3	N/A	N/A	N/A	none	2017-04-04	Trails + Roads + Hotspots
KTA-ChrOdo-28	0.69	0.35	1.0	1	N/A	N/A	N/A	2017-03-07	2017-03-07	Trails + Roads + Hotspots
KTA-ChrOdo-29	78 m²	20 m²	0.5	1	N/A	N/A	N/A	none	2017-03-07	Outlier
TOTALS	**606.53**	**146.36**	**981.75**	**113**	**98.1**	**807**	**90**			

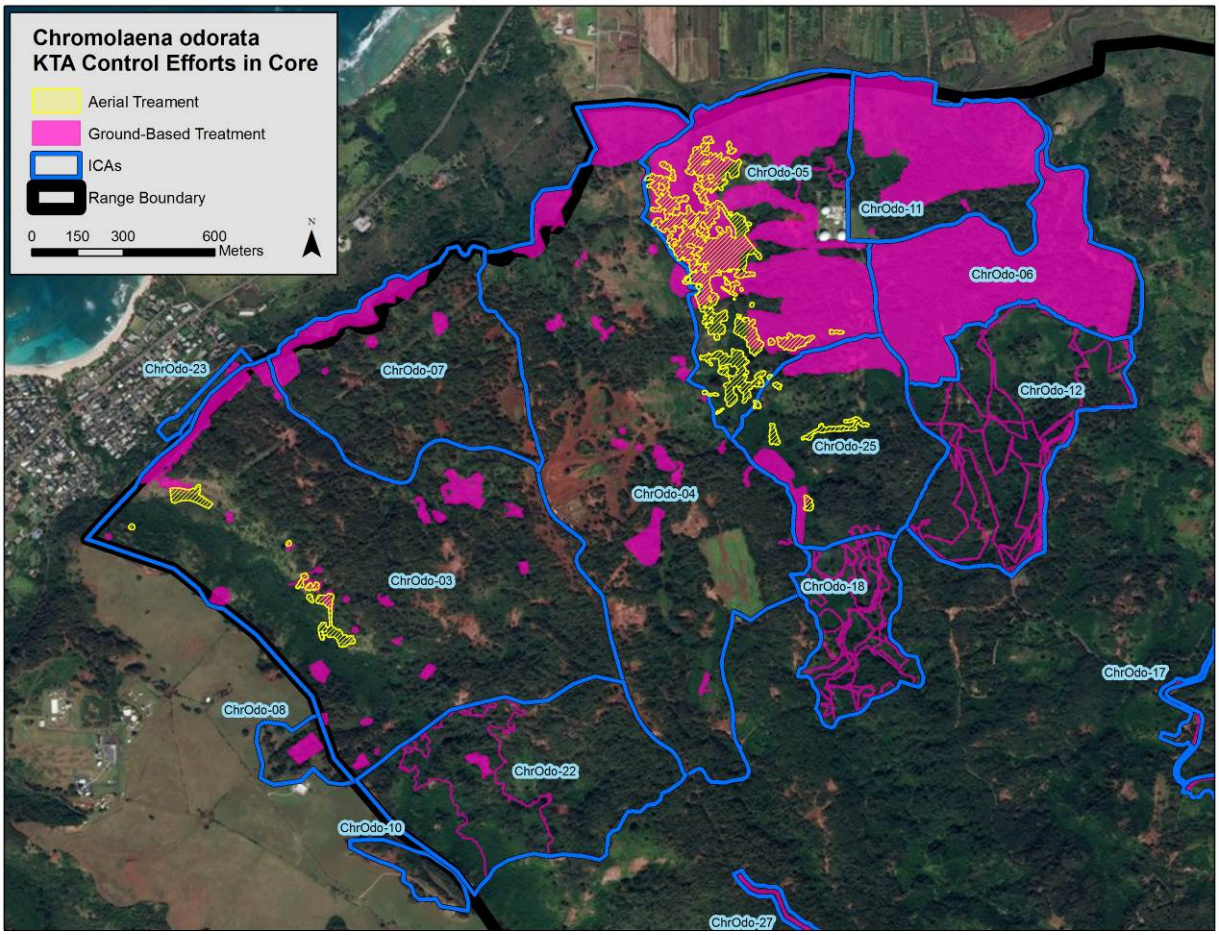


Figure 3. Aerial and Ground Treatment in the KTA Core Infestation

- Aerial Sprays. This year, 13.36 ha were sprayed aerially and 140.87 ha were treated on the ground, for a total of 146.36 ha of *C. odorata* controlled (ground and aerial treatments overlapped). The map above shows aerial and ground control efforts across the primary infestation. Aerial sprays were conducted in four different ICAs this year. While efforts focused on ICA 05 (11.08 ha), areas directly adjacent in ICA 25 (0.76 ha) and ICA 04 (495 m²) were also sprayed. A new spray zone was designated in ICA 03 to include several different hotspots, and 1.47 ha were sprayed. Staff noted that in ICA 05, few to no seedlings have been seen on follow-up visits, and sprays appear to successfully kill large mature plants. Due to helicopter budget limitations, no spray operations were conducted in the first six months of 2017, but staff expect to restart spraying prior to the winter 2017 *C. odorata* flowering season, when the detectability of plants increases. The efficiency of spray operations continued to improve this year, with tweaks to the aerial spray rig and continually growing pilot and staff experience with project operations.

Table 13. KTA Aerial and Ground Treatment Area

Report Year	Total Area Treated (ha)	Aerial Spray Area (ha)	Ground-Based Treatment Area (ha)
2016-2017	146.36	13.36	140.87
2015-2016	98.24	6.36	91.89
2014-2015	71.27	3.98	67.29

Dead *C. odorata* and alien grasses, treated via aerial spray.

- Outlier ICAs. Control efforts at the outlier ICAs have been successful, see Table 14. All outlier ICAs were monitored at least once this year. Staff will monitor outliers for at least ten years after the last plant was seen, or until more information is known about seed longevity.

Table 14. KTA Outlier ICA Status

ICA Code	Plant Type	Status
WaimeaNoMU-ChrOdo-01	Immature only	None seen since 2011
KTA-ChrOdo-02	Immature only	None seen since 2011
KTA-ChrOdo-09	Both mature and immature plants	None seen since 2013
KTA-ChrOdo-14	Mature only	None seen since 2014
KTA-ChrOdo-19	Immature only	None seen since 2014
KTA-ChrOdo-13	Mature only	None seen since 2015
KTA-ChrOdo-24	Mature only	None seen since 2016
KTA-ChrOdo-26	Both mature and immature plants	New this year
KTA-ChrOdo-29	Immature only	New this year

- ICA Discussion. Highlights of ICA management are summarized in the table below. The ICAs discussed are shown in Figures 2-4.

Table 15. KTA ICA Highlights

ICA Code	Discussion
KTA-ChrOdo-03	This ICA contains the largest number of hotpots, 38. Of these, 8 are now inactive. Another 8 are most easily reached from private land to the west, and OISC leads management of these. Several of the hotspots are large, and while treatment has been effective, getting these sites under control will take more time. Aerial sprays are needed at ten hotspots, all of which run along a line of grassy cliffs. Next year, staff will switch from just spraying the hotspots to treating the entire cliff.
KTA-ChrOdo-04	OANRP treat all hotpots in this ICA. Of 24 hotspots, 6 are now inactive, 5 show clear declines in numbers, and control efforts are progressing well at the remaining 13. Aerial sprays supplement ground efforts at 4 hotspots.
KTA-ChrOdo-05	Landscape sweeps were conducted across much of the eastern slopes of this ICA, and hotspots were treated several times. These efforts complement intensive aerial sprays. Some patches of plants were found on the makai end of the ICA. Staff hope to prevent plants from dispersing to the agricultural fields below.
KTA-ChrOdo-06	This ICA was fully swept once this year and was expanded to include a small patch of plants found in a gulch to the north. Control efforts have been quite successful here; there is a clear downward trend in the number of *C. odorata* found over the years.
KTA-ChrOdo-07	OANRP staff focus on hotspot treatment. Of 8 hotpsots, 2 are inactive, plant numbers are declining at 3, and control efforts are progressing well at the remaining 3. The highest numbers of plants are found on the north edge of the ICA.
KTA-ChrOdo-11	All areas not swept last year were surveyed once this year, and the distribution of *C. odorata* in the ICA is clearly defined. The majority of plants were found in the southwest corner of the ICA, closest to the Pahipahialua core. One hotspot was designated around a large mature patch just off the Opana road. A single mature plant was found on the east ridge. No plants were found on the northern slopes. The northern slopes will be surveyed with binoculars and sweeps every 2-3 years, while the southern flats will be surveyed annually.
KTA-ChrOdo-12	The numbers of plants found has increased greatly since 2014. This is due, at least in part, to improved coverage and the discovery of a hotspot. More frequent trail surveys and hotspot treatments may be needed. Through landscape sweeps may be needed to get numbers down.
KTA-ChrOdo-15	While staff surveyed all trails and roads in this ICA, there was a small increase in numbers of plants found. More consistent surveys may be helpful.
KTA-ChrOdo-16	In previous years, all plants in this ICA were found in the vicinity of a large clearing where gravel is stored. This year, plants were found down the road to the west. While numbers remain low, this dispersal is concerning.

ICA Code	Discussion
KTA-ChrOdo-17	The roadside portions of this ICA were monitored, but several outlier points within the ICA were not surveyed. More consistent coverage is needed. This year, there was bump in the number of plants controlled; this is entirely due to a cluster of immatures found at the site of one large treated mature plant.
KTA-ChrOdo-20	While staff consistently survey know trails in this ICA, there is no decline in the number of plants treated per year. Pre-emergent sprays have not been conducted at this ICA, and may be helpful in reducing numbers.
KTA-ChrOdo-21	Staff surveyed new areas to the north of the ICA this year, and found quite a few *C. odorata*, as well as a zipline tower (discussed in section 3.4 above). Further surveys are needed to completely delimit this ICA. Given the number and distribution of plants, staff may need to transition to landscape sweeps in addition to trail surveys. Also, pre-emergent sprays will assist in reducing plant numbers.
KTA-ChrOdo-22	This large ICA is directly south of ICA 03, which is surveyed by OISC. All trails within it were surveyed last year, and *C. odorata* distribution appears to be limited. This ICA needs to be assigned to one field team for more thorough coverage.

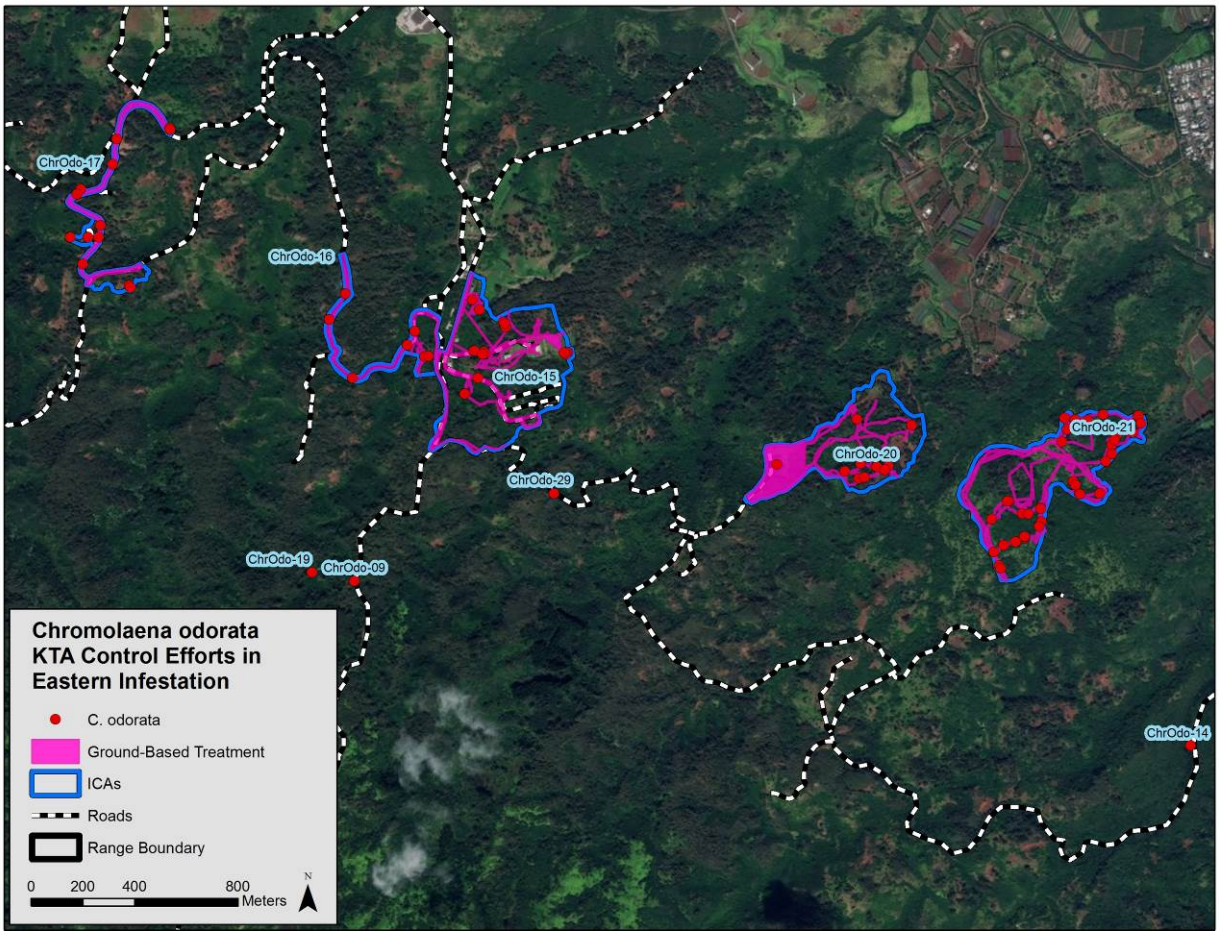


Figure 4. Treatment in the Eastern ICAs at KTA

- ICAs on Private Land. Last year, OANRP and OISC conducted surveys at KahukuLaie-ChrOdo-23 and at the Waialee Agricultural Research Station. No additional ground surveys were done this year, but staff expanded ICA 23 after noting that plants from Hotspot 37 in ICA 03 had spread off of KTA onto the steep slopes below. OANRP will share this find with OISC, and strategize how best to work in this area. OANRP was able to conduct one aerial survey of the region, but would like to expand these efforts again next year.

SBW Update

Control efforts at SBW are limited by range availability and the need for an UXO escort in the area. OANRP has been able to take advantage of regularly scheduled range maintenance 'cold' days, which have provided sufficient access. The table below summarizes control efforts at SBW in 2017. No new *C. odorata* ICAs were found on SBW this year.

