CHAPTER 3: ECOSYSTEM MANAGEMENT

Notable projects from the 2015-2016 reporting year are discussed in the Project Highlights section of this chapter. This reporting year covers twelve months, from July 1, 2015 through June 30, 2016. Last year's report covered only nine months, from October 1, 2014 through June 30, 2015.

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 Kaala and Ohikilolo (Lower and Upper) ERMUPs were revised, and the Kamaili ERMUP was completed; they are included as Appendices 3-1 to 3-4.

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.

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 8,447 hours controlling weeds across 539.5 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.

Report Year	Effort (hours)	Area (ha)
2015-2016	8,447	539.5
2014-2015 (9 months)	4,654	325.9
2013-2014	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.

Keeping native forest from getting flushed down the drain.

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 (*Morella faya* 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 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 61 taxa in 268 ICAs, and considers eradication to have been achieved at 18 ICAs.

Of the total 539.5 ha swept, ICA efforts covered 388.1 ha. Staff spent 2,452 hours on ICA management and conducted 539 visits to 175 ICAs. This is the greatest effort spent and area managed for incipient weeds in a reporting period to date; see table below. Additional staff time was directed towards incipient control this year, particularly surveys, sweeps, aerial sprays, and intensive hotspot treatment of several priority taxa, including *Chromolaena odorata*, *Schizachyrium condensatum*, *Cenchrus setaceus* and *Ehrharta stipoides*. This year, ICA work accounted for 72% of the total area controlled and 29% of total effort. This makes sense, as incipient control generally requires less time per acre than habitat restoration weed control.

Report Year	# ICAs	Visits	Effort (hours)	Area (ha)
2015-2016	175	539	2,452	388.1
2014-2015 (9 months)	147	333	1,537	245.6
2013-2014	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.

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 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 12 ICAs, for a total of 18 eradications. Among these are two *Buddleja madagascariensis* sites (SBE), one *Cenchrus setaceus* site (SBE), one *Melochia umbellata* site (KTA), one *Rhodomyrtus tomentosa* site (KTA), and one *Senecio madagascariensis* site (SBS).

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

2016 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* *Rhodomyrtus tomentosa*	117	897.95	Almost 37% of ICA effort was spent at KTA this year. KTA hosts several ecosystem-altering weeds, including the largest population of *Chromolaena* in the State. As one of the most heavily used Ranges, KTA is a high priority incipient control area. *Chromolaena* control accounts for 89% of time spent at KTA. Hours recorded here do not include hours spent by OISC, which are included in Appendices 3-5 and 3-6. While all the other listed 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.
Kaala Army	7	*Anthoxanthum odoratum* *Crocosmia* x *crocosmiiflora* *Diplazium esculentum* *Festuca arundinacea* *Juncus effusus* *Pterolepis glomerata* *Sphagnum palustre*	52	365.40	Staff work with volunteers to control most of the *Crocosmia*, *Juncus*, and *Sphagnum* ICAs. *Sphagnum* control efforts have been very successful, and the focus of control has shifted from drenches of large moss banks to detailed sweeps for small patches. Staff found one small new *Diplazium* site this year, and two new *Festuca* sites. All three sites are close to the FAA exclosure, in degraded areas, and likely had been around for years. *Festuca* in particular is very cryptic, especially when it is not fruiting. No *Pterolepis* were found at the transect trail or boardwalk sites this year.
SBE No MU	9	*Buddleja madagascariensis*	85	349.10	Located next to residential Wahiawa, heavily used for training, SBE is home to

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
		Cenchrus setaceus			a diverse array of weeds not found on other Army lands. This year, 14% of all ICA effort was spent at SBE. Of this, 60% was spent on *Schizachyrium*. Staff surveyed most of the remaining appropriate habitat, installed 'no mowing' signage around hotspots, and instituted a new strategy of annual sweeps coupled with quarterly hotspot treatments. Two new ICAs were identified this year. This will continue to be a challenging species in future. Both *Buddleja* ICAs, one *Cenchrus* ICA, and the single *Senecio* ICA were declared eradicated this year. The remaining *Cenchrus* ICA will likely be declared eradicated in late 2016. No *Heterotheca* were seen at any of the three ICAs. Even more exciting, no plants have been seen at the *Chromolaena* ICA since 2015-02, suggesting the infestation was removed before creating a seed bank. *Rhodomyrtus* continues to persist across a large region.
		Chromolaena odorata			
		Heterotheca grandiflora			
		Rhodomyrtus tomentosa			
		Schizachyrium condensatum			
		Senecio madagascariensis			
		Smilax bona-nox			
		Vitex trifolia			
Kaala NAR	5	*Crocosmia* x *crocosmiifolia*	32	253.45	Staff assisted NEPM staff with treatment of *Sphagnum* both along the boardwalk, and in the core of the infestation; this accounts for about half the time spent in this MU this year. Most of the remaining time was spent on control of *Crocosmia* with volunteers. Volunteers also conducted most of the *Juncus* control. Several *Pterolepis* were found at the shelter this year.
		Diplazium esculentum			
		Juncus effusus			
		Pterolepis glomerata			
		Sphagnum palustre			
SBW No MU	2	*Erythrina poepiggiana*	38	213.00	During annual road surveys, an outlying *E. poepiggiana* was mapped more than 3km from known sites. This single tree was likely immature, despite its height, as it was not flowering during the annual flowering season. This species is wind dispersed. Aerial surveys of the area confirmed that it was a lone outlier. The largest mature tree along Kolekole Road was removed by DPW contractors, eliminating the largest remaining source of seed. Control of *Chromolaena* at SBW continues to be a high priority and accounts for 99% of the time spent at SBW No Mu. A combination of ground and aerial treatment was used to cover a large portion of the infestation. No new outlier sites were found this year.
		Chromolaena odorata			

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
Ohikilolo Lower	1	*Cenchrus setaceus*	9	78.52	Both ground control and aerial sprays were conducted at the *Cenchrus* infestation. While progress at the core is encouraging, cliff-dwelling plants continue to be challenging to reach with spray gear, and better techniques are needed to sweep the entire infestation area. On the annual road survey, several outliers were found in the mowed zones bordering the firebreak road.
Kapuna Upper	2	*Angiopteris evecta* *Sphaeropteris cooperi*	13	48.91	*Angiopteris* ICAs cover 12.6 ha in Kapuna and Keawapilau gulches. This year, mature plants were found at only two of the eight ICAs. Staff will continue to conduct annual surveys of all ICAs, to prevent new plants from maturing. While abundant elsewhere, *Sphaeropteris* is known from a single site in this MU. Plants continue to be found at the site, although few matures have ever been seen; it is unknown how long spores or gametophytes persist.
Palikea	3	*Crocosmia* x *crocosmiiflora* *Dicliptera chinensis* *Setaria palmifolia*	13	39.25	The majority of time was spent on *Crocosmia* control and utilized volunteer labor. No *Dicliptera* were found at the gulch ICA this year; if no plants area seen by 2019, it will be declared eradicated. Small numbers of *Setaria* continue to pop up at all ICAs.
Manuwai	2	*Dietes iridioides* *Pterolepis glomerata*	12	33.21	Additional time and effort will be needed to effectively control *Pterolepis* in the coming year. This year, the largest ICA expanded along the fence/trail and downslope towards the gulch, while a new ICA was discovered during fence checks. Current efforts appear to be insufficient to either prevent spread or reduce the number of mature plants. Removing soil from directly around mature plants may help reduce the number of seeds on site, as well as increased use of pre-emergents. This area is not accessible to hikers, and improved staff sanitation may help reduce spread.
Pahole	6	*Angiopteris evecta* *Axonopus compressus* *Dicliptera chinensis*	35	21.65	Most of the ICAs at Pahole, with the exception of those for *Angiopteris* and *Dicliptera*, are found along the Makua/ Pahole fenceline. This year, increased effort was spent on *Ehrharta* ICAs, with 1-2x quarterly visits. Some of the ICAs are approaching eradication, although the

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
		Ehrharta stipoides			Pahole Snail Enclosure site will require at least another year of monitoring. Likewise, sustained attention will be needed at the *Pterolepis* ICA, where staff continue to regularly find small numbers of plants. No mature *Angiopteris* were found at any ICA this year, and no *Dicliptera* were found.
		Pterolepis glomerata			
		Rhodomyrtus tomentosa			
Ohikilolo	4	*Cirsium vulgare*	19	20.96	Due to range closure issues at MMR last year, little time was spent at Ohikilolo. Once access was restored, staff were able to renew ICA work. Unfortunately, staff found several new locations of *Pterolepis*, including one on the LZ and two along the ridge fence. In addition, the *Ehrharta* infestation at the LZ and cabin has spread along the fence and management trails. Both taxa are cryptic, challenging to identify and remove. Hopefully the *Pterolepis* sites were discovered before creating seed banks. *Ehrharta* seeds are not-persistent, but frequent trips will be necessary in the future to bring this pest under control.
		Ehrharta stipoides			
		Pterolepis glomerata			
		Rubus argutus			

The table below highlights the taxa which required the most control effort in the past year. Effort from report year 2015 is presented for comparison. Note that report year 2016 covers twelve months, while 2015 covers only nine months.