Table 16. SBW Control Efforts

ICA Code	2017 Report Year				2016 Report Year		
	ICA Area (ha)	Area Weeded (ha)	Effort (hours)	# Visits	Area Weeded (ha)	Effort (hours)	# Visits
SBWNoMU-ChrOdo-01	22.28	5.60	56.7	11	14.77	56	9
SBWNoMU-ChrOdo-02	1.10	0.88	7.0	3	0.73	7.5	4
SBWNoMU-ChrOdo-03	0.49	0.46	9.5	3	0.40	6.5	4
SBWNoMU-ChrOdo-04	23.51	7.79	56.8	9	11.66	140.5	19
TOTAL	**47.39**	**14.72**	**130.0**	**26**	27.56	210.5	36

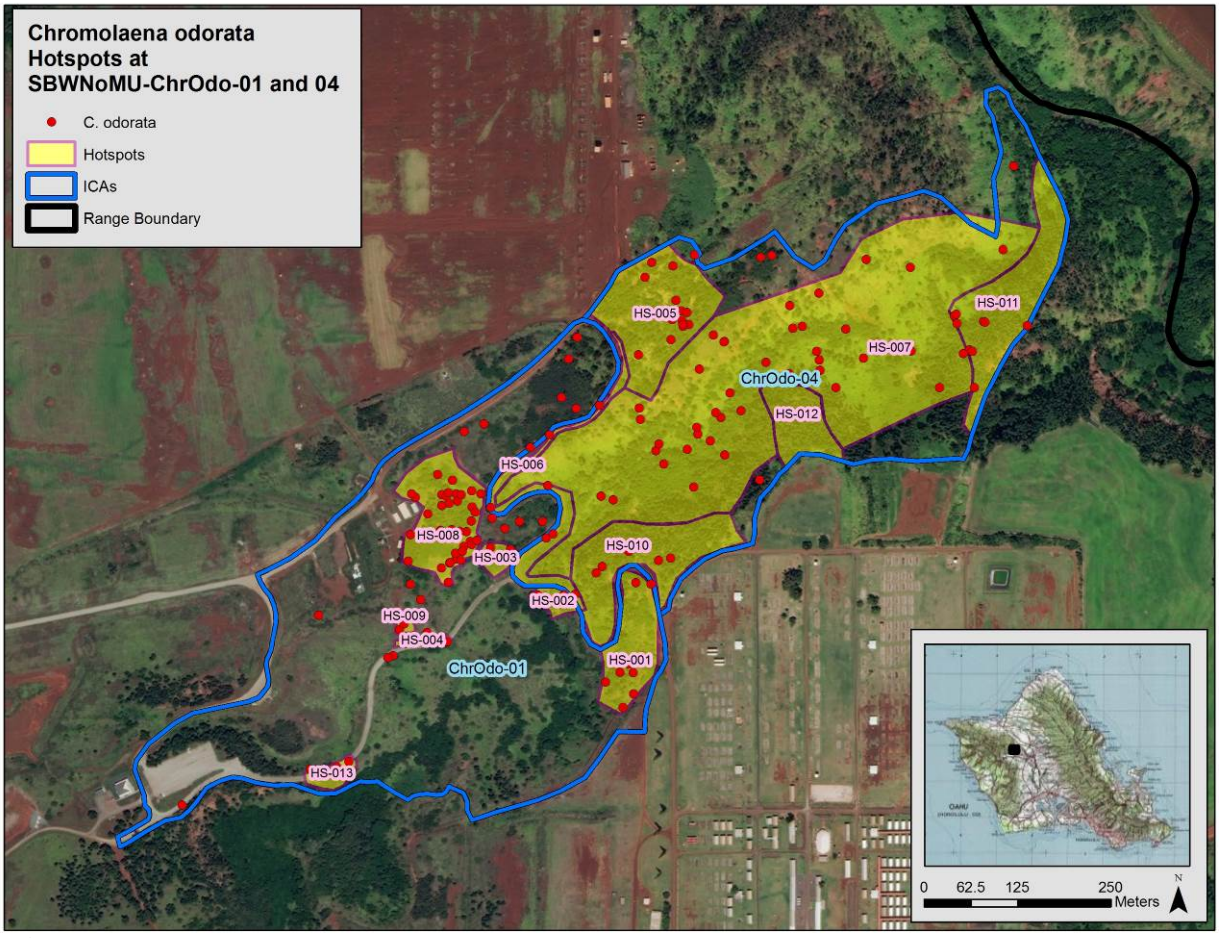


Figure 5. Hotspots in SBW Core ICAs

- SBWNoMU-ChrOdo-01. This ICA covers the western half of the primary *C. odorata* infestation. Bordered by roads to the north and east, the center of this ICA is dominated by dense stands of *Urochloa maxima*. The grass is so thick in some areas that *C. odortata* doesn't appear to easily colonize it, unless a disturbance creates bare ground. These grass patches are unsafe to survey due to UXO concerns. Next year, staff will survey them from vantage points using binoculars, and

possibly conduct an aerial survey. These surveys were done last year, but not this year, and account for the change in area swept this year. Geographic hotspots are designated around concentrations of plants to facilitate efficient and thorough coverage of this large ICA (see map above). This year, staff swept all hotspots except one, HS-003, which was partially sprayed from the air (see map below). In addition, the northern finger of the ICA was thoroughly swept; several outlier plants were found during the sweeps, but no large patches. Staff expanded HS-008 to include a narrow, deep gulch on the edge of the finger. There is a large patch of *C. odorata* in the gulch, but control efforts are limited by the presence of a very low-lying electrical cable, only a couple feet off the ground at its lowest point. The cable hazard was reported to DPW and Range Control. If it cannot be fixed, OANRP will ask if it can be temporarily turned off in order for staff to safely treat the gulch. One new hotspot was designated this year, HS-013. This hotspot stretches from the road down a steep slope into a gulch. Treating this hotspot is a priority, as seed can easily disperse down gulch. The ICA was expanded to include HS-013 and an outlier plant found along the road near a large building. Despite this expansion, staff note that the hotspot strategy seems to be effective in reducing plant numbers in those locations.

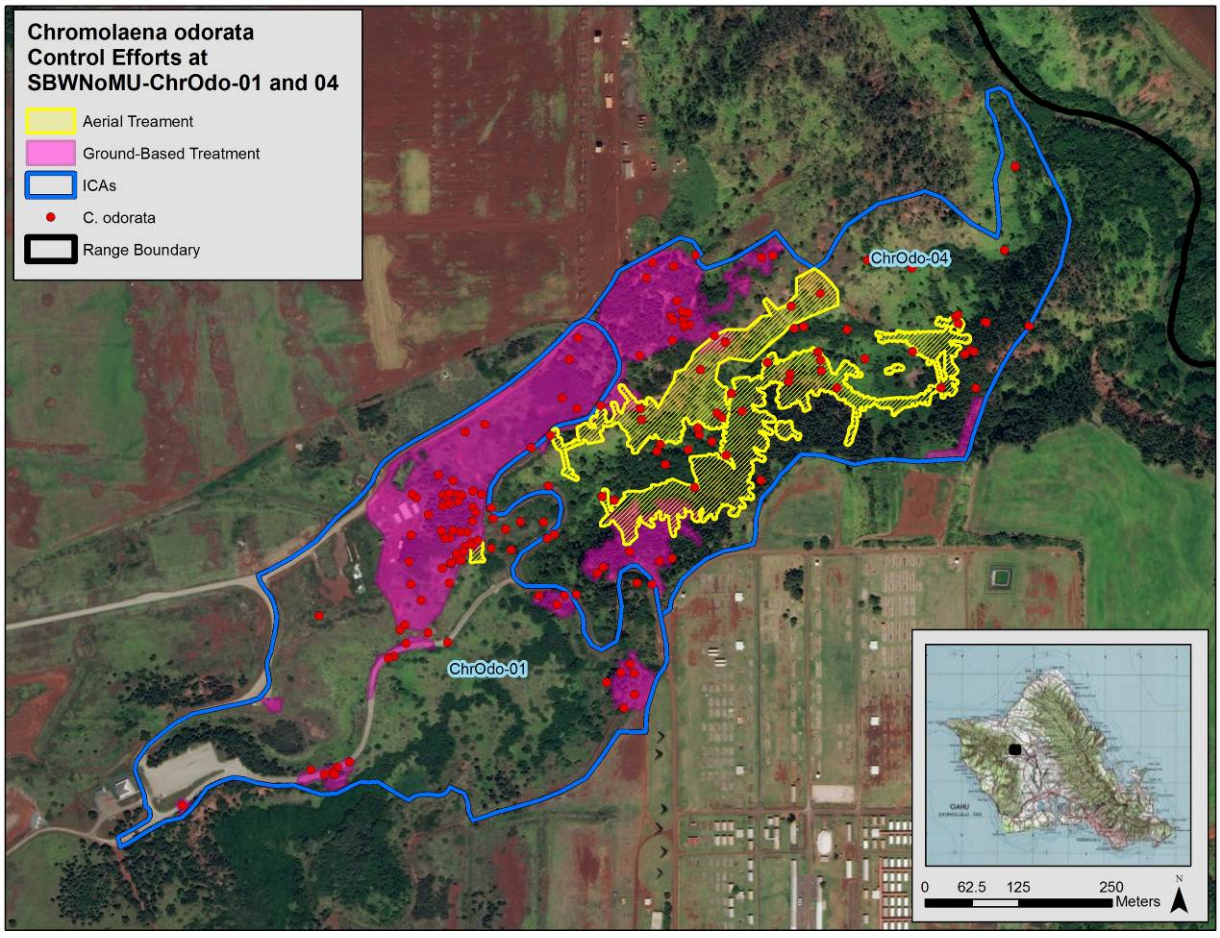


Figure 6. Aerial and Ground Treatment in SBW Core Infestation

- SBWNoMU-ChrOdo-02. The most northerly of the ICAs at SBW, control at this site is complicated by the fast-growing, thick *U. maxima* which dominates it. Regular sprays are needed to keep grass from growing over the ICA, which would prevent staff from thoroughly surveying it and reduce control efficacy. This year, only 9 immatures and 1 seedling were found at this ICA, the lowest annual number since it was discovered in 2014. The last mature plant was removed in

April 2016. These promising results may indicate that the seed bank at the ICA is successfully being depleted. No plants were seen along the road this year, making it two years since any roadside plants have been found. Staff continue to use pre-emergent herbicide to reduce potential *C. odorata* germination and reduce grass cover. In the coming year, staff will work to maintain consistent pressure on this ICA.

- SBWNoMU-ChrOdo-03. Over the years, relatively few plants have been found at this ICA, including just 7 mature plants. However, this year, staff found the highest number of plants ever seen, including 1 mature, two immatures, and a tight cluster of 250 small immatures. The cluster of immatures was found next to an orange flag which marked a previously controlled mature plant, and appeared to be in an area which was not monitored recently. Thorough coverage of the entire ICA is critical. This ICA is located next to a firing target and UXO has been identified in the area. Parts of the ICA are covered by dense patches of tall grass. Due to UXO risk, it is unsafe to walk wherever grass obscures the ground. In the coming year, staff will use the power sprayer to safely treat grass patches from a distance. This should allow staff to conduct more thorough surveys of the entire ICA while maintaining safety.
- SBWNoMU-ChrOdo-04. This ICA encompasses the eastern portion of the primary *C. odorata* infestation, including the core. The terrain is challenging. Portions of the gulch are dominated by dense grass, the slopes are very steep, and there is a high UXO hazard which limits ground access. As in ChrOdo-01, hotspots were drawn around concentrations of plants. Some of the hotspots are treatable from the ground, but the largest, HS-007 is best treated via aerial sprays. This year, 4.97 ha were aerially sprayed and 5.56 ha were treated on the ground. In contrast, 8.14 ha were aerially sprayed last year and 4.38 ha treated on the ground. Only one round of aerial sprays occurred this year, due to helicopter budget constraints, as opposed five rounds last year. This also accounts for the drop in effort from 2016 to 2017. Despite this, staff did manage to aerially spray the majority of HS-007 this year, a testament to the success of last year's efforts. Staff focused ground control efforts on the westernmost hotspots, but little work was done on the east end of the ICA. In the coming year, staff hope to expand ground control in the east and south of the ICA and maintain a regular aerial spray schedule.

View of the core looking south, towards Area X. Note the bare ground on the slopes beneath the Eucalyptus.

- UAV Trial. *C. odorata* is difficult to detect in thick vegetation both on the ground and from the air, even with experienced staff. This year, OANRP worked with Cultural Resources to test the potential of UAVs in spotting *C. odorata* at SBW. Cultural Resources staff have both a UAV and a certified UAV pilot, and have already received clearance to conduct flights at SBW. They conducted a test flight in October 2016, flying over a previously identified patch of plants, as well as across a large swath of the north slope of Mohiakea gulch. While it was difficult to spot *C. odorata*, with a more tailored flight path, low flight altitude, and higher resolution camera, detection would be improved. Staff also experimented with geo-referencing the images. Again, there were some difficulties, but these appear fixable with mastery of select software.

Above: OANRP and Cultural Staff conducting UAV flight. Below: *C. odorata* is visible but difficult to pick out.

Above and below: two different angles of the same *C. odorata* patch, marked with an arrow. The different perspectives are useful but somewhat nauseating to review. Unfortunately, *C. odorata* does not have a strong visual element to cue into.

SBE Update

First discovered in October 2014, only 15 plants have ever been found at SBE, all in one ICA: 14 immatures in October of 2014 and 1 mature in February 2015. Although the single mature did set seed, the area around it was treated with pre-emergent herbicide, and no plants have been found since then. This makes almost two and a half years with no plants found, which strongly suggests that no seed bank was formed. Control efforts are summarized in the table below.

Table 17. SBE Control Efforts

ICA Code	2017 Report Year				2016 Report Year		
	ICA Area (ha)	Area Weeded (ha)	Effort (hours)	# Visits	Area Weeded (ha)	Effort (hours)	# Visits
SBE-ChrOdo-01	0.18	0.18	3.25	3	0.18	12.25	7

A 200 meter buffer survey around the infestation site was completed last year and this accounts for the high number of visits and effort in 2016. This year, control focused solely on the known ICA. Both last year and this year, staff noted that the area appears to be sprayed regularly by some other group. Since the ICA is directly adjacent to powerline poles, it could be HECO. In any case, these sprays keep the area open and easy to survey. The ICA will continue to be monitored for at least five to ten years from the date of the last mature plant, although the monitoring frequency will decrease to once a year after five years. As seed longevity trials progress, staff will revise plans based on the best available data.

Given the intensity of training at SBE and the high number of plants at KTA and SBW, there is a chance that *C. odorata* will be reintroduced to SBE. Fortunately, staff already survey or sweep much of SBE. Road surveys are conducted once a year and include all drivable trails. Large areas are regularly swept in the course of ICA control work on *S. condensatum* and *R. tomentosa*. Staff hope these efforts will detect any new *C. odorata* infestations in a timely manner.