2016 ICA Effort by Target Taxa

Taxa	2016 Effort (hours)	2015 Effort (hours)	Comments
Chromolaena odorata	1029.70	524.6	*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 3.6 below. OANRP continued to contract OISC to conduct work across half of the KTA infestation; see Appendices 3-5 and 3-6 for OISC's progress report.
Sphagnum palustre	331.35	186.4	Due to the success of previous control efforts, there is much less *S.palustre* on the Army side of the Kaala boardwalk than ever before. Volunteer efforts continued in a narrow, 3m buffer along the boardwalk. Staff swept the remainder of the Army infestation, beyond this 3m buffer. While small florets and occasional patches persist, the overall cover of *S. palustre* in the core is greatly reduced, as is shown by the reduction in moss killer used over the years. In 2012-2013, during initial treatment of the core, 1,177 L of moss killer were used. In contrast, only 457 L were used in the core this year. In addition to treating the core and outliers this year, staff also spent 76 hours (23% of total) conducting *S. palustre* control in the Kaala NAR under NEPM direction.

Taxa	2016 Effort (hours)	2015 Effort (hours)	Comments
Crocosmia x *crocosmiiflora*	229.00	115.75	Volunteers conduct the majority of *Crocosmia* control at both Kaala and Palikea. Most effort (78%) is spent at Kaala, where *Crocosmia* forms dense, localized banks. Corms are removed by hand. While this is effective on small populations, such as those at Palikea, it is not effective on the large patches at Kaala. A trial of chemical control methods was installed this year; results are pending.
Schizachyrium condensatum	210.80	190.95	SBE remains the only location on Oahu with *Schizachyrium*. Efforts to fully delimit the boundaries of the infestation continued this year, with only a few small areas remaining. Two new ICAs was identified in August 2015. Control efforts are ongoing, and are discussed in section 3.9.
Rhodomyrtus tomentosa	111.70	64.13	*Rhodomyrtus* is known from SBE, KTA, and Pahole. This year, a thorough survey was conducted at KTA, with no plants found; this site is considered eradicated. Only one plant was ever seen at Pahole, along the fence. Although short, the plant was mature and staff will monitor the site for several more years, as it may have set seed. The largest infestation is at SBE, where 96% of the total *Rhodomyrtus* effort was spent. Several new locations were found this year during *Schizachyrium* surveys. The size of the infestation is the greatest challenge; systematic sweeps must be implemented to make real progress towards eradication. Also, much of the infestation area is mowed periodically. While mowing doesn't kill the shrubs, it does make them difficult to locate, as the grass quickly grows tall, hiding the pruned *Rhodomyrtus*.
Cenchrus setaceus	90.27	75.05	ICAs for this fire-prone grass are located in DMR, KTA, SBE, and MMR. *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.
Pterolepis glomerata	77.4	34.45	This taxon is only a target in the Waianae Mountains, where it is a control priority in Kaala, Manuwai, Makaleha, Pahole, and Makaha. New sites were found this year at Manuwai, Ohikilolo, Makaleha West, and outside of Makaleha West. The tiny seeds of *Pterolepis* likely were tracked to these sites via staff, recreational hikers, hunters, and/or invasive animals. New tools and increased vigilance are needed to prevent further spread and suppress germination. It is thought *Pterolepis* forms a persistent seed bank. A biocontrol for a related species, *Tibouchina herbacea*, also attacks *P. glomerata* and may provide welcome assistance; the biocontrol has not yet been released.
Juncus effusus	68	33.9	Volunteers conduct the majority of control on this species, Since the seeds are long-lived, control will be required for years to come. This year, staff discovered *Juncus* on the upper portion of the Dupont Trail, about ten minutes hike from the Kaala road. It likely was tracked here by hikers from the Kaala boardwalk. Staff will begin control in the coming year.
Melochia umbellata	66.5	59.5	This species, incipient to KTA, has been controlled by OANRP since 2002. It likely forms a persistent seed bank. Of the eight ICAs, one has been eradicated, 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. Staff used aerial surveys to guide control efforts, and target control efforts around known hotspots and along roads. All known mature trees have been removed.

Taxa	2016 Effort (hours)	2015 Effort (hours)	Comments
Angiopteris evecta	58.41	20.67	This taxon is relatively widespread, but has been 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.
Ehrharta stipoides	49.15	24.3	Only one new *Ehrharta* location was found this year, on the contour trail at Huliwai. This is an improvement over last year, when new sites were found at four MUs. However, *Ehrharta* seems be established along large portions of the southern Lihue fence and in some non-MU areas of Makaleha. While difficult to identify, the lack of a persistent seed bank suggests this taxa is locally eradicable. Intensive monitoring of ICAs in Kahanahaiki and Pahole this year resulted in large reductions in numbers of plants found; several ICAs are expected to be declared eradicated in late 2016. The lone Makaha No MU ICA was declared eradicated, with no plants found for many years. At Kaluaa, no plants were found at the Hapapa site this year, although the access trail ICA was expanded to include new plants along the fence. Similarly, one of the Ekahanui ICAs was expanded; located in steep area bisected by a cliff, this is a challenging site to survey.

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, and integrity of native forest, invasive species presence, and fire threat. Different WCAs have different goals; some simply track trail and fenceline vegetation maintenance. The goals and priorities for weeding in a particular WCA are detailed in the appropriate ERMUP. For some low-priority WCAs, no control may be planned for many years. WCAs drawn outside of MUs typically provide a way of tracking weed control effort at genetic storage rare plant sites or along access trails and roads. 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. Visitation rates and goals are further elucidated in the ERMUPs. 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.

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

This year, WCA efforts covered 151.3 ha. Staff spent 5,995 hours over 713 visits at 156 WCAs. WCA work accounted for 28% of the total area controlled and 71% 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. Note that last year's reporting period covered only nine months, but all other reporting periods, including 2015-2016, cover twelve months each. Area data from 2008 through 2011 was not collected as accurately as current practices and is not presented for comparison.

Increased use of new tools, the use of volunteers and interns, additional staff, the establishment of restoration projects, and an increased programmatic focus on weed control all contribute towards this year's high numbers. However, as MU vegetation monitoring results from the last several years show, many of the long-term (20 year), landscape level IP goals have not yet been met. Controlling alien plants and reestablishing native forest in Hawaii's unique ecosystems requires sustained effort and optimism. MU vegetation monitoring does not capture small-scale responses to weed control, for example, changes directly within a restoration site. In order to learn more about this type of change, this year staff installed plots and photopoints at a new Makaha restoration site and the new proposed Palikea North Snail enclosure (see Appendix 3-7); these trials will run for at least five years. Staff also monitored the Kahanahaiki Maile Flats restoration site this year, OANRP's oldest restoration project; results are detailed in Appendix 3-8.

Control efforts are summarized in the MU WCA Weed Control Summary table below. The table lists all MUs where WCA control was conducted in the past year. Data from the 2015 report is included for reference, although the two reporting periods cover different amounts of time, as described above. This year's data is shaded and in bold. For each year, the total actual area weeded is reported; for example, if one rare plant site of one acre 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.

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/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 for select sites in the coming year.

The top twenty MUs where the most effort was spent this reporting year are summarized in the table below. Most of these MUs are large, host multiple rare IP taxa, contain large swaths of native forest, and are easily accessible, but there are several exceptions. Ohikilolo Lower is home to two rare IP taxa and completely alien grass dominated. Maintaining the fuel reduction areas around the rare taxa is a high priority and requires consistent, large inputs of time in a normal year. Due to a safety incident, staff access was limited to most of MMR for many months. When staff regained access, alien grasses and herbs had colonized much of the fuel break and had to be re-cleared. While there was less invasive grass than prior to initial clearing in 2001, this is the most effort spent in the MU since then. Another exception is SBW No MU, which covers all weed control at OANRP's West Baseyard. While maintaining a weed-free baseyard is critical to minimizing the risk of accidental dispersal via management, most of this effort is due to volunteer weeding in the interpretive garden.

Volunteer weeding efforts contributed a large amount of time to the Kaluaa and Waieli, Makaha I, Kahanahaiki, Palikea, West Makaleha, and Pualii North MUs. At Kaluaa and Waieli, Makaha I and II, Kahanahaiki, Palikea, and Manuwai, staff conducted targeted sweeps for specific canopy weeds, treating them with low dose herbicide methods (i.e., incision point application) or conventional girdle/herbicide

techniques. Understory weeds are not targeted on such sweeps, allowing staff to cover large acreages, and contributing to the high area/person hours spent at these MUs. Similarly, at Kaala Army staff conducted single-target sweeps for *Hedychium gardnerianum* in native-dominated forest. Much of the increase in effort at Kahanahaiki is due to new and on-going restoration projects. Since all alien canopy was removed at the sites, regular follow-up was conducted to prevent colonization by pioneer weeds and promote growth of native recruits. Likewise, increases in effort at Palikea are in part due to active restoration of *Drosophila* habitat sites, a volunteer site, and the new proposed snail enclosure.

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?
Kahanahaiki	1106.50	125	10.07	Yes (*Grevillea robusta*)	Yes
Palikea	939.40	103	6.13	Yes (*Morella faya, Cryptomeria japonica*)	Yes
Kaluaa and Waieli	550.50	56	15.11	Yes (*Grevillea robusta, Toona ciliata*)	Yes
Kaala Army	420.66	47	14.94	Yes (*Hedychium gardnerianum*)	Yes
Ohikilolo Lower	390.00	27	3.72	No	No
Makaha I	305.25	38	17.02	Yes (*Grevillea robusta, Toona ciliata*)	Yes
Manuwai	239.25	30	11.74	Yes (*Grevillea robusta, Schefflera actinophylla, Spathodea campanulata, Toona ciliata, Trema orientalis*)	No
Makaleha West	238.00	20	0.59	No	Yes
Lihue	227.75	35	12.14	No	No
SBW No MU	166.45	15	0.84	No	Yes
Pahole	160.00	29	2.67	No	No
Ohikilolo	152.15	19	0.99	No	Yes
Makaha II	146.00	23	6.64	Yes (*Grevillea robusta*)	No
Kapuna Upper	113.70	21	2.59	No	No
Opaeula Lower	101.75	8	0.90	No	No
Kamaili	72.00	12	0.71	No	No
Pualii North	63.50	10	0.66	No	Yes
Pahole No MU	57.25	11	6.61	No	No
Ekahanui	56.25	13	0.80	No	No
Makaha No MU	49.00	3	2.81	No	No

Native shrubs colonizing the Kahanahaiki ‘Shire’ restoration site.

MU WCA Weed Control Summary, 2015/07/01 through 2016/06/30

Management Unit	2016 Report Year					2015 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Aimuu No MU	N/A	0.22	**0**	**0**	**0**	0.04 *(369 m²)*	1	2	Last year, staff controlled weeds around the remaining *Eugenia koolauensis* at this site. Weed control around *Eugenia* is currently a low priority, given the greater threat posed by *Puccinia* rust. No control occurred this year.
Alaiheihe No MU	N/A	9.99	**9.99**	**1**	**8.50**	9.22	1	9	This area includes the Lower Kaala NAR access road. Staff sprayed roadside weeds, focusing on *Urochloa maxima* and *Caesalpinia decapetala*. An *Ehrharta stipoides* site at the end of the road was monitored, with only 20 plants found.
Ekahanui	87.5	77.91	**0.80**	**13**	**56.25**	1.79	12	99.25	Control efforts focused around rare species sites, particularly reintroduction zones. Effort again declined this year, in part because resources were diverted to rare snail projects in the MU.
Haili to Kealia I	7.91	0.61	**0.05** *(518 m²)*	**3**	**21.00**	0	0	0	A new reintroduction of *Hibiscus brackenridgii* subsp *mokuleianus* was planted along the Kealia trail this year. Weed control targeted woody weeds and some grasses at the site.
Haili to Kealia No MU	N/A	3.37	**0.43**	**1**	**1.00**	0.03 *(296 m²)*	1	1	This area encompasses the Kuaokala access road. Staff controlled *Sphaeropteris cooperii* along the road, and will continue to do so opportunistically.
Helemano	60.63	61.86	**0.21**	**1**	**2.00**	0.91	2	2	Helemano is a low priority MU due to the small number of Tier 1 taxa, and is challenging to access due to weather. Staff targeted *Setaria palmifolia* along the fenceline.
Huliwai	0.12	0.20	**0**	**0**	**0**	0	0	0	This small MU is centered at an *Abutilon sandwicensis* population. No weed control was conducted this year. *Abutilon* appears to tolerate high weed cover.

Management Unit	2016 Report Year					2015 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Huliwai No MU	N/A	9.44	**0.02** *(151 m²)*	**1**	**6.00**	0	0	0	While monitoring a *Cenchrus agrimonioides* var. *agrimonioides* site, staff also conducted weed control around it.
Kaala Army	49.02	51.18	**14.94**	**47**	**420.66**	5.43	22	280.5	*Hedychium gardnerianum* continues to be the primary weed target at Kaala. This year, staff targeted the WCAs closest to the boardwalk, portions of which had not been systematically swept for many years, as well as some of the steep slopes on the east side of the MU. Weeds also were treated at rare plant reintroduction sites
Kaala NAR	20.03	9.98	**0.70**	**3**	**4.00**	0	0	0	Staff assisted NEPM in sweeping across part of the bog, targeting *Hedychium gardnerianum* and *Psidium cattleianum*. A small amount of time was spent mowing the shelter/campsite area.
Kaena	10.06	3.28	**2.54**	**3**	**30**	0	0	0	Last year, reduced staffing on the Kaena crew contributed to the lack of weed control. This year, staff were able to renew weed control efforts, focusing on areas directly around *Euphorbia celastroides* var. *kaenana*. Since past control efforts were successful in controlling all woody weeds, staff expanded control to the westernmost *Euphorbia*.
Kaena East of Alau	14.51	0.89	**0.89**	**4**	**39**	0	0	0	Weed control efforts were renewed this year, and focused on reducing fuel loads around a small population of *E. celastroides* var. *kaenana*.
Kahanahaiki	37.7	41.47	**10.07**	**125**	**1,106.5**	2.71	38	302.67	An exceptionally large amount of area was swept and time was spent at Kahanahaiki this year. This is primarily due to work at restoration sites: 1. the Maile Flats chipper site, a volunteer project; 2. two gulch restoration sites (started last year); and 3. a third new gulch restoration site. In addition, staff weeded rare taxa sites and swept large areas to remove remaining *Grevillea robusta* canopy.