Lanikai Discovery and Update

While enjoying her weekend in September 2016, an OANRP staff was horrified to find a single immature *C. odorata* peeking out from the naupaka hedge lining the Kuailima Street access to Lanikai beach.

Beach access where the two-branched *C. odorata* was found. The plant was removed prior to this photo.

The plant was handpulled and submitted to the Bishop Museum Herbarium. Staff have many theories as to how the *C. odorata* got to the beach access, but all are pure speculation: a recreational hiker or motocross rider with dirty gear could have walked by, or staff from OANRP or OISC, or a solider off-duty; someone could have parked next to the (now removed) large *C. odorata* bush in the Camp Smith parking lot and picked it up there before heading to the beach; a tourist from Guam may have transported it; or, worst case, it could be an outlier from a new infestation in the Kailua/ Lanikai/Waimanalo region. OANRP reported the find to OISC, who surveyed the publicly accessible portions of the surrounding neighborhood. No additional *C. odorata* were found. The OANRP staff who found the plant also happens to sit on the board of the non-profit Lanikai Association. With OISC's support, she brought up the find at the board's next meeting to increase public awareness of *C. odorata* and OISC's mission.

OANRP also reported the find to MCBH staff, as the Marine Corps Training Area Bellows and Bellows Air Force Station is located less than 1.5 km to the south. Marines train both at Bellows and on Army lands, particularly KTA. The risk of *C. odorata* spreading to Bellows via training is high. Bellows has excellent habitat for *C. odorata*, with dry, scrubby forest and open, disturbed clearings. In February 2017 OANRP staff joined MCBH, OISC, and Air Force staff on a survey of the roads and trails across the Bellows facilities. The map below shows the proximity of the Lanikai plant to Bellows. The group divided into three survey teams; the ground surveys on the map are only for survey team with OANRP staff and don't include areas monitored by the other two teams. The beach and cabin areas were not surveyed. Encouragingly, there does not appear to be a large *C. odorata* infestation at Bellows, as no plants were found.

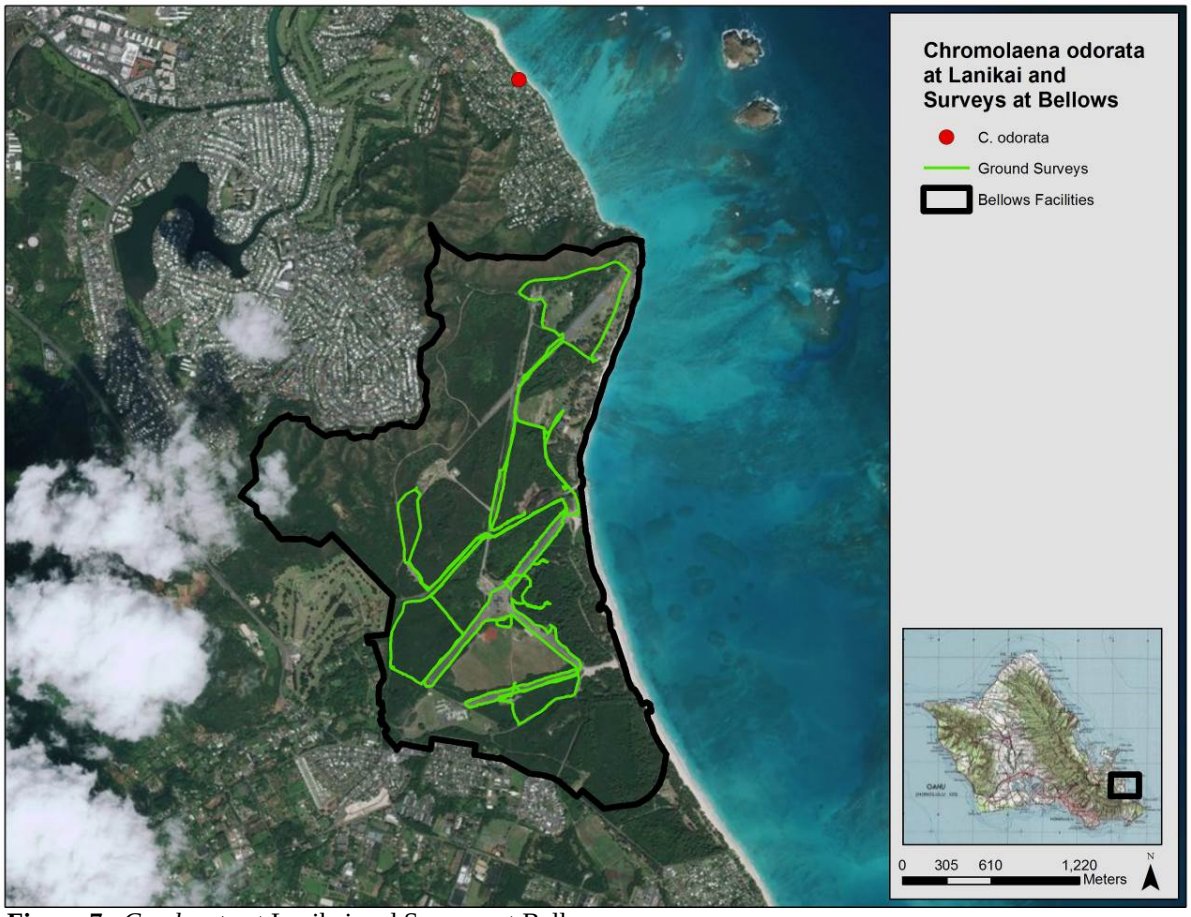


Figure 7. *C. odorata* at Lanikai and Surveys at Bellows

Manuwai Update

On February 23, 2017, staff found one *C. odorata* along the eastern end of the interior Manuwai fenceline, near a tree stump which often serves as a resting spot for staff hiking this steep trail. The plant was large enough to have flowered the previous flowering season (starting December 2016), but was vegetative and did not have any obvious signs of spent inflorescences. Staff did not have time to conduct a survey of the surrounding area that day. Returning to the site in early March, two smaller immature plants were found. The ground in the area was sprayed with pre-emergent herbicide, and staff surveyed the nearby trails on the ridge and along the interior fenceline to the gulch bottom to delimit the ICA (see map below). No other plants were found. This discovery of *C. odorata* was very disheartening, not only because it spread to an entirely new location, but also because Manuwai is a steep and challenging area to work, and most importantly, because OANRP staff were very likely the vector. This incident prompted OANRP's move to having field gear dedicated to *C. odorata* control.

The two immature *C. odorata* found March 2, 2017 at Manuwai.

After looking at records of management in Manuwai, staff determined the dispersal likely occurred during a camp trip either in January 2016 or December 2015. On both trips, staff walked past the stump site and had worked in KTA on *C. odorata* in the preceding days. Seed could have hitched a ride via packs, footwear, or other improperly cleaned gear. The focus of both camp trips were large sweeps treating alien canopy trees. In total, 9.26 ha were swept across a total of six different WCAs; these are the 'Potentially Contaminated' purple polygons in Figure 8. While portions of the MU seem like marginal *C. odorata* habitat, the open ridges, grassy slopes and northern forest patches all are ripe for *C. odorata* invasion. Rather than surveying a 200m buffer around the ICA, staff plan to prioritize surveys of the 'Potentially Contaminated' polygons, as well open habitat within the 200m buffer. These surveys are a priority in the coming year. Thus far, survey efforts have been limited to frequently used trails. Surveys will be challenging, as terrain is steep and visibility through surrounding vegetation is poor (particularly in areas where alien canopy was controlled, leading to increased light and understory growth), meaning the potential of detecting any *C. odorata* present will be low. Unfortunately, there is no easy way to improve this. Aerial surveys have limited utility, as the canopy is tall and *C. odorata* is cryptic. However, staff

may be able to identify areas which appear to be particularly good habitat via aerial survey, and spend more time surveying them on the ground. All staff have been briefed to look for *C. odorata* in the course of other management work.

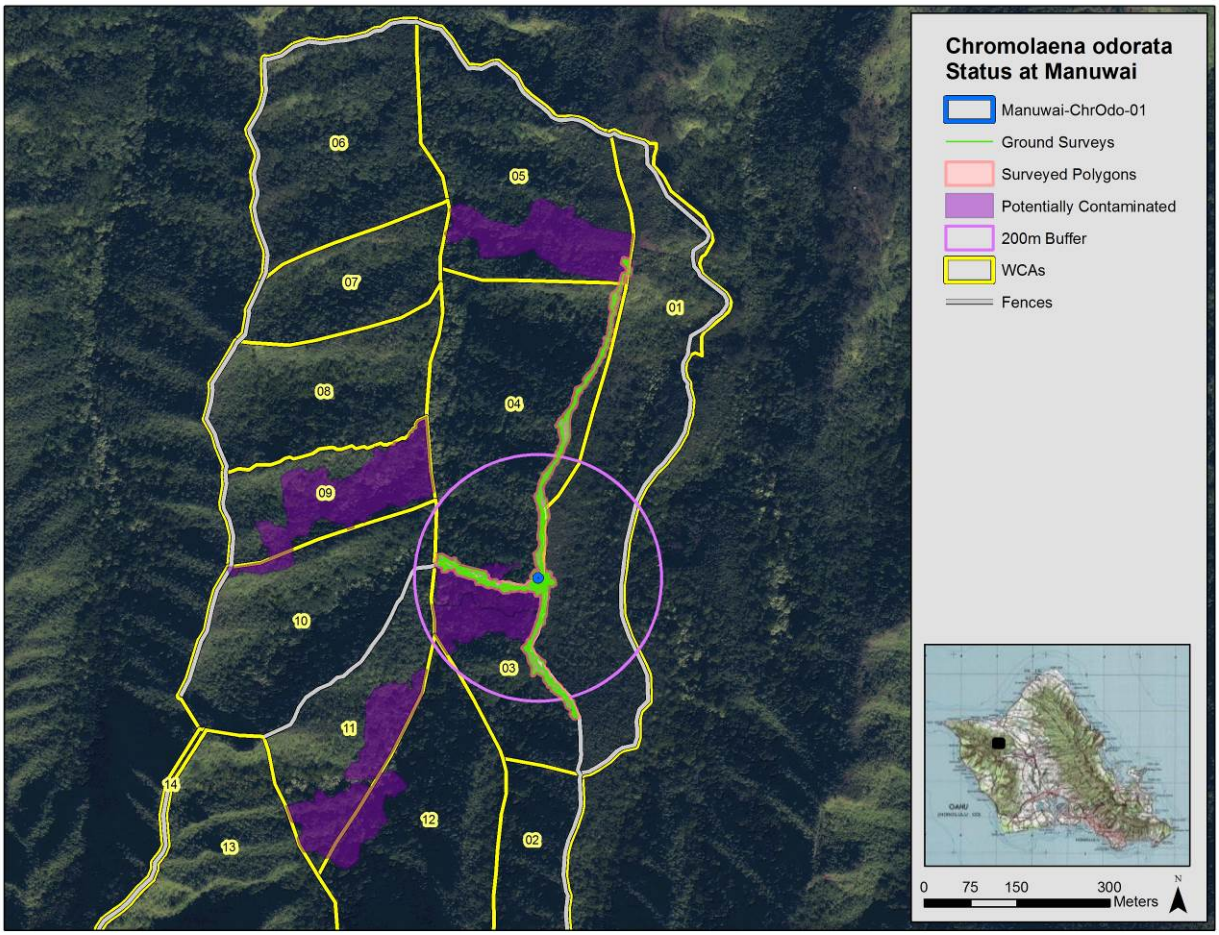


Figure 8. *C. odorata* Status at Manuwai

Control efforts for the year are summarized in the table below. No plants have been found since March 2017 thus far, and the site will be checked quarterly in the coming year.

Table 18. Manuwai Control Efforts

ICA Code	2017 Report Year				2016 Report Year		
	ICA Area (m^2)	Area Weeded (m^2)	Effort (hours)	# Visits	Area Weeded (m^2)	Effort (hours)	# Visits
Manuwai-ChrOdo-01	78	78	13.75	4	n/a	n/a	n/a

The discovery of *C. odorata* at Manuwai and Lanikai this year, as well as its spread to new sites previously documented by OANRP and OISC in years past, drives home the need for a viable biocontrol. If OANRP and partners are successful in releasing *Cecidochares connexa*, reputed to be capable of infecting widely scattered *C. odorata* plants across the landscape, eradication is possible. This aggressive invasive plant requires aggressive control measures.

3.8 INVASIVE SPECIES UPDATE: *CENCHRUS SETACEUS*, FOUNTAIN GRASS

Cenchrus setaceus is a priority for control whenever found on Army training lands due to its invasive behavior, documented fire risk, and ability to thrive on steep rocky habitats where IP taxa dwell. *C. setaceus* is easy to kill. As a general rule, staff always clip and bag any inflorescences for later disposal at H-Power. Plants may be hand-pulled or treated with a foliar spray of glyphosate. A pre-emergent herbicide is often mixed with the glyphosate to reduce recruitment of seedlings. Aerial sprays are effective in killing plants. However, herbicide is most effective when applied to actively growing plants and many of the ICAs are found in dry habitats; herbicide application needs to be timed to coincide with wetter periods when plants are green.

A buried seed trial conducted by OANRP staff found that it forms a transient seed bank (seeds viable for up to 1.5 years; see 2016 YER Appendix 3-9). For this taxon, OANRP conservatively declares a site eradicated if consistent monitoring finds no plants at a site for twice the time of seed persistence, in this case, three years. If the site is difficult to survey and staff do not have high confidence in the detectability of *C. setaceus*, monitoring may be extended for several more years. This taxon is eradicable, particularly from discrete infestations, and OANRP has indeed successfully extirpated it from six different ICAs over the years. Three of these eradications occurred this year. The table below summarizes all eradications to date. Note that the number of plants removed from DMR is likely an underestimate, as records from the early 2000s are incomplete. All of the eradicated ICAs were located in areas with easy access and flat or easily navigable terrain. All the eradicated ICAs were discovered before infestations spread widely.

Table 19. Eradicated *C. setaceus* ICAs, Data Totaled for All Years of Control

ICA Code	Total Area ICA (m^2)	Date First Found	Date Eradicated	Total Effort (hrs)	Total # Visits	Total # Plants Removed
DMR-CenSet-01	6,057	2001-08-30	2015-08-03	9.95	13	12
KTA-CenSet-01	4,739	2000-07-01	2014-01-06	57	31	806
KTA-CenSet-02	960	2012-04-11	2017-04-05	21.75	13	86
MMR-CenSet-01	2	2006-03-13	2012-03-12	0.51	6	1
SBE-CenSet-01	15	2004-09-21	2016-08-15	4.85	11	1
SBE-CenSet-02	98	2012-02-06	2016-08-15	8.8	13	12

Table 20 summarizes control efforts for this year. Last year, 8.9 ha were weeded over 90.27 person hours on 20 visits. This year's totals are much higher, mostly due to an increase in area surveyed across Makua Valley and parts of Keaau and additional time spent in the core on the makai portion of Ohikilolo ridge. Ten ICAs were monitored this year. Of these, three were eradicated, as mentioned above. Two were newly discovered, one in Makua valley and the other in Kahanahaiki. Five of the active ICAs, including the two newest, are small in area and have a good prognosis for eradication, with clear declines in plant numbers. The remaining two ICAs, MMR-CenSet-02 and KeaauNoMU-CenSet-03, cover the most area and are home to the most plants. Both continue to pose management challenges. Given that *C. setaceus* is widespread at PTA, well-established along at least two popular southeast Oahu hiking trails, and there is an illegal trail on Ohikilolo ridge, it is likely new ICAs will be found on Army lands in future. Sanitation measures are in place to clean military vehicles leaving PTA, but there is currently no effective way to prevent recreational hikers from becoming vectors.