Management Unit	2016 Report Year					2015 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kaleleiki	0.12	0.80	**0**	**0**	**0**	0	0	0	The *E. koolauensis* population protected in this MU has been heavily impacted by the *Puccinia* rust. Weed control efforts are a low priority until a plan for *Eugenia* is developed.
Kaluaa and Waieli	80.97	82.96	**15.11**	**56**	**550.5**	14.63	48	603	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	**2.26**	**5**	**30**	1.33	4	13	Limited effort is spent outside of the fenced enclosure. Staff maintained the access trail and road, and also controlled weeds within a small TNC exclosure home to several rare taxa.
Kaluakauila	42.73	10.56	**1.14**	**6**	**33**	2.24	3	31	Control efforts focused on grass control and shrub control around rare taxa sites. The ridgeline fuelbreak was maintained.
Kamaileunu No MU	N/A	0.96	**0.06** *(643 m²)*	**2**	**6**	0.10	3	19	All control was conducted at the LZ and campsite this year. Staff hope to install weed suppression of some kind to prevent weeds from obscuring the LZ between visits.
Kamaili	2.57	3.92	**0.71**	**12**	**72**	0.07 *(691 m²)*	2	11	This is the first year of significant weed control, as the fence was completed only last report year. Control efforts focused on rare taxa sites and along the fencelines. An experimental thinning of *Grevillea robusta* promoted growth of *A. sandwicensis*, which was very encouraging. Much of the MU is weed-dominated, and staff otherwise avoid creating large light gaps.
Kapuna Upper	172.35	179.20	**2.59**	**21**	**113.7**	1.29	22	104.84	Control efforts continue to focus around rare taxa and reintroduction sites. Additional time was spent clearing weeds from along the north-western fenceline, which was very overgrown.

Management Unit	2016 Report Year					2015 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kaunala	1.98	2.24	**0**	**0**	**0**	0.06 *(553 m²)*	1	20	Until an effective strategy to combat *Puccinia* rust is created, OANRP is hesitant to commit resources to habitat restoration at any *E. koolauensis* sites.
Kawainui No MU	N/A	38.36	**0.08** *(823 m²)*	**1**	**0.5**	0	0	0	While hiking on the summit trail, staff opportunistically controlled some outlying *Leptospermum scoparium*. There is a large infestation of *L. scoparium* in the northern Kooalu mountains, although it is not established in the Koloa MU.
Keaau and Makaha	1.19	0.18	**0**	**0**	**0**	0	0	0	Minimal effort is needed around this *Sanicula mariversa* site.
Keaau Hibiscus	3.64	3.23	**0.04** *(362 m²)*	**1**	**20**	0	0	0	This is the first weed control in this newly fenced MU. Efforts focused on preparing a site for a *H. brackenridgii* outplanting.
Koko Crater No MU	N/A	0.28	**0.23**	**3**	**43.5**	0.23	2	15.5	Weed control was conducted around living collections of *H. brackenridgii* and *E. koolauensis* at Koko Crater Botanical Garden
Koloa	71.54	73.16	**0.12**	**1**	**9**	0.82	8	94.5	Located at the summit of the Koolau Mountains, weather poses a major challenge to conducting effective weed control. This year, staff controlled weeds around a reintroduction of *Phyllostegia hirsuta*. In future, control of the dominant weed *Psidium cattleianum* will resume.
KTA No MU	N/A	1.31	**0**	**0**	**0**	0.01 *(96 m²)*	1	1	Last year, minimal weeding was conducted at an *E. koolauensis* site in conjunction with rare plant monitoring. This is a low priority action.
Lihue	711.92	714.91	**12.14**	**35**	**227.75**	3.02	12	93.5	The large increase in area weeded this year is primarily due to fenceline and roadside weeding, which accounts for 10.5 ha and 56 hours. The majority of remaining effort centered around rare taxa sites, including new reintroductions.

Management Unit	2016 Report Year					2015 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Makaha I	34.2	34.32	**17.02**	**38**	**305.25**	5.8	34	271.75	Both effort and area treated increase dramatically this year. In part, this is due to targeted sweeps for *Grevillea robusta*. BWS granted OANRP permission to use Milestone herbicide for one year to control *G. robusta*. Aerial surveys were used to map large *G. robusta* and direct sweep efforts. Staff also targeted *Toona ciliata* in select areas. Other control efforts at Makaha I continue to focus around rare taxa sites and native forest patches in the mauka portion of the MU and select *Coffea arabica* patches. Volunteers contribute greatly to *Coffea* removal.
Makaha II	26.69	7.19	**6.64**	**23**	**146**	0.31	8	66	The entirety of Makaha II was swept for *G. robusta* this year; this accounts for much of the increase in area and effort. Staff also spent more time controlling weeds around rare taxa, as reintroduction sites expanded.
Makaha No MU	N/A	16.65	**2.81**	**3**	**49**	0	0	0	The BWS access road, already narrow in places, was overgrown with grass. Staff weedwhacked it for safety purposes.
Makaleha Central No MU	N/A	0.1	**0.01** *(144 m²)*	**1**	**5**	0	0	0	Staff controlled weeds while monitoring a *Kadua degeneri* subsp. *degeneri* site.
Makaleha West	38.04	1.49	**0.59**	**20**	**238**	0.59	11	125.25	This MU has two widely separated WCAs. Staff weeded around rare taxa at the remote site, but the 99% of effort was spent at the 3-Points exclosure. At 3-Points, staff effort is targeted around rare taxa, while volunteers provide much of the labor to remove a large stand of *Psidium cattleianum* and assist with clearing weeds from the fence.
Makaleha West No MU	N/A	0.51	**0.17**	**2**	**1**	0.12	1	0.5	Control is conducted as needed to maintain the access trail.

Management Unit	2016 Report Year					2015 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Manuwai	122.49	127.44	**11.74**	**30**	**239.25**	10.14	9	144	Effort at Manuwai was split fairly equally between large landscape sweeps for canopy weeds and focused control around rare taxa sites. Landscape sweeps account for most of the area treated. Staff noted particularly aggressive alien grass growth this year, likely due to the wet summer.
Manuwai No MU	N/A	3.4	**2.65**	**6**	**34.5**	0	0	0	All effort was spent controlling vegetation along access roads, particularly the road leading to the west side of the exclosure.
MMR No MU	N/A	18.22	**1.8**	**4**	**32.5**	0.35	1	5	Last year, fencing was completed along the Kuaokala road, connecting Kahanahaiki and Kaluakauila. This year, the majority of effort was spent controlling alien grasses along the fenceline. Minimal time was spent maintaining living collections at Makua Range Control.
Moanalua No MU	N/A	5.66	**0**	**0**	**0**	3.31	1	24	Last year, grass clearing was conducted along the four wheel drive Moanalua access road.
Nanakuli No MU	N/A	4.00	**0.49**	**2**	**2.5**	0.04 *(381 m²)*	1	3	This is the Halona ridgeline, between the Palikea and Palikea IV MUs. Staff improved the LZ on this ridge, and swept the area for *Morella faya*.
Napepeiaoolelo	0.75	0.48	**0.07** *(724 m²)*	**1**	**4**	0	0	0	The MU exclosure contains only 1 rare taxa, and historically has not been weeded much. This year, staff controlled weeds along the fenceline.
Ohikilolo	232.79	147.40	**0.99**	**19**	**152.15**	0.04 *(432 m²)*	3	15.5	MMR was closed for part of the year due to a safety incident. In the Lower Makua portion of the MU, limited weed control was conducted, all around rare taxa sites. In the Ohikilolo Ridge portion of the MU, efforts were more extensive, but also centered around rare taxa and native forest sites, although some grass control was conducted. One volunteer trip was made to the cabin area.