In November 2016, staff discovered a new infestation of *C. setaceus* on high cliffs in the Waianae Kai Forest Reserve. The find was shared with the State. OANRP plans to assist the State with aerial spraying of the infestation. In addition, staff will also assist OISC and KMWP with aerial sprays of another infestation above Aiea.

Table 20. 2017 Report Year *C. setaceus* Control Efforts

ICA	ICA Total Area (ha)	Area Weeded (ha)	Effort (hours)	# Visits	Comments
KeaauNoMU-Censet-03	21.51	6.64	8	2	This year, staff conducted surveys from Ohikilolo ridge using binoculars and found that the infestation was much larger than previously thought, extending to about 2,000 ft. elevation. A few plants were handpulled, but most were inaccessible and well below the fence. OISC manages this ICA, which is on private property. The owner denied all OISC requests to use herbicide, which means aerial sprays are not an option. Given the infestation extension found this year, aerial sprays are likely necessary for eradication. OANRP will continue to assist OISC as requested.
KTA-CenSet-02	0.1 (960m^2)	0.1 (960m^2)	2	2	Eradicated this year. The last plants were seen in 2013. Initial treatment removed 16 matures and 63 immatures, with few plants found on subsequent trips. This small site was monitored consistently since its discovery, and this regular follow-up contributed to its rapid eradication.
KTA-CenSet-03	0.77	0.34	2	2	The last plants were seen in February 2015, and this site is approaching eradication. While quite a few plants were removed when it was first discovered (84 mature and 42 immature), fewer than 10-20 plants were found on any subsequent visit. This ICA is in the highly trafficked Kahuku Motocross Park.
MMR-CenSet-02	37.45	26.48	120.16	11	This is the largest infestation on Army land, and the largest in the Waianae Mountains. It is discussed in detail below.
MMR-CenSet-03	0.01 (78m^2)	0.01 (78m^2)	2.75	4	Three mature and nine immature plants were discovered and removed in January 2016. No plants have been found on subsequent visits, a promising trend. Located along the firebreak roads of MMR, this ICA likely is the result of dispersal from nearby MMR-CenSet-02.
MMR-CenSet-04	0.01 (78m^2)	0.01 (78m^2)	1.35	4	One mature plant was discovered and removed in January 2016. No plants were found on subsequent visits. This ICA is located in the mowed area bordering the firebreak road in MMR. *C. setaceus* thrives in disturbed habitat, and likely dispersed to the area from the established MMR-CenSet-02.
MMR-CenSet-05	0.01 (78m^2)	0.01 (78m^2)	26.3	5	In August 2016, staff found a single immature plant along the western edge of the Kahanahaiki fence. This ICA is discussed in detail below.
MMR-CenSet-06	0.01 (78m^2)	0.01 (78m^2)	0.45	2	This site was discovered in March 2017 during a MMR road survey. Three mature plants were removed, but none have been found since. The ICA is on a road crossing a large mowed field east of MMR-CenSet-02.
SBE-CenSet-01	0.001 (15m^2)	0.001 (14m^2)	0.25	1	Eradicated. This site is along a well-used training road. The likely vector was a contaminated vehicle from PTA. One plant was found in 2004 but none have been seen since. Due to very irregular monitoring intervals, this site was monitored for several extra years.
SBE-CenSet-02	0.01 (98m^2)	0.01 (98m^2)	0.5	1	Eradicated this year. No plants have been found since 2012. Since monitoring intervals were somewhat irregular, staff monitored the site for an extra year. This site is along a well-used training road. The likely vector was a contaminated vehicle from PTA.
TOTAL	**59.86**	**33.60**	**163.76**	**34**	

MMR Status

This year, the bulk of *C. setacus* management time and effort was spent in MMR. ICAs are located in the valley (outside of any MU), in Ohikilolo Lower MU, in Kahanahaiki MU, and just outside the training range in Keaau.

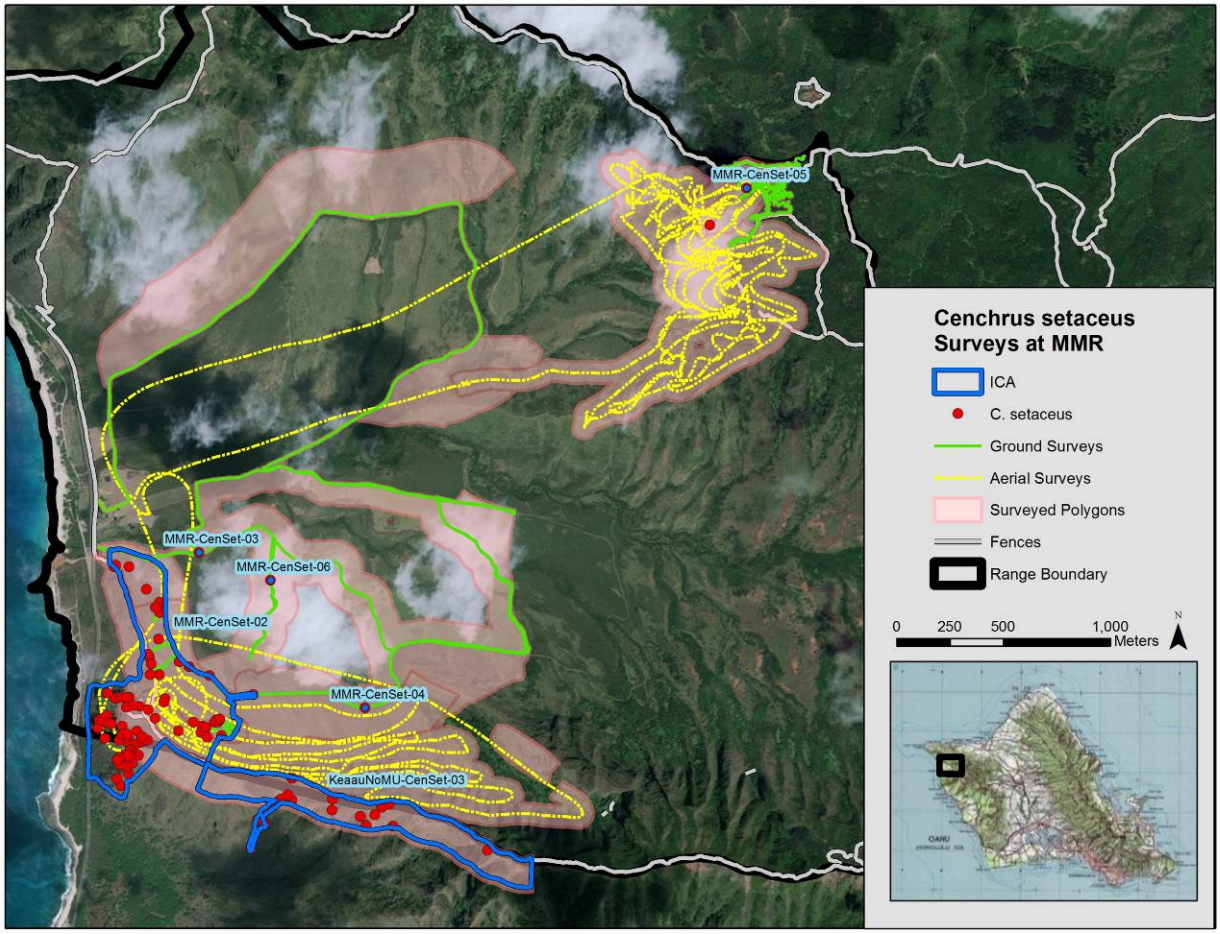


Figure 9. Ground and Aerial Surveys in MMR

- Makua Valley Surveys. In November 2016, staff conducted a large-scale survey of appropriate *C. setaceus* habitat in MMR. It had been five years since similar surveys were done following the discovery of the core infestation in late 2011. The map above shows the scope of survey efforts. Staff conducted both aerial and ground surveys, using binoculars to scan cliffs from safe vantage points. Due to UXO, it is not safe to survey the valley without EOD support, and even with EOD densely grassy areas are unsafe. Crews surveyed down Ohikilolo ridge from White X LZ, drove the firebreak road and scanned nearby cliffs, swept the Hibiscus and Akoko WCAs and binocular-surveyed the slopes between them, and surveyed parts of Kahanahaiki (discussed below). While no brand new sites were found, both the MMR-CenSet-02 and KeaauNoMU-CenSet-03 ICAs were expanded to include plants found outside their old borders. At MMR-CenSet-02, several clusters of *C. setaceus* were found close to the Hibiscus WCA, while another cluster was found south of the Upper Akoko WCA. Additional plants were found north of the Lower Akoko WCA, with one cluster on the northern toe of Ohikilolo Ridge. At KeaauNoMU-CenSet-03, staff mapped clusters of plants extending up the southern slopes of Ohikilolo Ridge, almost up to White X LZ. Most of these plants were quite far from the fence, in Keaau proper.

Aerial surveys spanned the slopes between the Upper Akoko Patch to Koiahi gulch, and from C-Ridge to just north of Kahanahaiki Gulch.

- Kahanahaiki, MMR-CenSet-05. Staff discovered an immature plant along the western, gulch section of the Kahanahaiki fence in August 2016. It was submitted to Bishop Museum and determined to be a vegetative match for *C. setaceus*, but without an inflorescence, identification cannot be confirmed. One re-sprout was found and treated in November 2016 and no plants have been seen since. The site of the ICA is unusual for *C. setaceus*: a forested slope, heavily shaded but with an open understory, on the lower slope of a mesic gulch. Generally, dry, open, sunny slopes are its preferred habitat. It is possible staff were the vector for this plant, or more disturbingly, the vector could have been the wind. A 200 m buffer was drawn around the plant, see map below. Most of this buffer included densely forested slopes in the actively managed Kahanahaiki fence. Trails and appropriate habitat within the buffer were prioritized for ground surveys. Parts of the buffer were surveyed from vantage points using binoculars, while staff walked other, more-accessible areas. No additional plants were found within the buffer.

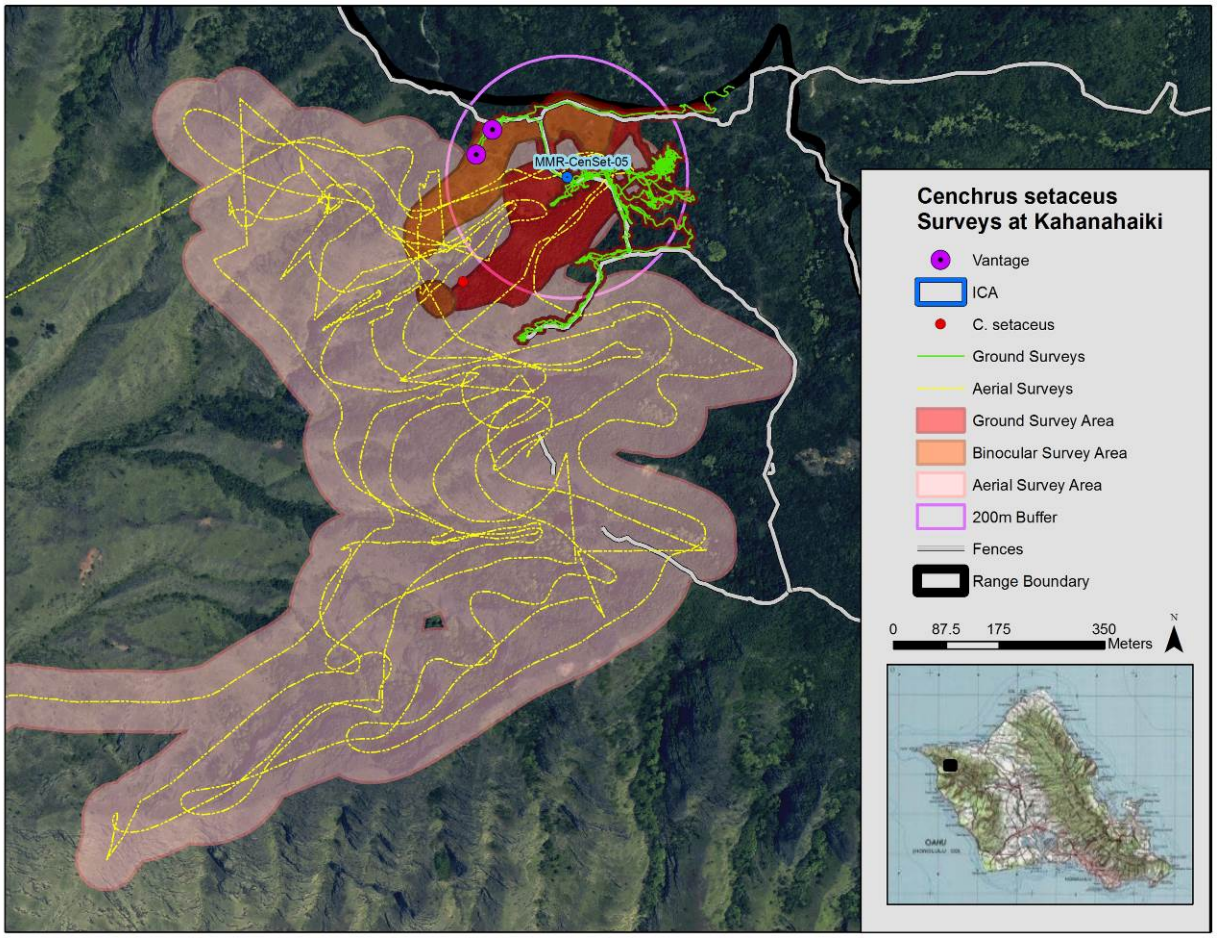


Figure 10. Ground and Aerial Surveys at Kahanahiki

- Kahanahaiki Outlier. However, staff did note a suspicious plant outside of the Kahanahaiki buffer, on a cliff across the gulch, south of the Makua-Kuaokala fence (see map above). The plant is more than 200m from the best vantage points, and was not reproductive either when it was initially seen in November 2016, or on a second survey date in February 2017. Aerial surveys took place the day before the plant was seen by ground-based staff in November. No *C. setaceus* was identified on these aerial surveys, although several patches of another, native clumping grass

were seen. The photo below gives a sense of the difficulty of identifying such a remote plant. In the coming year, staff plan to survey the site again to make a definitive identification via helicopter or drone or spotting scope. As a last resort, staff will attempt to rappel to the site. If it is not possible to identify the plant, staff will attempt to aerially spray it as a conservative measure. The plant could be the result of wind dispersal from the core.