Management Unit	2016 Report Year					2015 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Ohikilolo Lower	28.75	4.52	**3.72**	**27**	**382**	3.66	13	148	Last year's range closure greatly set back fuel maintenance efforts. Multiple days of weedwhacking were needed to open the WCAs and allow them to be inspected for UXO. This accounts for the large bump in effort seen. Despite the closure, an experimental outplanting of *Scaevola taccada* survived the summer. New outplantings were installed at two WCAs in hopes of shading out fast-growing weeds. Monitoring of shrub cover was initiated during the past year (Appendix 3-2A)
Oio	1.33	1.39	**0**	**0**	**0**	0.09 *(908 m²)*	1	16	Until an effective strategy to combat *Puccinia* rust is created, OANRP is hesitant to commit resources to habitat restoration at any *E. koolauensis* sites.
Opaeula Lower	10.15	6.80	**0.9**	**8**	**101.75**	0.27	3	6.5	This year, a trial examining the optimal interval between weeding events to minimize *C. hirta* recruitment was completed (Appendix 3-9). It was determined that follow-up weed control needed to be conducted at least once a year. With this information and increased staffing levels, *C. hirta* and other understory control efforts were expanded across central part of the MU and around rare taxa.
Pahipahialua	0.6	0.80	**0**	**0**	**0**	0.03 *(346 m²)*	1	15	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	31.86	**2.67**	**29**	**160**	2.59	21	126	Weed control effort at Pahole is targeted primarily around rare taxa locations. Staff also sprayed alien grasses along the Pahole/ Kahanahaiki fenceline border.

Management Unit	2016 Report Year					2015 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Pahole No MU	N/A	11.98	**6.61**	**11**	**57.25**	5.58	6	36.5	Staff continues to control weeds along the Pahole road, around the Nike greenhouse, and at the Nike LZ.
Palawai No MU	N/A	4.81	**0.48**	**4**	**13**	0.02 *(215 m²)*	1	0.5	This area immediately abuts the Palikea MU. Control efforts targeted *Sphaeropteris cooperi*. There is a large source population here, and control efforts prevent ingress into the MU.
Palikea	9.95	11.39	**6.13**	**103**	**939.4**	1.29	33	281.3	Both effort and area controlled increased greatly this year. Much of the increase in area is due to sweeps targeting gradual removal of *Morella faya* and *Cryptomeria japonica*. No additional such canopy sweeps are planned, until OANRP is confident that further increasing light levels will not trigger an unmanageable increase in alien understory cover. Most effort was spent in three WCAs, which include active restoration sites, a volunteer project, and a potential new snail enclosure. Clearing for the new snail enclosure accounts for 271 hours.
Poamoho No MU	N/A	119.78	**1.38**	**3**	**41**	0	0	0	OANRP participated in a State-organized interagency road clearing effort at Poamoho.
Poamoho North	257.77	202.77	**6.32**	**1**	**15**	0	0	0	Staff spent one trip aerially spraying *Angiopteris evecta* with NEPM staff. This MU is of moderate priority, as it contains few MFS IP taxa and is actively managed by two other agencies. OANRP will continue to assist partner weed control efforts, as feasible.
Puaakanoa	10.7	1.07	**0**	**0**	**0**	0	0	0	Weed control efforts were hampered by the closure of MMR last year, and have not yet resumed. This MU was considered lower priority than Ohikilolo Lower, with regards to re-clearing grassy fuels.

Management Unit	2016 Report Year					2015 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Pualii North	7.99	4.58	**0.66**	**10**	**63.5**	0.30	6	79.75	Staff control efforts focused around rare taxa sites and reintroductions. A volunteer project started in the gulch last year accounts for much of the effort spent.
Puu Kumakalii	4.83	6.12	**0**	**0**	**0**	0.27	1	1	No weed control was conducted around the cliff-side rare plant reintroductions this year. Control will be conducted as needed in this delicate habitat in future.
SBE No MU	N/A	4.16	**0.09** *(901 m²)*	**3**	**3**	0.04 *(439 m²)*	1	4	Weeds were cleared at the sediment disposal site, to keep it open for future use by DPW. A small amount of time was spent controlling weeds at the East Baseyard.
SBW No MU	N/A	2.08	**0.84**	**15**	**166.45**	1.28	9	20.75	The high number of hours is due to 142 hours of volunteer effort in the West Baseyard interpretive garden. The remaining staff effort focused on maintaining weeds at West Base to reduce the potential for staff to act as vectors.
Waianae Kai	3.66	1.14	**0**	**0**	**0**	0.15	2	5.5	Generally, control efforts focus around rare taxa locations and along the fenceline. No control was conducted this year due to scheduling issues.
Waianae Kai Neraudia Mauka	0.53	2.59	**0**	**0**	**0**	0.13	1	6	No control was conducted within this fence this year, as it will not be a MFS site for *Neraudia angulata* in future, and thus is low priority.
Waimanalo to Kaaikukai No MU	N/A	1.28	**0.83**	**1**	**3**	0.04 *(390 m²)*	1	12.5	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	**0.34**	**4**	**40**	0	0	0	Weed control was conducted around living collections of *Nototrichium humile* at Waimea Valley botanical garden.
TOTAL	N/A	2,420.4	**151.3**	**713**	**5,995**	80.36	352	3,117	The previous reporting year covered only 9 months, while this year covers 12 months.

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. In the past year, joint projects have included *Cenchrus setaceus* and *Chromolaena odorata* control efforts. The OANRP Ecosystem Restoration Program Manager is currently serving as the OISC Chair, a two-year position.
- Bishop Museum and the Oahu Early Detection (OED) program of OISC. Plant samples submitted to the Bishop Museum Herbarium were identified by Museum and OED staff. Noteworthy finds are discussed in section 3.5.
- College of Tropical Agriculture and Human Resources (CTAHR). OANRP has worked with Dr. James Leary of CTAHR in research on novel weed control techniques, see section 3.9.
- 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). This year, OANRP staff collaborated with NEPM on one day of aerial spraying of *Angiopteris evecta* at Poamoho.
- Board of Water Supply (BWS)
- Koolau Mountains Watershed Partnership (KMWP)
- Puu Ohulehule Conservancy
- Waianae Mountains Watershed Partnership (WMWP)
- Waimea Valley

OANRP participated 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 third 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 Ecology and Management of Alien Plant Invasions conference, held in Waikoloa, September 2015. Posters exhibited at the conference are included in Appendix 3-9.

3.3 VEGETATION MONITORING

Vegetation monitoring during the past year was conducted and analyzed for the Kaluaa and Waieli MU (Appendix 3-10), Manuwai MU (Appendix 3-11), and both subunits of Kamaili MU (Appendices 3-4A and 3-4B). The results of these studies are being incorporated into the latest draft of the ecosystem restoration plans and will be used to modify weed control plans for these MUs. Vegetation monitoring was also conducted across the Ohikilolo MU at the end of this report year. Results are being analyzed and will be presented next year. At the Ohikilolo Lower MU, a native shrub cover analysis using Gigapan was done as a pilot monitoring project (see Appendix 3-2A).