Possible *C. setaceus* outlier west of Kahanahaiki MU, with landmarks noted.

- MMR Road Surveys. During the annually scheduled road survey, MMR-CenSet-06 was found. This is the third ICA to be found within or on the firebreak roads, in a mowed area. It is unsurprising that *C. setaceus* takes advantage of open, disturbed areas. This find further illustrates the importance of the annual road survey. Fortunately, mowed, open areas are relatively easy to survey and monitor.
- Core Infestation, MMR-CenSet-02. The primary *C. setaceus* infestation is entirely within MMR-CenSet-02. Due to its large size, challenging terrain, thick *Urocholoa maxima* cover, split ownership and the presence of UXO in MMR, multiple actions are needed to treat the entire site. Please see last year's report for a detailed breakdown of the control strategy for this ICA. Figure 11 details different Control Regions within the ICA; the red line estimates the boundary between MMR and private land in Keaau.
    - Both ground-based control and aerial sprays were conducted at ICA #2 this year and are shown in the map below, Figure 12. This year, 26.48 ha were treated in ICA #2. Of this, 2.92 ha were treated from the air and 24.87 ha were swept on the ground (ground and

aerial treatments overlapped). In 2016, 8.39 ha were swept, with 4.11 ha of aerial treatment and 5.89 ha of ground treatment, while in 2015, 3.81 ha were swept, with 2.80 ha aerial and 2.42 ha of ground. Note that WCA areas (in red on map) were swept multiple times during the course of ecosystem weed control work in both report years, but only time and area spent specifically controlling *C. setaceus* is counted in these totals. Aerial treatment centered over the steep infestation core in the Aerial Spray Zone this year, although one outlier patch on the north side of the ICA was also treated. Only two days of aerial spraying (130 gal of RangerPro 2% dilution in water) were conducted, due to helicopter budget limitations. Ground sweeps covered most Control Regions, including follow-up treatment in the core. Few plants were found in WCAs. The area covered in ground sweeps is particularly high this year, due to surveys conducted between the Hibiscus and Akoko patches.

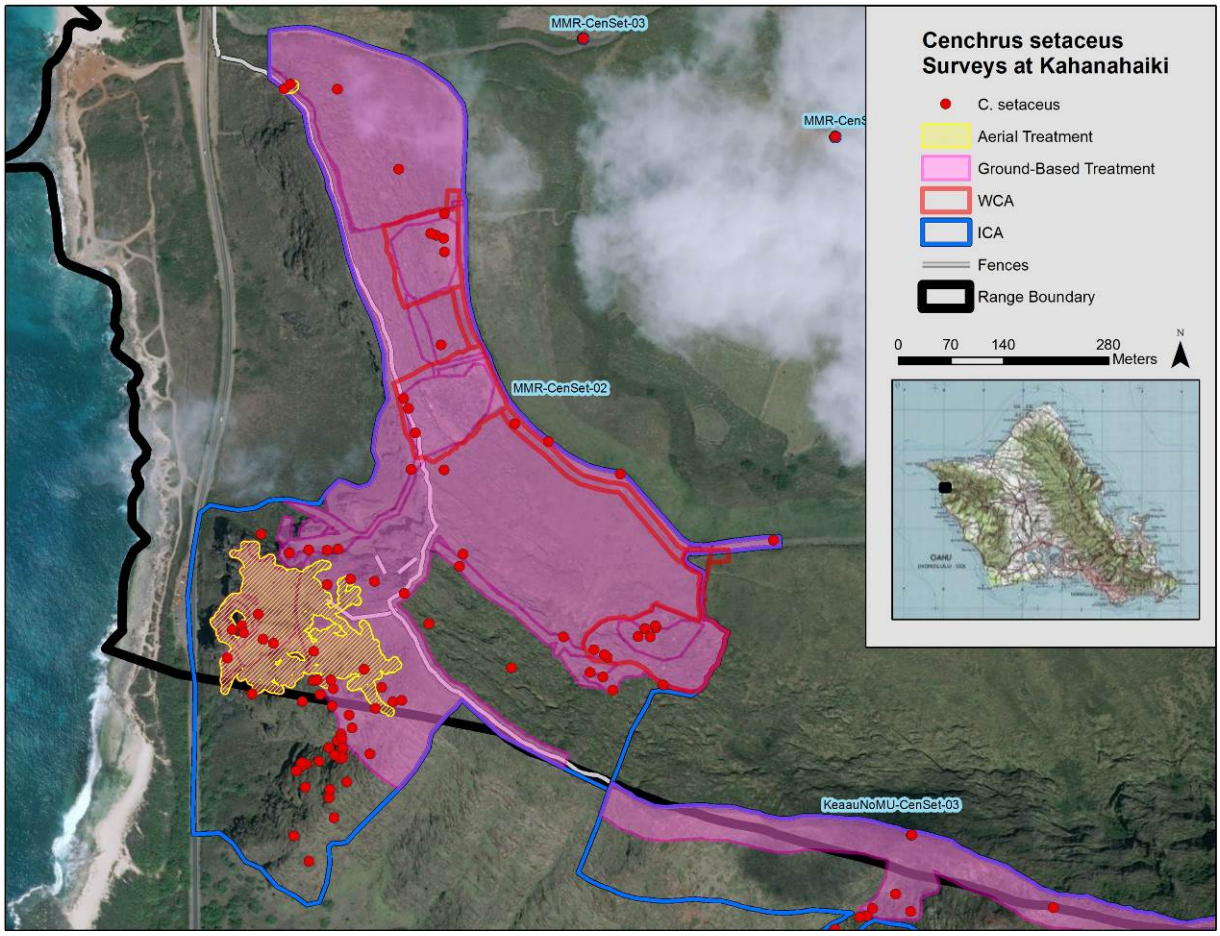


Figure 11. MMR-CenSet-02 Treatment

- The *Melanthera* Cliff zone did not receive treatment this year. This area will be a priority in the coming year, as gigapan analysis conducted last year noted an increasing number of plants in the area. Prior to treatment, the area will be monitored for any remaining *Melanthera tenuifolia* (IP taxa) at a historical site on the cliffs.
- The Cliff Bottom zone also did not receive treatment this year. Comparatively few plants have been found here over the years, however, the area includes an unofficial trail used by trespassing hikers. In future, this area will be a higher priority. The entire infestation must be treated to reach eradication.

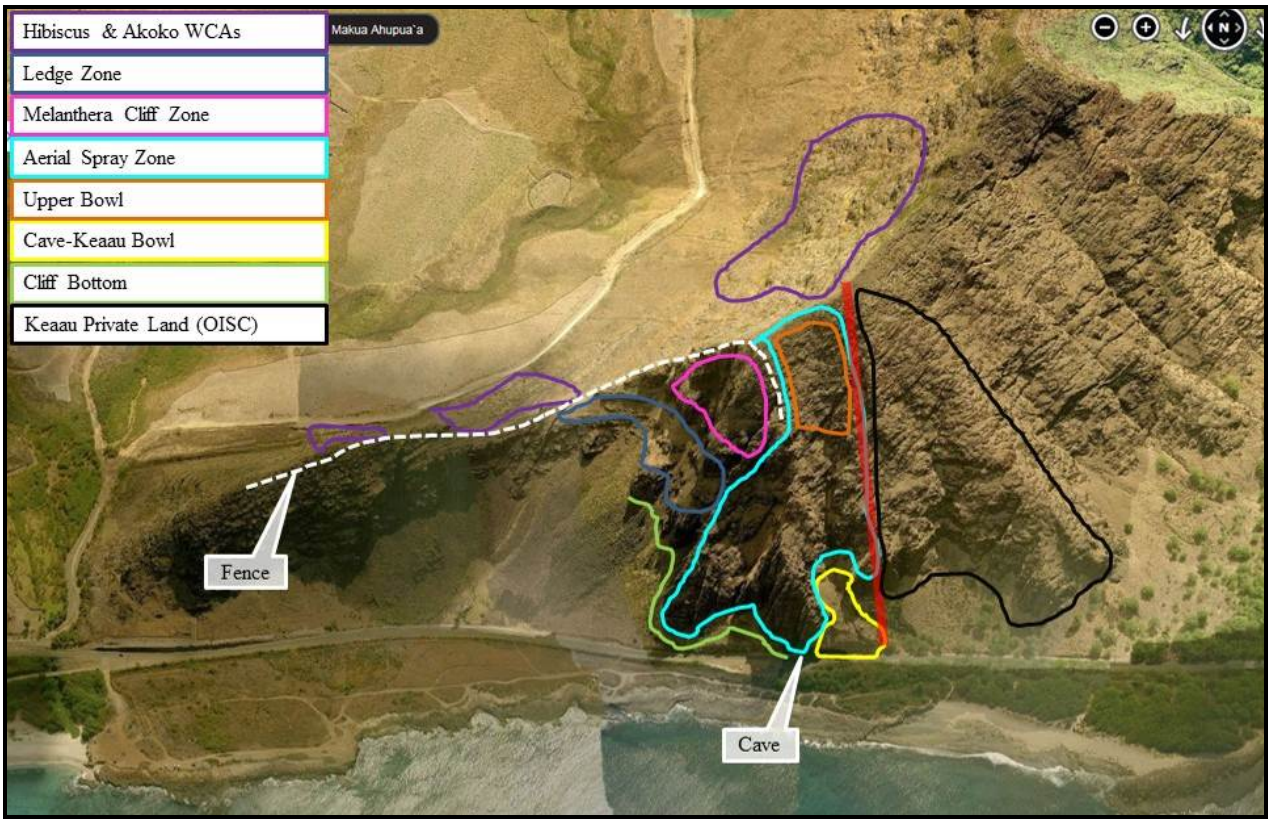


Figure 12. MMR-CenSet-02 Control Regions

- Of particular concern are cliff side plants which are either not reachable with the aerial spray rig, or too close to the road to spray without closing Farrington Highway. Staff need to both determine the feasibility of either temporarily closing the road, and work with Dr. James Leary of CTAHR to use HBT to treat these plants; an appropriate herbicide must first be encapsulated in the HBT projectiles.
- The grassy zones between the WCAs, between the fence and highway, and all other areas not in a Control Region will be surveyed once a year. This year's surveys were successful in identifying outlier plants.
- In the past, OISC has conducted control in the Keaau Private Land zone. OANRP does not have permission to access this area. This year, OISC was not able to treat this area regularly due to competing priorities. A complicating factor was the landowner's restriction of all herbicide use, which makes control efforts less efficient. OANRP will continue to support OISC in working at Keaau and also seek support from WMWP.
- In the coming year staff would like to test the efficacy of non-EPA regulated weed control products with natural ingredients, such as Burnout by Bonide®. The active ingredients in Burnout are citric acid and clove oil. While such products are rarely as effective as traditional herbicides, the private landowner in Keaau may be open to the use of a natural product. Currently, OARNP does not have a location for a trial, but will investigate the feasibility of a greenhouse study and enlist support from OISC. If Burnout is at all effective, it may be possible and worthwhile to use it to aerially spray both the Keaau portions of MMR-CenSet-02 and all of KeaauNoMU-CenSet-03.

Left: Aerial sprays at MMR. Right: Dead, brown *C. setaceus* treated via aerial spray

- The illegal trail running from Farrington Highway to the upper Makua cave continues to be popular with hikers, despite 'No Trespassing' signage. The Ohikilolo Cabin is also a major attraction, despite efforts to lock it securely. Hikers may spread *C. setaceus* from MMR to other regions, or re-introduce it to MMR from other known infestations. The entire Ohikilolo ridge is good *C. setaceus* habitat.
- With aggressive treatment and consistent, thorough coverage, *C. setaceus* may still prove eradicable at MMR, as other incipient populations of have been successfully extirpated by OANRP.

The worst case scenario for Oahu: rolling fields of *C. setaceus*, as seen at PTA.

3.9 RESTORATION ACTIONS UPDATE

This year, restoration actions continued in high priority Weed Control Areas. Restoration activities aim to complement weed control efforts in areas with high weed recruitment, to restore connectivity and structure to native forest patches, and to replace vegetation following removal of dense patches of alien species. Many of OANRP's restoration efforts require dedicated project planning and follow-through. Many are started with the goal of removing all alien canopy from a defined site within a WCA, and outplanting, sowing seeds and planting divisions of native plants for multiple years until native cover goals are reached. Frequent weed control is often required right after non-native canopy is removed, but effort reduces as native plant cover increases via restoration efforts. Ideally, a restoration site is complete when MU native cover goals are met, and weed control can be conducted on a reasonable maintenance level to remove encroaching understory weeds, or MU target species. There are however other restoration actions that are completed with very specific goals in mind such as increasing native canopy around a specific population of rare plant, creating a vegetative fire break, or as a host species for an endangered *Drosophila*, to name a few.

Restoration actions continued in several of the same Management Units as last year including: Kahanahaiki, Kaluaa and Waieli, Ohikilolo Lower, Palikea, and Makaleha West. This year restoration efforts increased substantially in Kahanahaiki, Makaha, Palikea, and Makaleha West. Maps of these sites follow below. No restoration actions were conducted at Ohikilolo due to greenhouse space limitations, or at Kaala, where restoration efforts are a lower priority.

The total area over which a given restoration action takes place is recorded in ArcMap, and restoration details including species used, propagule type and number, source populations, etc. are recorded in the OANRP access database.

Winnowing *Dodonea viscosa* seed

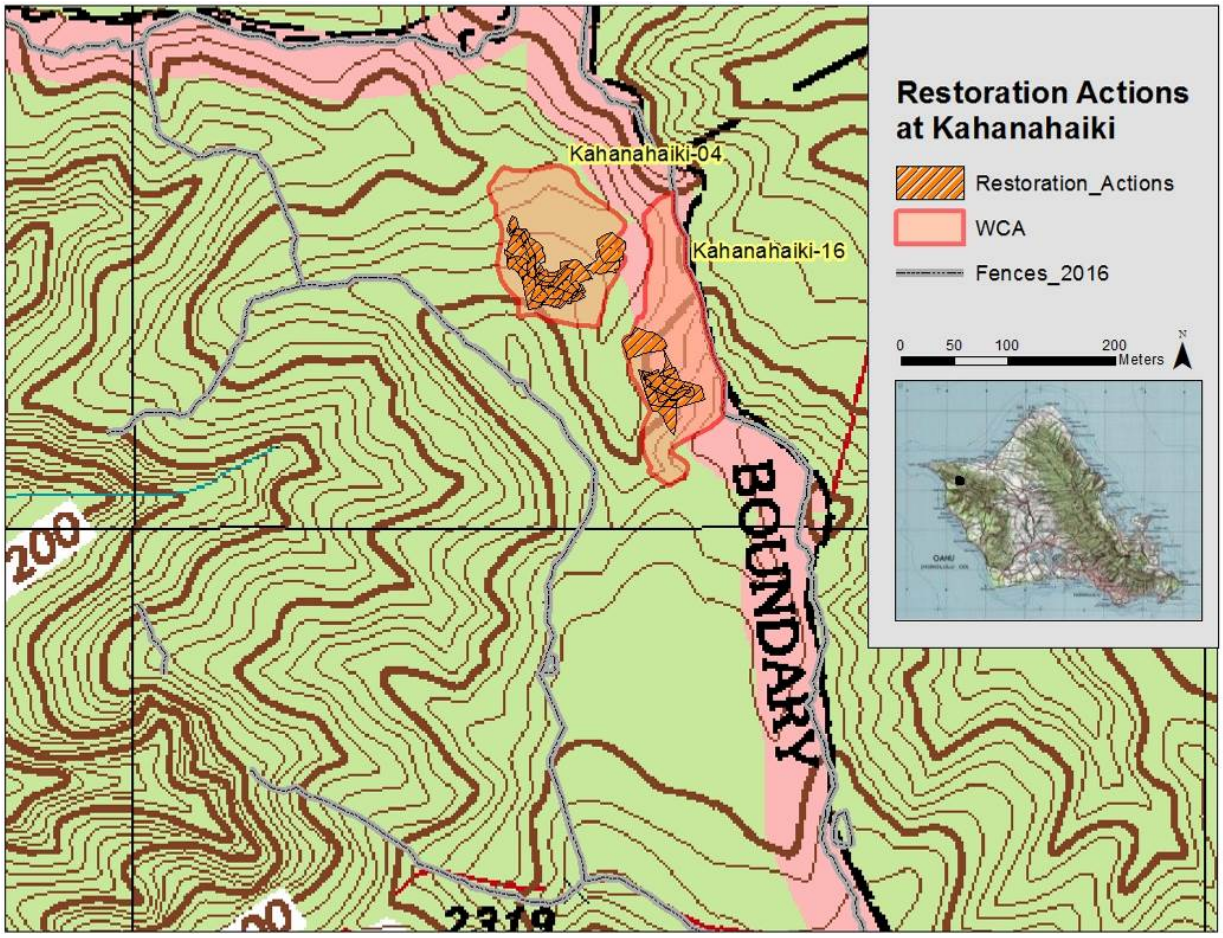


Figure 13. 2017 Report Year Restoration Actions at Kahanahaiki

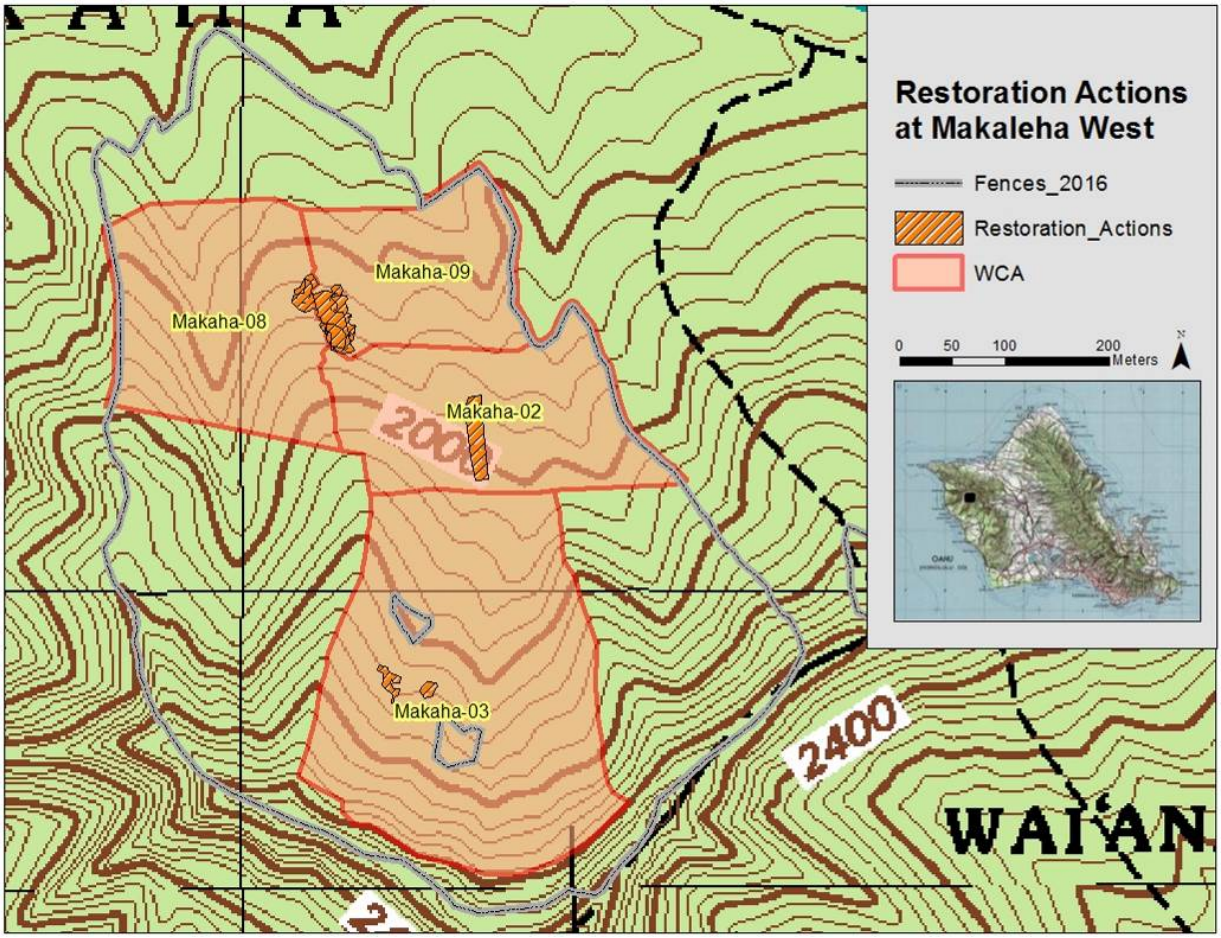


Figure 14. 2017 Report Year Restoration Actions at Makaha

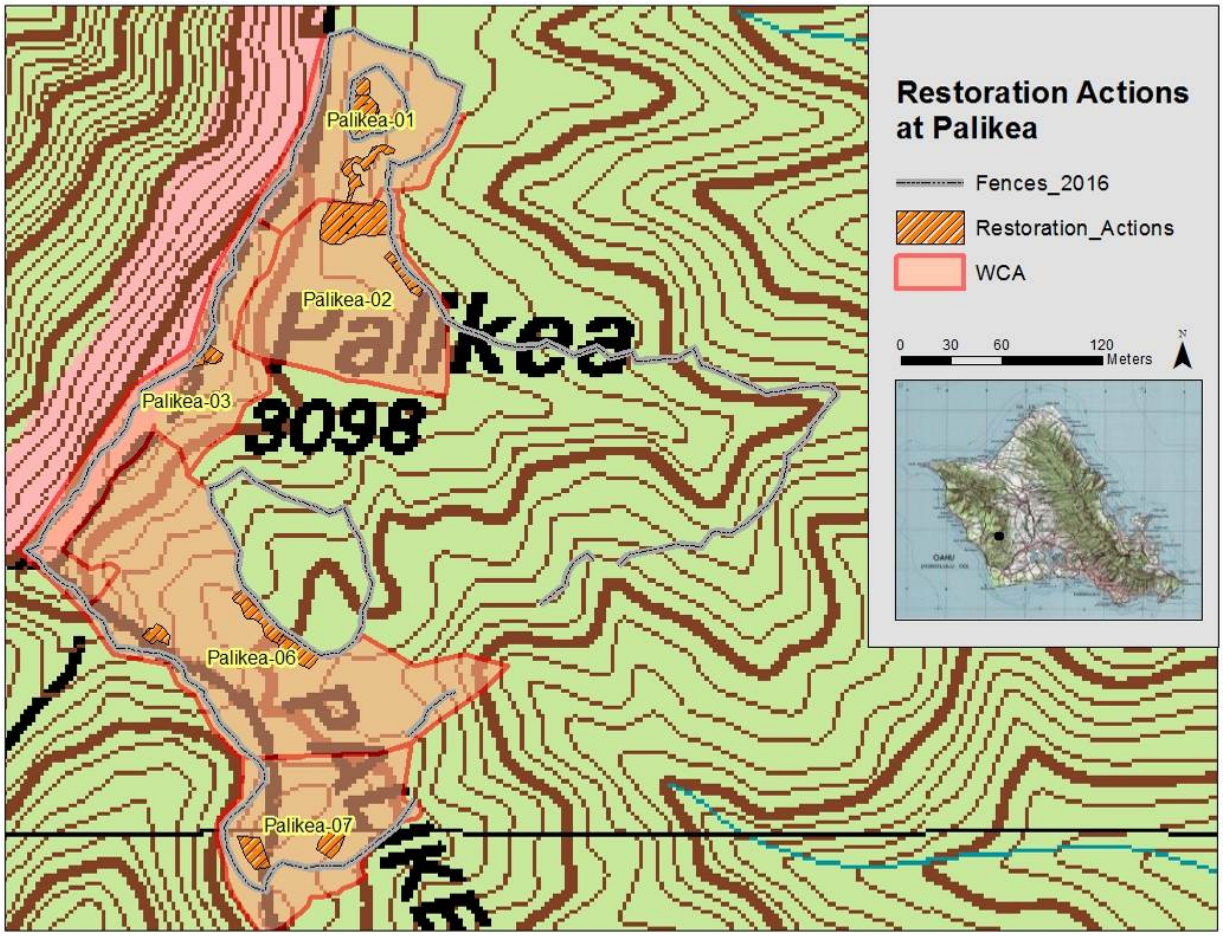


Figure 15. 2017 Report Year Restoration Actions at Palikea

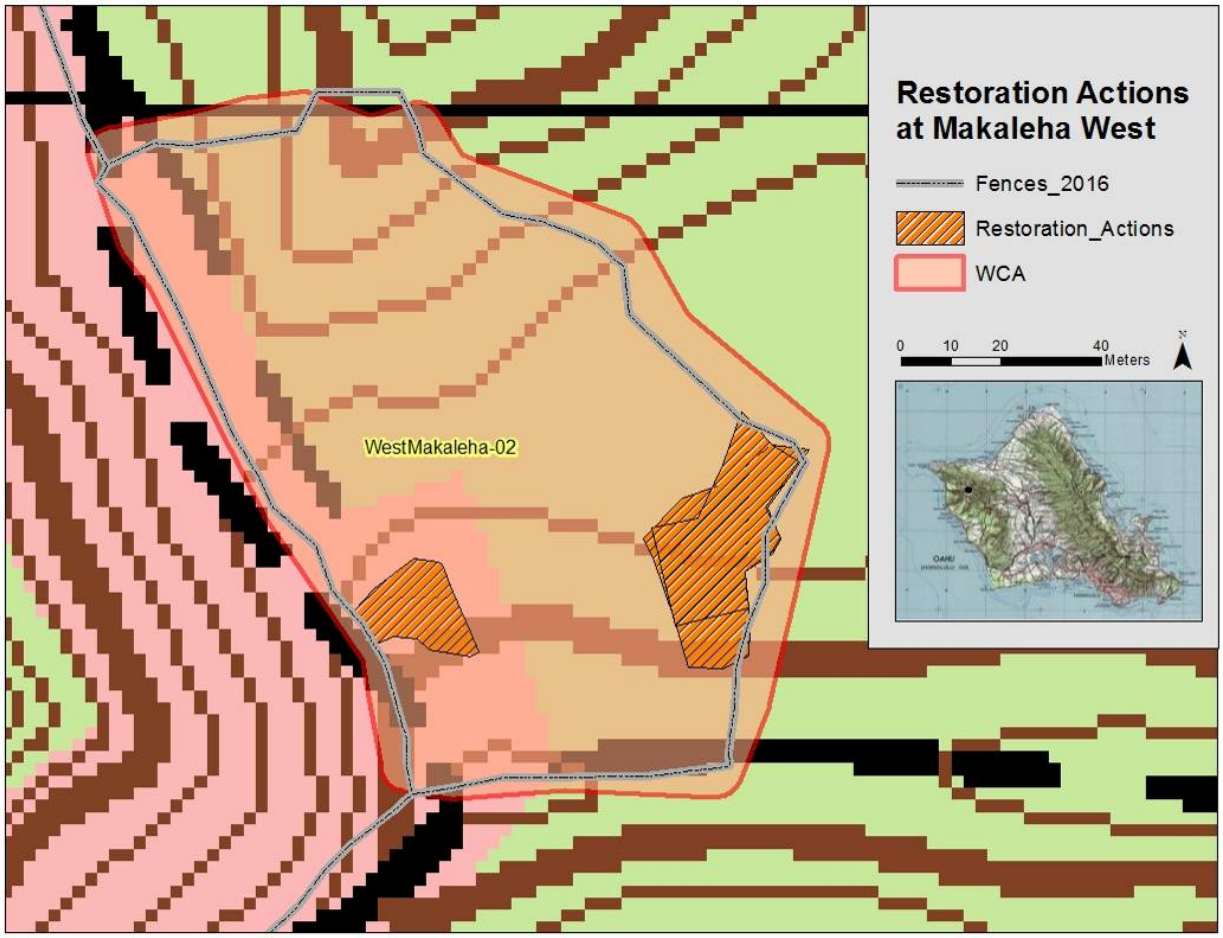


Figure 16. 2017 Report Year Restoration Actions at Makaleha West

The table below details MU restoration efforts for this report year. Restoration actions are tracked within WCAs, as they are a pre-existing system used to track management efforts within MUs. Restoration actions are tracked as two types: 1) outplantings; and 2) seed sows, divisions, transplants (SDT). Outplantings require a higher level of planning and effort, and SDT actions can be done opportunistically and as needed.

Table 21. Summary of Restoration Actions by WCA

'Area' for each restoration type is calculated by merging all the efforts into a single geographic footprint within a given WCA for the year (overlapping areas are not additive).