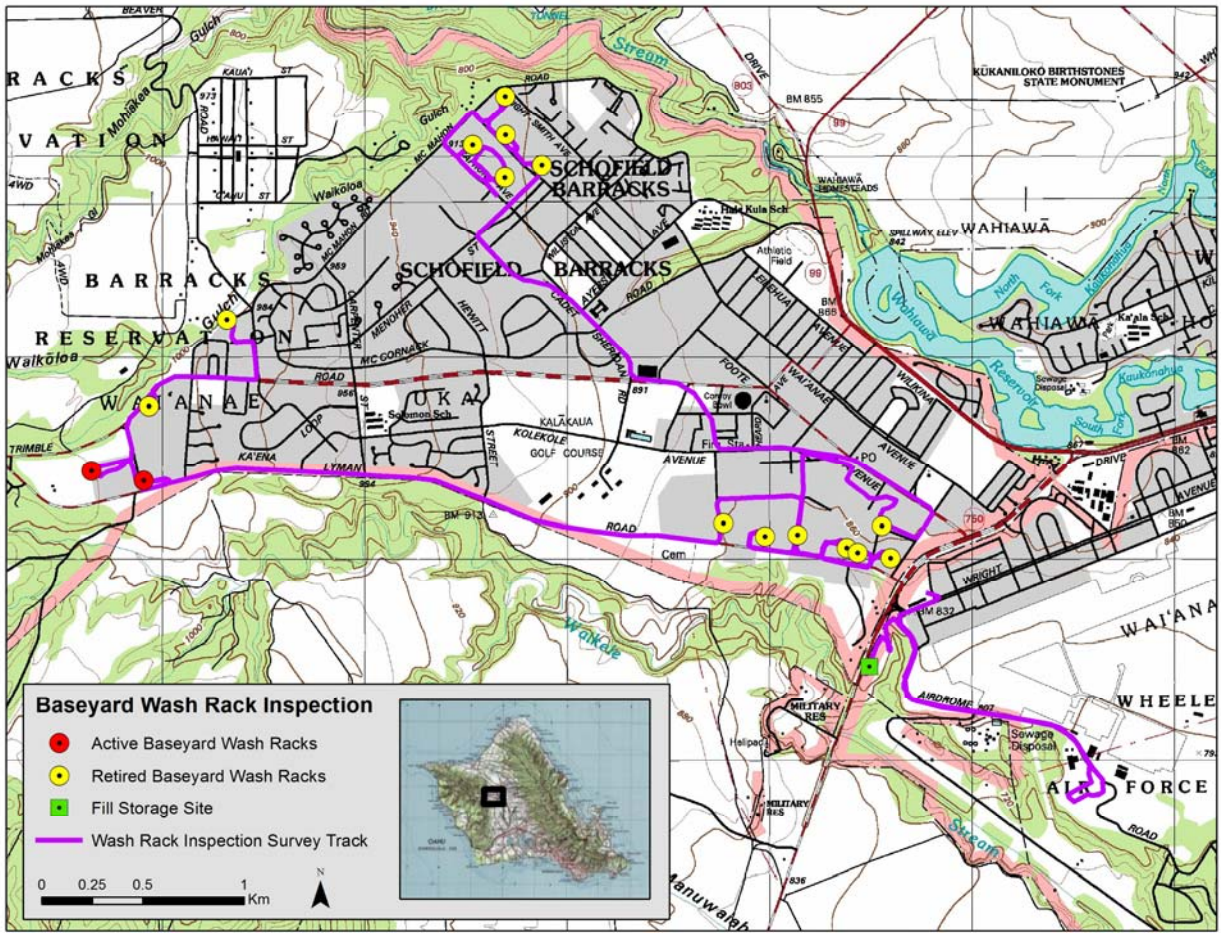
3.4 INVASIVE SPECIES SPREAD PREVENTION ON ARMY TRAINING RANGES

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.

Wash Rack Status

- Use at the Central Vehicle Wash Facility (CVWF) continued this year with regular hours of operation: 0800-1600.
- The SBE Wash Rack has not been operational for much of this report year, from December 2015 through April 2016. It closed again in July 2016. Last year, it was closed from November 2014 through March 2015 and again in May 2015. Repairs are expected to occur from September 12 through October 30, 2016. Units are encouraged to use the CVWF as an alternative. Once the SBE Wash Rack reopens, it will be run by the CVWF contractor.
- This year OANRP and OISC staff continued to utilize the wash rack at KTA by checking out the facility key at Range Control, operating the machinery, and washing vehicles. On a few instances, the wash rack was not operational, but it was at least partially operational for much of the year.
- Throughout the year, staff noted several instances where the KTA wash rack was not used by departing troops, in direct contradiction to Range requirements. The Federal Biologist worked with Range Control and DPW to develop measures to improve compliance, which are currently going into effect (August 2016). In the coming year, the maintenance and scheduling of the wash rack will be done by the CVWF contractor; this should insure the facility is always functional. Units will be required to schedule the wash rack whenever reserving a KTA training range via the online Range Facility Management Support System (RFMSS). The contractor has requested that scheduling happen two weeks prior to washing. Contractors are expected to show up at the scheduled time, run the facility, and track actual usage via a sign-in log. Same-day usage requests will still be possible, but will require a Form 84; these also will be kept. Under the new system, OANRP staff will still be able use the wash rack without contractor oversight. OANRP will be able to use RFMSS to monitor whether or not the wash rack is scheduled, and the sign-in log to ensure scheduled washing actually occurred. It is hoped this increased oversight will lead to better compliance.
- 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.
- Prior to the construction of the CVWF, many units used small wash racks at their own baseyards. The CVWF has replaced these, and all but two on Schofield and one on Wheeler are no longer in use. All sites, except for the active Wheeler site, were surveyed for invasive weeds this year; see map below. Most of the decommissioned sites were converted to parking areas or covered by storage containers. The two active wash racks remaining on SBW are used primarily by tracked vehicles, which cannot be washed in the CVWF. The Wheeler site is for helicopter washing. All sites were manicured and pose little risk of invasive weed spread. During the survey, staff also inspected a DPW fill (sand, gravel, dirt) storage location on Wheeler. This site is part of the new Wheeler road survey and will be inspected annually.

Schofield Barracks Wash Rack Inspection Survey



Landing Zones

- The Range Scheduling office requested OANRP assistance in updating the list of LZs units can use and schedule. This involved removing any LZ either not on a training range or not on Army-leased land. The LZs which were removed include: Depression, Bryans, Hammer, Lychee, Non-Stop and Rose.
- Staff were notified that an LZ located on Dole land, Basilian LZ, is periodically leased by the Army for landing and possible bivouacking. OANRP will determine annual usage and will schedule surveys at this old airstrip at Opaeula, below Drum road starting in 2017.

Integrated Training Area Management (ITAM) and Contractors

- OANRP reviewed the Soldier Field Card at ITAM's request. These cards are meant to be a resource for soldiers, and a way of sharing information with them about proper range usage. The cards emphasize the importance of cleaning gear and vehicles, preventing range fires, altering vegetation and reporting alien invasive species, such as snakes.
- Staff drafted memos and maps detailing invasive species sites on SBE, SBW and KTA that ideally would be avoided by soldiers and maintenance personnel. While these sites will not be officially excluded from training, it was agreed that small sites could be marked with signs and cones, and that personnel would be briefed on avoiding them.

- Staff briefed new contract maintenance staff on invasive weed threats on the training ranges. The presentation provided images of *C. odorata*, *C. setaceus*, and *S. condensatum*, discussed newly established 'no mowing' sites, and detailed what the Natural Resource office's expectations are regarding work around these sites.
- Following the discovery of two new outlier *C. setaceus* sites in mowed areas in MMR, staff contacted the contract lead and provided her with a map and plant identification photos. She said that she would brief her staff regarding this new threat.

KTA and KLOA

- In response to concerns from Range Control about heavy impacts from motocross use to X-Strip LZ and the rampant trespassing by motocross riders onto KTA (beyond the boundaries of the designated motocross park), the State built a fence around X-Strip LZ.
- The Army plans to conduct rockfall mitigation work along Drum Road. Staff reviewed proposals for where to deposit material generated by this project; these included portions of KTA and KLOA. Staff provided maps of invasive species sites, and requested that the fill avoid these areas, particularly the newly discovered *Chelonanthes acutangulus* location near Puu Kapu LZ.

SBW

- DPW removed a large *Erythrina poeppiggiana* from along Kolekole Road this year, see photos below. This 20-30m tall tree was likely the source of most of the other *E. poeppigiana* found on range. OANRP staff will sweep the surrounding area for other plants.

- Staff identified a site for disposal of sediment from the CVWF.
- Staff provided advice to the Cultural Resources office and contractor GDIT on a proposed aerial spray of Schofield Barracks, following a controlled burn. Funding for the spray did not come through.
- Firing Points (FP) 303, 304, and 306, all located on McCarthy Flats, were surveyed prior to rehabilitation by ITAM. These FPs have not been used in years and were completely overgrown. This area is adjacent to the Mohiakea gulch *C. odorata* infestation, but no plants were found. Both aerial and ground surveys were conducted. Once work is complete, these FPs may provide

improved access to portions of the *C. odorata* infestation, which will assist with eradication efforts.

- The Explosive Hazard Training Lanes, aka the 'mine detection area' was surveyed prior to rehabilitation by ITAM. At one point this area had been fenced and maintained as open ground, but at the time of the survey, the fence was partially collapsed and the area was covered in alien grass. There are *C. odorata* less than 30m from the lanes. Re-locating the lanes would have required digging up training devices and re-burying them elsewhere; the risk of moving soil potentially containing *C. odorata* seed was deemed higher than the risk posed by renewing the lanes. Staff requested that the new fence entirely enclose the site, which would prevent anyone from accidentally wandering into the *C. odorata* infestation.
- Last year, signs were placed near the mine detection area to prevent soldiers from training within the *C. odorata* infestation. This year, additional signs were installed along Area X and FPs 212 and 213 for the same purpose. As *C. odorata* control efforts have expanded, areas formerly dominated by invasive grasses were sprayed and cleared to allow for access to the infestation and improve visibility. These cleared areas look like good places for soldiers to bivouac. The signs do not block areas previously open to training, but rather define the edge of the training area and ensure that control efforts don't encourage additional traffic to *C. odorata* sites.