MU	WCA code	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Kaala	Kaala-01	SDT	n/a	61	*Pipturus albidus*	*P. albidus* was sown on the Army side of the boardwalk in an open area where *Juncus effusus* removal is ongoing. This location is particularly wet (isolated patches of standing water) and sows were targeted on higher ground. No significant efforts will be conducted here in the coming year.
Kahanahaiki	Kahanahaiki-04	Outplanting	430	1616	*Acacia koa, Carex wahuensis, Hibiscus arnottianus subsp. arnottianus, Kadua affinis, Myrsine lessertiana, Pisonia* spp.	Intensive restoration work continued at 'The Shire' this year with 2 outplanting efforts. Planting was focused in locations with the fewest existing outplants. Weeding efforts at the site were expanded to connect with a new adjacent restoration area in the same WCA. At the new site, 'Mirkwood', *Psidium cattleianum* and *Schinus terebinthifolius* were controlled, and plants were outplanted. Additional reintroductions are planned this coming year for the same sites in WCA-04.
		SDT	n/a	3658	*Bidens torta, Dianella sandwicensis, Pipturus albidus*	12 seed sow or transplanting efforts were conducted at the 'Shire' restoration site. Staff continue to anecdotally observe increases in cover using these methods.
	Kahanahaiki-16	Outplanting	94	227	*M. lessertiana, K. affinis, A. koa*	A new set of taxa were outplanted in the 'Schweppes' restoration site this year (~.5 acre site). Restoration efforts will expand in the coming year by clearing an adjacent stand of *Psidium cattleianum*; outplants will follow.
		SDT	(n/a)	1843	*Alyxia stellata, B. torta, D. sandwicensis, P. albidus*	4 seed sow or transplanting efforts were conducted at the 'Schweppes' restoration site. *D. sandwicensis* divisions have been noted by staff to perform substantially better when planted as a larger clump.
Kaluaa and Waieli	Kaluaa and Waieli-02	Outplanting	22	1563	*Freycenetia arborea, Antidesma platyphyllum*	Plants were outplanted inside the Hapapa snail enclosure to increase cover levels of the important snail host species *F. arborea*.

MU	WCA code	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Makaha I	Makaha-02	SDT	n/a	1186	*A. stellata, Coprosma foliosa, Diospyros sandwicensis, Nestegis sandwicensis, Pisonia umbellifera, Psychotria mariniana*	With a group of Youth Conservation Core staff, a variety of species were transplanted into regularly weeded locations.
	Makaha-03	Outplanting	55	478	*H. arnottianus subsp. arnottianus, Perrottetia sandwicensis*	These taxon were planted around a reintroduction of *Cyanea superba* var. *superba* in open areas regularly invaded by weeds.
	Makaha-08	SDT	n/a	540	*B. torta, P. albidus*	Seed sow efforts were conducted in this WCA following a weed sweep in the area.
	Makaha-09	SDT	n/a	1644	*P. albidus*	Seed sow efforts were conducted in the 'Giant Ohia' restoration area in Makaha where *P. cattleianum* was removed (see Appendix 3-11 for monitoring details pre- and post-clearing). Common native plants will be outplanted at this site in the coming year. A new restoration project in the WCA adjacent to this one will commence this coming year.
Ohikilolo Lower	Lower Ohikilolo-02	Outplanting	683	3978	*Dodonea viscosa, Myoporum sandwicense, Erythrina sandwicensis, Scaevola taccada*	Outplantings have been conducted for 2 reintroduction seasons around a managed population of *Euphorbia celastroides* var. *kaenana* to suppress weeds and fire-prone grasses, and improve habitat. Additional plantings of *D. viscosa* were planted densely on a shelf above the wild *E. celestroides. M. sandwicensis* and *Scaevola taccada* were scattered in open pockets this year. This coming year, a similar suite of plants will be planted a few hundred meters away in Lower Ohikilolo-03 around a population of *Hibiscus brackenridgei* var. *mokuleianus*.
Palikea	Palikea-01	Outplanting	20	357	*Cheirodendron trigynum*	Outplants and seed sows continued inside the Palikea snail enclosure. Restoration efforts inside this snail enclosure will continue until all non-native canopy vegetation is removed over the long term.
	Palikea-01	SDT	n/a	553	*P. albidus*	
	Palikea-02	Outplanting	314	830	*C. trigynum, Coprosma longifolia, K. affinis, Psychotria hathewayi, Scaevola gaudichaudiana, Urera glabra*	Restoration activities expanded in Palikea-02 this year to include the area surrounding a new reintroduction of the *Cyanea grimesiana* ssp. *obatae*. Canopy weed species were removed and a variety of native shrub and tree species were
	Palikea-02	SDT	n/a	227	*P. albidus*	

MU	WCA code	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
						planted. *P. albidus* seed sows were also conducted on several occasions.
	Palikea-03	Outplanting	16	47	*Rumex albescens, K. affinis, C. longifolia*	Additional outplantings and seed sows were conducted to shade out grasses on an open slope along the crestline, adjacent to known snail populations.
	Palikea-03	SDT	n/a	94	*B. torta*	
	Palikea-06	Outplanting	41	125	*C. longifolia, K. affinis*	Outplants continued this year in shallow bowls and slopes off the crestline. *Morella faya* has been targeted in these areas, and outplants are being used to fill in light gaps. *P. albidus* was sown on a couple of occasions in an ongoing restoration site in a small gulch in this WCA. This coming year more intense restoration efforts will begin higher in that same gulch (closer to the crest).
	Palikea-06	SDT	n/a	539	*P. albidus*	
	Palikea-07	Outplanting	125	440	*C. trigynum, Coprosma longifolia, K. affinis, Psychotria hathewayi, Scaevola gaudichaudiana*	The Ecosystem Restoration crew completed the removal of *P. cattleianum* at a site in WCA-07, and outplants were planted in light gaps created by removing alien canopy.
Makaleha West	West Makaleha-02	Outplanting	151	801	*A. platyphyllum, Clermontia kakeana, Coprosma longifolia, Metrosideros polymorpha, Perrottetia sandwicensis*	These taxa were planted and sown in locations where canopy weed control has taken place. Filling in light gaps quickly is important at this location where *Rubus argutus* is present and known to invade open areas.
	West-Makaleha-02	SDT	n/a	289	*P. albidus*	

Table 22. 2017 Report Year Summary of Restoration Actions by Management Unit

MU	Total # Outplants/Total Area(m^2)		SDT Total Area(m^2)	
	2017	**2016**	**2017**	**2016**
Kaala	0	69/95	61	0
Kahanahaiki	524/1843	358/3639	5501	3236
Kaluaa and Waieli	22/1563	82/575	0	184
Makaha I	55/478	0	3370	0
Ohikilolo Lower	683/3978	578/3354	0	0
Ohikilolo	0	250/1286	0	0
Palikea	516/1799	323/1220	824	66
Makaleha West	151/801	83/751	289	238
Year End Totals	1951 plants 10462 m^2	1743 plants 10920 m^2	10045 m^2	3724 m^2
Total Restoration Area 2016:	11,750 m^2			
Total Restoration Area 2017:	20,164 m^2			

Previously established vegetation monitoring methods are ongoing to track vegetation change within small restoration sites. Vegetation monitoring techniques vary at each site including: vegetation plot monitoring, point-intercept vegetation monitoring, photopoints, and Gigapan Imagery analysis. Post-clearing monitoring was completed this year at the Makaha 'Giant Ohia' restoration site and the discussion about pre- and post-clearing comparisons can be found in (Appendix 3-11). There is also the anticipation that restoration actions including large scale canopy weed removal, outplantings, and SDTs will accelerate efforts towards reaching MU vegetation cover goals and will be observed in the large-scale MU vegetation monitoring conducted across MUs.

Watering *Dianella sandwicensis* transplants at Kahanahaiki

Pipturus albidus fruit collected for sowing

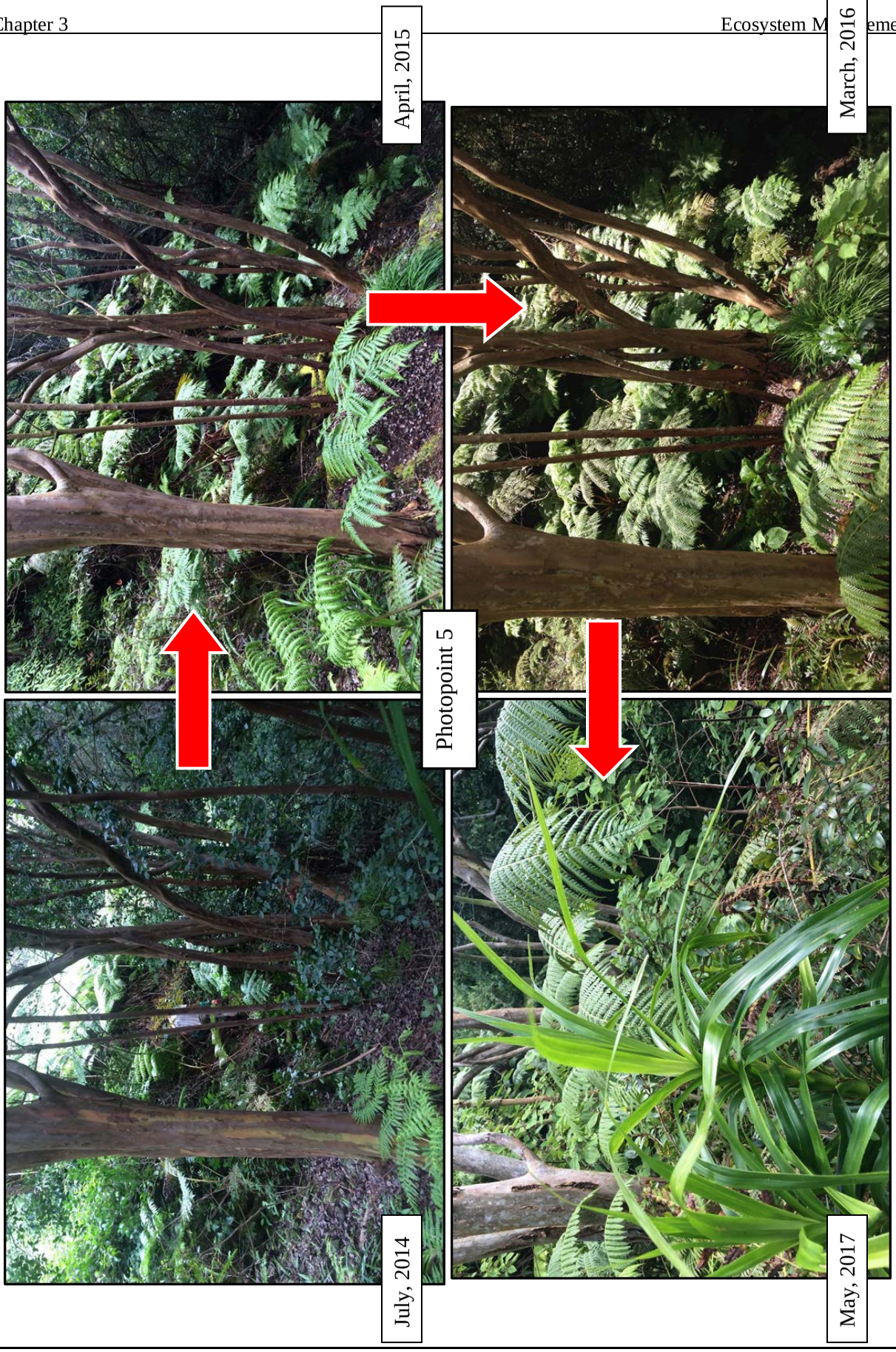
The photopoints below document change at intensive restoration sites. All sites pictured below began with high levels of non-native canopy that were all treated. Some large trees were left standing, but most were cut down and bucked up into slash piles on site. *P. albidus* recruitment after sowing large amounts of seed on several occasions can be seen in all of the Kahanahaiki restoration sites.

The photopoints below document change from July, 2014 (top left) through May, 2017 (following arrows) at the 'Shire' site in Kahanahaiki-04.

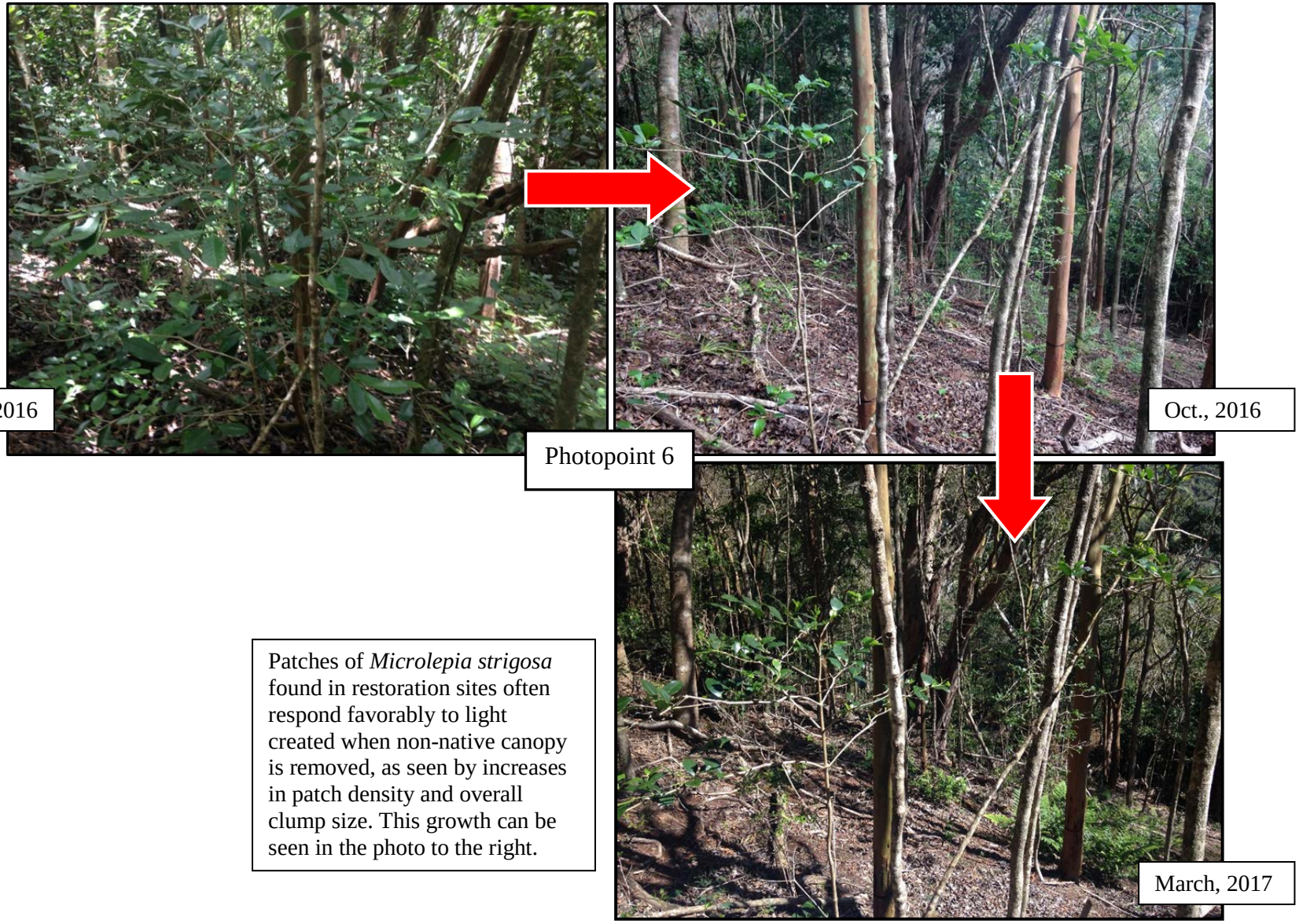

Sept., 2015
June, 2016
Photopoint 2
July, 2014
May, 2017


Sept., 2015
June, 2016
Photopoint 3
July, 2014
May, 2017

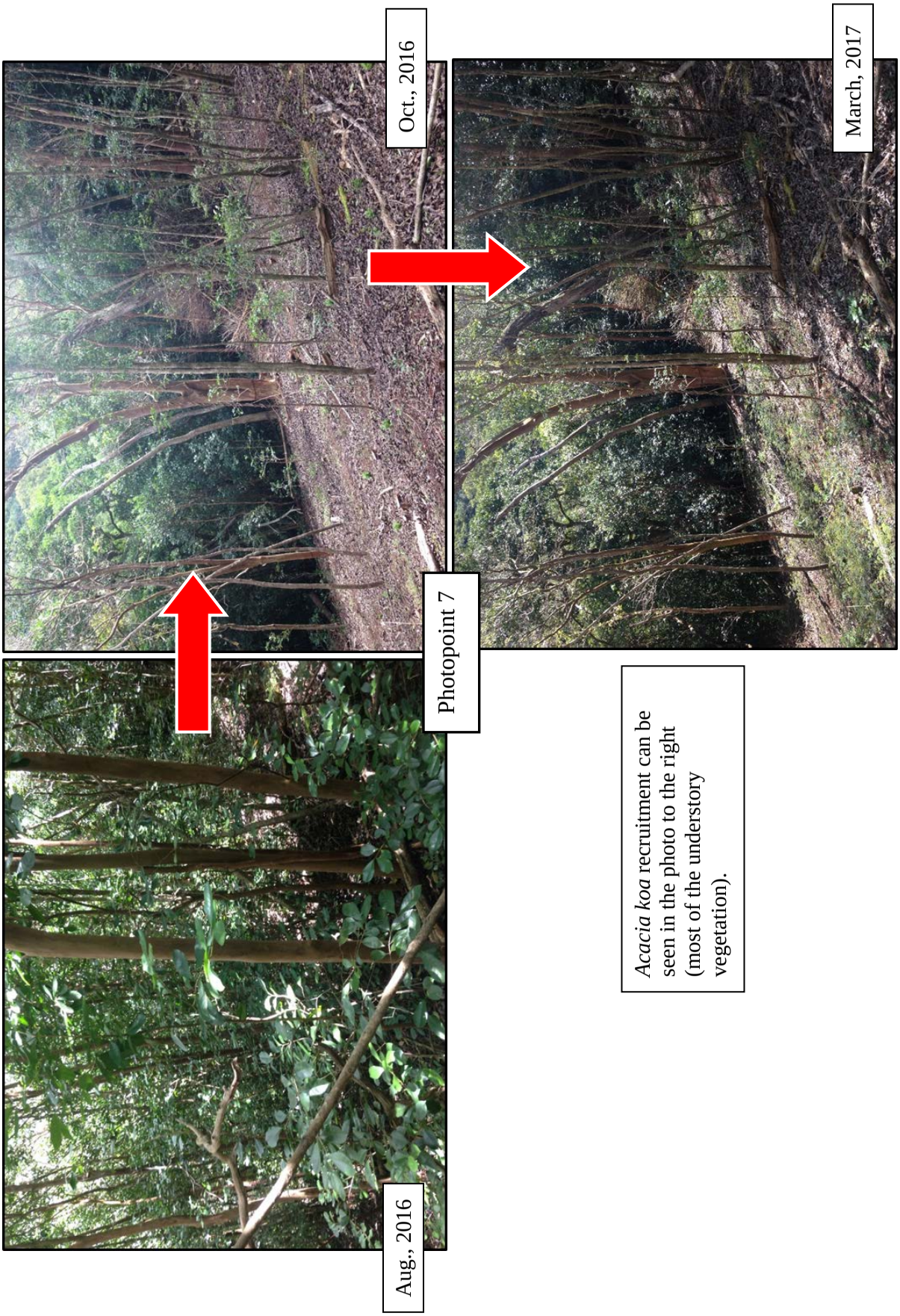
The photopoints below document change from July, 2014 (left) through May, 2017 (following arrows) at the 'Schweppes' site in Kahanahaiki-16.


April, 2015
March, 2016
Photopoint 5
July, 2014
May, 2017

The photopoints below document change from August, 2016 (left) through March, 2017 (following arrows) at the 'Giant Ohia' site in Makaha-09.



Patches of *Microlepia strigosa* found in restoration sites often respond favorably to light created when non-native canopy is removed, as seen by increases in patch density and overall clump size. This growth can be seen in the photo to the right.


Oct., 2016
March, 2017
Photopoint 7
Aug., 2016
Acacia koa recruitment can be seen in the photo to the right (most of the understory vegetation).

Common Native Species Collection

This year efforts were made to target and collect seed from an increased diversity of common native species and populations in support of ongoing restoration actions in high priority weed control areas. To inform seed collection targets, a list of 57 restoration species was developed (Table 23). This list includes species commonly used in OANRP restoration outplantings and seed sows, as well as species not used in past actions, but which exhibit traits beneficial to OANRP restoration goals. Common native seed collections are processed and curated in the OANRP Seed Lab until they are withdrawn for the propagation of restoration plant materials or to develop seed storage and/or propagation protocols for those species where this information is lacking. The "Propagation Protocol Developed" column lists "yes" if any method of OANRP propagation is currently used, including propagation from cuttings.

Table 23. Summary of taxa for OANRP restoration projects

Taxa	Family	Growth Habit	Seed Storage Possible	Propagation Protocol Developed	Total # of Seeds in Storage	Total Seed Accessions Currently in Storage	# of Seed Accessions 2017
*Acacia koa**	Fabaceae	Tree	Yes	Yes	21169	12	4
*Alyxia stellata**	Apocynaceae	Vine/Shrub	Yes	Yes	827	9	7
*Antidesma platyphyllum**	Phyllanthaceae	Tree	Yes	Yes	0	0	0
*Asplenium kaulfussii***	Aspleniaceae	Fern	Unknown	No	NA	0	0
*Bidens torta**	Asteraceae	Forb/Herb	Yes	Yes	413509	19	10
*Carex meyenii***	Cyperaceae	Graminoid	Yes	No	16729	3	3
*Carex wahuensis***	Cyperaceae	Graminoid	Yes	Yes	18258	11	10
*Cheirodendron trigynum**	Araliaceae	Tree	Yes	Yes	12437	5	4
*Chenopodium oahuense**	Chenopodiaceae	Shrub	Yes	Yes	17816	3	1
*Cibotium spp.***	Dicksoniaceae	Fern	Unknown	No	NA	0	0
*Coprosma longifolia**	Rubiaceae	Tree/Shrub	Yes	Yes	2320	17	2
*Cyperus hillebrandii var. hillbrandii***	Cyperaceae	Graminoid	Unknown	No	0	0	0
*Cyperus polystachyos***	Cyperaceae	Graminoid	Unknown	No	0	0	0
*Deparia prolifera***	Athyriaceae	Fern	Unknown	No	NA	1	1
*Dianella sandwicensis**	Xanthorrhoeaceae	Forb/Herb	Yes	Yes	816	2	2
*Diplazium sandwichianum***	Athyriaceae	Fern	Unknown	No	NA	0	0
*Dodonaea viscosa**	Sapindaceae	Tree/Shrub	Yes	Yes	201641	92	21
*Doodia kunthiana***	Blechnaceae	Fern	Unknown	No	NA	1	1
*Eragrostis grandis**	Poaceae	Graminoid	Yes	Yes	14879	3	3
*Eragrostis variabilis**	Poaceae	Graminoid	Yes	Yes	7088	1	0

Taxa	Family	Growth Habit	Seed Storage Possible	Propagation Protocol Developed	Total # of Seeds in Storage	Total Seed Accessions Currently in Storage	# of Seed Accessions 2017
*Erythrina sandwicensis***	Fabaceae	Trees	Yes	Yes	2208	18	2
*Freycinetia arborea**	Pandanaceae	Vine/Shrub	Yes	Yes	32294	7	2
*Gahnia beecheyi***	Cyperaceae	Graminoid	Yes	No	4091	4	3
*Hibiscus arnottianus subsp. arnottianus**	Malvanceae	Tree/Shrub	Unknown	Yes	0	0	0
*Ilex anomala**	Aquifoliacea	Tree/Shrub	Yes	Yes	8131	5	5
*Kadua acuminata**	Rubiaceae	Shrub/ Subshrub	Yes	Yes	0	0	0
*Kadua affinis**	Rubiaceae	Tree/Shrub /Vine	Yes	Yes	42811	31	6
*Labordia kaalae**	Loganiaceae	Tree/Shrub	Yes	Yes	1515	2	0
*Luzula hawaiiensis**	Juncaceae	Graminoid	Yes	Yes	158	0	0
*Machaerina angustifolia***	Cyperaceae	Graminoid	Yes	No	0	0	0
*Melicope oahuensis***	Rutaceae	Tree/Shrub	Unknown	No	0	0	0
*Metrosideros polymorpha**	Myrtaceae	Tree/Shrub	Yes	Yes	3269802	73	56
*Microlepia speluncae***	Dennstaedtiaceae	Fern	Unknown	No	NA	1	1
*Microlepia strigosa var. strigosa**	Dennstaedtiaceae	Fern	Unknown	Yes	NA	2	2
*Myoporum sandwicense**	Scrophulariaceae	Tree/Shrub	Yes	Yes	1612	2	2
*Myrsine lessertiana**	Primulaceae	Tree/Shrub	Yes	Yes	0	3	2
*Nephrolepis exaltata ssp. hawaiiensis***	Nephrolepidaceae	Fern	Unknown	No	NA	0	0
*Nestegis sandwicensis**	Oleaceae	Tree	Yes	Yes	0	0	0
*Perrottetia sandwicensis**	Dipentodontaceae	Tree/Shrub	Yes	Yes	0	0	0
*Pipturus albidus**	Urticaceae	Tree/Shrub	Yes	Yes	1839	1	0
*Pisonia brunoniana**	Nyctaginaceae	Tree/Shrub	No	Yes	0	0	0
*Pisonia sandwicensis***	Nyctaginaceae	Tree/Shrub	Unknown	No	0	0	0
*Pisonia umbellifera**	Nyctaginaceae	Tree/Shrub	No	Yes	0	0	0
*Planchonella sandwicensis**	Sapotaceae	Tree/Shrub	No	Yes	0	0	0
*Plumbago zeylanica**	Plumbaginaceae	Shrub	Unknown	Yes	0	0	0

Taxa	Family	Growth Habit	Seed Storage Possible	Propagation Protocol Developed	Total # of Seeds in Storage	Total Seed Accessions Currently in Storage	# of Seed Accessions 2017
*Polycias sandwicensis***	Araliaceae	Tree	Yes	Yes	0	0	0
*Psychotria hathewayii**	Rubiaceae	Tree	Unknown	Yes	407	9	3
*Psydrax odorata***	Rubiaceae	Tree/Shrub	Yes	Yes	0	0	0
*Pteris excelsa***	Pteridaceae	Fern	Unknown	No	NA	1	1
*Rumex albescens**	Polygonaceae	Shrub/ Subshrub	Yes	Yes	4260	3	0
*Santalum spp.***	Santalaceae	Tree/Shrub	Yes	Yes	87	3	1
*Scaevola gaudichaudii***	Goodeniaceae	Shrub	Unknown	No	0	0	0
*Scaevola gaudichaudiana**	Goodeniaceae	Shrub	Yes	Yes	24	1	1
*Scaevola taccada**	Goodeniaceae	Shrub	Yes	Yes	0	0	0
*Sida fallax***	Malvaceae	Shrub	Yes	Yes	1865	1	1

*= Native species outplanted or seeded in past restoration efforts

**= Native species targets for future restoration efforts

Common native species seed production for seed based restoration efforts

OANRP has largely relied on sourcing seed from wild populations in support of its seed based restoration efforts. However, obtaining the necessary provenance and quantity of seed from wild plant populations can be difficult due to access, availability, and unpredictable seed production from year to year. In order to overcome shortages of genetically appropriate native seed necessary to restore ecological function, connectivity, and structure of native remnant vegetation, and to replace cover following the treatment and removal of exotic and invasive species, OANRP will establish native seed production plots or areas at Kahua to ensure a reliable source of seed for future programmatic seed based restoration efforts. Seed production areas are a viable source of seed for post wildfire restoration, however, production would have to be appropriately scaled to ensure the necessary volume of seed is available for effect post fire revegetation. See Appendix 4-7 for a detailed description of this new seed production site.

The goal of seed production at Kahua is to produce a reliable source of genetically appropriate seed adapted to the specific areas where OANRP restoration efforts are taking place. The aim is to maximize seed production while implementing management strategies to minimize intentional and unintentional selection throughout the production process that may result in maladaptation in the wild.

Seed production areas exist at many scales; at Kahua these areas will be small-sized, intensively managed seed plots likely ranging from 500-2000 square feet. Planting stock for production plots will be sourced from wild populations and propagated in OANRP greenhouses. Ideally, each plot will include stock representing a minimum of 50 wild individuals. Plots will be irrigated by hand initially; however, the current catchment-based automated irrigation system can be expanded if necessary. Harvested seed will be processed in the OANRP Seed Lab and stored for the short term until utilized in the field. Alternatively, harvested seed can be stored as foundation seed for the establishment of larger seed production areas. To initiate seed production activities at OANRP two plots will be established, *Bidens torta* and *Carex wahuensis* (Table 24). Both of these species can be characterized as workhorse species, locally adapted native plants that are abundant across a wide range of ecological contexts, establish

quickly and produce ground cover on disturbed sites. Base wild collections were targeted in March and April 2017 at Makaha and Kahanahaiki for *C. wahuensis* and Palikea for *B. torta*. Weed control began on site in March 2017 and will continue through August 2017. Planting is estimated to take place in September 2017 for *B. torta* and November 2017 for *C. wahuensis*. Stock plant will be planted in 12" rows, 12" apart into woven ground/weed cloth.

Bidens torta production in the OANRP greenhouse.

Table 24. Seed Production Plot Details

Taxa	Source Population (s)	# of Wild Individuals Represented	Plot Size (m^2)	Plants/Plot	Estimated Planting Date
Bidens torta	Palikea	30 (more individuals to be added through time)	175	1476	September, 2017
Carex wahuensis	Kahanahaiki and Makaha	68	93	1000	November, 2017