- Staff conducted a site visit with a unit planning to train at FP 213, 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 them to bivouac in stand of Eucalyptus just outside the FP, as the area was far from known *C. odorata*. The Range Scheduling office referred the unit to OANRP; this was encouraging, as it showed that Range staff understood the importance of the restrictions placed on the area by the Natural Resources office.

SBE

- The wash rack sediment disposal site at SBE was completely overgrown this year. The SBE wash rack was out of commission, so the site was not used. The sediment barrier fencing fell over under the weight of all the vegetation. Staff cleared the area and fixed the sediment barrier.
- OANRP continued working with ITAM and range maintenance contractor General Dynamics Information Technology (GDIT) to address the *S. condensatum* infestation. GDIT regulars mows the open grassy fields of SBE, which are preferred habitat for *S. condensatum*. OANRP placed cones and signs around known concentrations of plants. Contractors were directed to avoid these areas during maintenance work, which hopefully will reduce the potential for dispersal.

Poles, rope and signs installed around *S. condensatum* hotspots at SBE

3.5 WEED SURVEY UPDATES: NEW FINDS

This year OANRP conducted surveys along Roads and Landing Zones (LZs) used by both natural resource staff and the Army. A new survey was conducted this year across all the roads (paved and unpaved) on Wheeler Army Airfield (WAA). Three new OANRP LZs were surveyed for the first time this year. To help prompt staff to conduct OANRP LZ surveys each quarter, staff upgraded the helicopter plan form on the database, so that it now generates the date of the last completed LZ survey for each LZ listed on the form. This report should allow staff to easily determine if a survey needs to be done by looking on their helicopter plans, required for any operation.

Staff also surveyed locations of potential introduction such as OANRP camp sites, Army washrack sediment disposal sites and MU access trails. Unusual and noteworthy plants found during the course of other field work are referenced in the Summary of Alien Taxa on Surveys table below as incidental and are also discussed in that table. OANRP received continued support from the Oahu Early Detection (OED) program and Bishop Museum to identify unknown species and evaluate taxa invasiveness potential. This year a total of 53 submissions were sent to OED for identification.

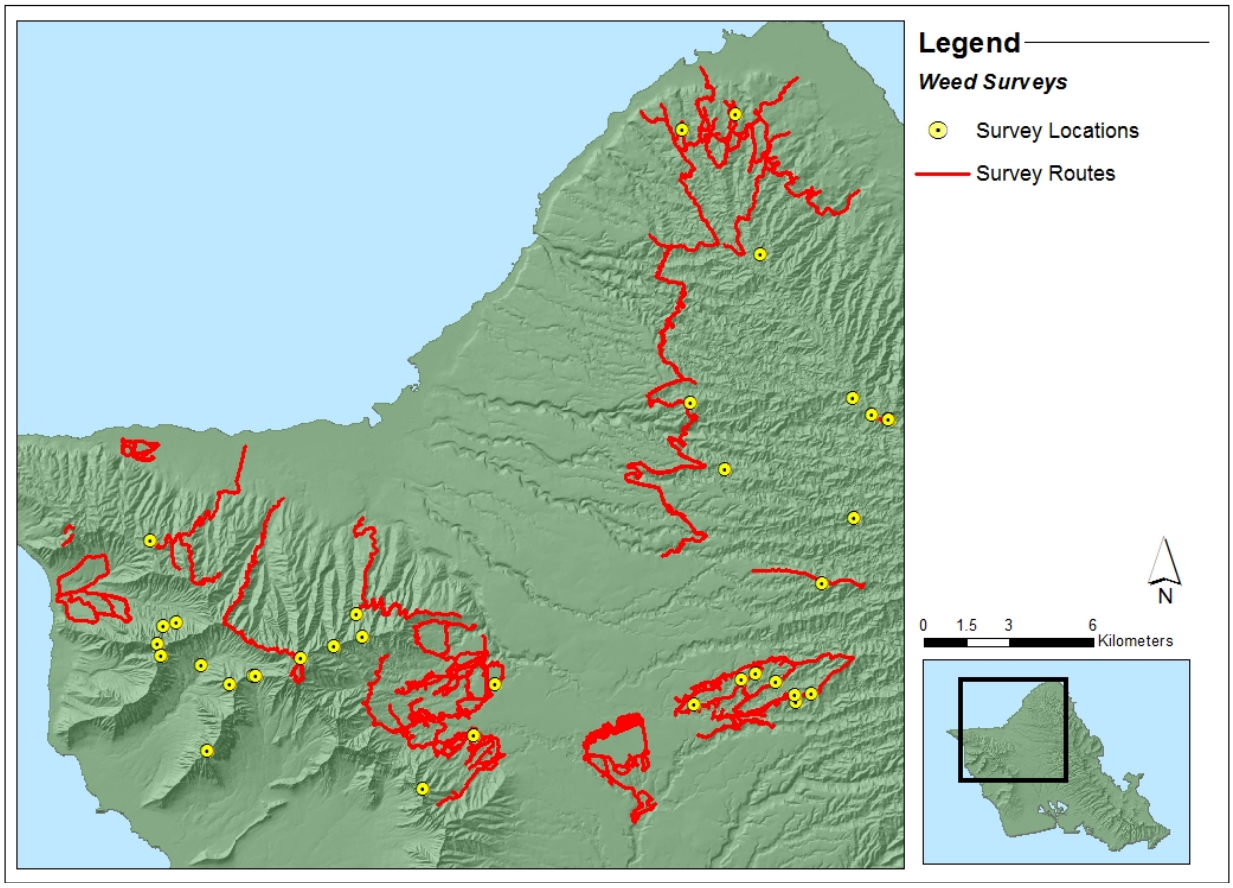
Access to roads throughout Schofield Barracks South Range has been difficult to schedule for the past 5 years, and only a partial survey was conducted the previous report year. OANRP gained access this year to all roads during a Range Maintenance week when no live-fire training was allowed. Continued access during these maintenance weeks is expected in the future.

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.	18 road surveys
LZ Survey	Actively used Army LZs are surveyed once per year. This year two Army LZs were not surveyed due to landing restrictions: LZ Black and Elephant's Foot. Landing issues are now resolved and staff will survey this coming year. OANRP LZs were surveyed if used within a quarter.	44 surveys on 34 LZs
Transect Survey	Surveys are conducted annually along high use access trails to OANRP MUs, and along selected MU fencelines and transects inside MUs.	18 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.	10 surveys at 6 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.

Map of Surveys Conducted in 2016



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

Summary of Alien Taxa on Surveys

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
Road	**DMR-01** Roads throughout DMR	*Eragrostis leptostachya*	This grass was found to be locally common on most roads surveyed in DMR. Bishop Museum identified it as a new island record. It is unlikely to be highly invasive, and no control is planned.
Road	**KLOA-08** Drum Road	*Chelonanthus acutangulus*	New State Record (photos below). Found growing out of erosion matting along the road. An expert on the genus was required for final identification. No record of *C. acutangulus* as a weed elsewhere, but it is a common roadside plant in the tropical Americas. It thrives in disturbed areas and has tiny seeds. It was given a Hawaii Pacific Weed Risk Assessment score of 7, suggesting that control is warranted. Plants have been removed, and an ICA has been created for this species for quarterly monitoring/control at the site.

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
		Digitaria abyssinica	*D. abyssinica w*as recorded as a New Island Record, however this mat-forming grass looks like a previously unidentified grass collected from this road, as well as a locally common unidentified grass at KTA. Distribution may be larger than previously thought. Will work to get mature samples from Drum Rd and KTA to document distribution. No control planned.
Road	**Pahole-01** Pahole Road	*Plantago debilis*	New distribution record for this species. Documented at only 3 other localities in the Bishop Museum records. No invasive threat record. No control planned.
Road	**SBS-01** Roads across Schofield South Range	*Mallotus phillippensis*	This species has a limited distribution. One individual found along a road in SBS this year. Scattered individuals in the nearby Kaluaa and Waieli MU are controlled during regular weed control sweeps. No control planned for this individual, as it is outside of a managed area, but staff will continue to document distribution as individuals are observed.
Road	**SBS-01 & SBW-04** Roads across Schofield South and West ranges	*Hypochaeris glabra*	Small aster with wide distribution across South and West Ranges. No invasive threat record. No control planned.
		Bothriospermum tenellum	Small herb with tiny white flowers. No invasive threat record. No control planned.
Road	**Wheeler-01** Roads throughout Wheeler Army Airfield (WAA)	*Anredera cordifolia*	This vine is highly invasive and spreads easily via aerial tubers. It was found in one location on the edge of a degraded gulch during this road survey. Staff will continue to monitor the spread of the plant during annual road surveys, but otherwise control is not planned.
		Cardiospermum grandiflorum	Found in a single location along a paved road near the airfield. This vine is known elsewhere from the island and is invasive. This location is not near a native area and is somewhat confined by roads. No control is planned, but any further spread on (WAA) will be documented.
		Cupaniopsis anacardioides	Planted as an ornamental street tree near the airfield, this taxon has some documented invasive behavior. No naturalized individuals noted. No control planned.
		Oldenlandia corymbosa	This small weed has a somewhat common distribution, and may be overlooked due to its small stature. No perceived invasive threat; no control planned.
		Triplaris weigeltiana	This species is potentially invasive and was found in a forested area surrounding the horse stables on WAA. OANRP have also documented it from Schofield Barracks. Staff will continue to document new locations, however, as it is far from native forest, no control is currently planned.

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
	Wheeler-01 Roads throughout Wheeler Army Airfield (WAA)	*Manihot glaziovii*	*M. glaziovii* was found naturalizing in the immediate vicinity of mature trees in a wooded area near the stables on WAA. Bishop Museum Herbarium kept this specimen to document its distribution. As with other plants found on the Wheeler road survey, no control is planned for this species, but new locations will be documented.
LZ	**LZ-MOKFR-189** Nike Site LZ	*Eragrostis tenuifolia*	Found on the frequently used LZ at the Nike site, this taxon is not commonly documented on Oahu. No invasive threat record is known, however weeds on this LZ should be kept to a minimum. No control planned specifically for this grass.
LZ	**LZ-MMR-12** Ohikilolo LZ	*Pterolepis glomerata*	It is very worrisome to find *P. glomerata* on this LZ. At one point only known to from the Koolau Mountains, this weed is being observed at many new locations in the Waianae mountains. It is important to eradicate this new location at Ohikilolo LZ to prevent further spread into the MU. An ICA has been established at this site. Further discussion of this taxon can be found in section 3.1.
		Toona ciliata	It is not surprising that a small *T. ciliata*, a widespread invasive tree common in Makaha valley and becoming more prevalent in Makua valley, dispersed to the LZ, but it is important for staff to maintain a zero tolerance for it in the managed forest patches in Ohikilolo MU during weed control sweeps. No creation of an ICA is planned.
Incidental	Keaau	*Bromus diandrus*	One small sample was found on a trail at the back of Keaau Valley and was noted as a new island record. *B. diandrus* is an invasive grass with the potential to carry wildfire. Staff will continue to monitor the location found during the course of other work in the area, however no control is planned.
Incidental	Huliwai (contour trail)	*Ehrharta stipoides*	A small population of this invasive grass was found on either side of the contour trail as it runs through Huliwai gulch. It is being controlled quarterly in an ICA to prevent spread along the trail.
Incidental	Wheeler Army Airfield sediment deposition site	*Heliotropium amplexicaule*	An unknown species found during a survey of washrack sediment. No invasive threat record. No control planned.
Incidental	Makaleha East, Dupont Trail	*Juncus effusis*	A small number of *J. effusus* (1 mature, 2 immature) were found on either side of a radio transmitter along the Dupont Trail 10 minutes off the Kaala road. This invasive rush is controlled on the Army side of Kaala summit at several ICAs. An ICA has been created at this new location to prevent spread along the Dupont trail and in new locations at Kaala summit.
Incidental	SBE	*Lablab purpureus*	This bean crop was found on East Range, but has a wide distribution and no invasive threat record; therefore no control is planned.

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
Incidental	Kaluakauila fenceline	*Linum trigynum*	This small plant is not well documented in the Bishop Herbarium, but has been noted by staff in several locations including the Ohikilolo and Kahanahaiki fencelines; it may be under reported. It does not appear to be particularly invasive or habitat altering. No control planned.
Incidental	Kaala summit near FAA fence	*Lolium multiflorum*	Several uncommon grasses occur at Kaala summit including *L. multiflorum*, submitted this year for identification. This grass has no invasive threat record and no control is planned.
Incidental	Multiple locations	*Pterolepis glomerata*	Found on the Ohikilolo LZ this year (see LZ write-up above), this invasive weed was additionally observed by staff at the following locations during the course of field work this year: Ohikilolo Ridge above the 'Ctenitis' fence (1 mature), at the junction where the Ohikilolo fence meets the West Makaleha fence (dozens of plants at all stages), and in West Makaleha Gulch below the fenced MU where a patch over 40m long and with over 600 plants. All of these locations have been designated as ICAs. Some of these locations are places traversed by both staff and recreational hikers. The population in West Makaleha Gulch (No MU) is unfenced with high levels of pig sign. Staff sanitation will continue to be stressed, and for now, populations occurring near high-value forest areas will be controlled, however this high rate of spread may at one point exceed OARNP staff ability to control this taxon in the Waianae Mountains. Additional discussion about this taxon can be found in section 3.1
Incidental	Kawaiki Gulch	*Saraca indica*	The Ashoka tree is prized for its flower display, and was found in a somewhat unusual location, in Kawaiki Gulch, in the Koolaus. This is a new adventive distribution for this species; it was possibly planted. It has no invasive threat record and no control planned.
Incidental	Makaha II fenceline (Kumaipo ridge)	*Setaria palmifolia*	Low numbers of the invasive grass *S. palmifolia*, have been observed in a small area and controlled (5 total) over a period of 8 months. An ICA has been established here with the hopes of quick eradication, and prevention of spread into the adjacent Makaha MU.
Incidental	Palehua, J/K/L Road	*Viola hederacea*	An isolated patch of *V. hederacea* was found along a side road off the main Palehua road. It was submitted to Bishop for identification and was noted as a new naturalized record. It is documented as cultivated on several islands and is known to produce seed, but has not been documented as naturalized before. No control planned.

Photos of New State Record, *Chelonanthus acutangulus*, found growing out of erosion control matting

3.6 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 42% (1,030 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 at *C. odorata*, as they do not include time spent conducting surveys outside of ICAs, such as motocross trail surveys in KTA, firing point surveys at SBW, and annual road surveys on all ranges. Also, they do not include time spent developing aerial spray equipment or improving power spray gear.

While the infestation at KTA was found to have expanded this year, no expansions were seen at either SBW or SBE. Encouragingly, no new sites were discovered off of Army land either. OISC continues to manage infestations at Kahana, Keamanea/Haleiwa, and Aiea/Camp Smith, see Appendices 3-5 and 3-6. However, no *C. odorata* surveys have been conducted in non-infested areas on Oahu, so it is possible that new infestations may be found in the future. To date, all discoveries on non-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 treatment in known infestations, much less survey potentially un-infested lands, and more aggressive tools are needed. Several biocontrol agents for *C. odorata* have been identified and released in other parts of the world, including Australia, Guam and Palau. At the Ecology and Management of Alien Plant Invasions (EMAPi) conference, September 2016, staff learned of a successful release of a gall fly, *Cecidochares connexa* in Papua New Guinea (Day, 2016). The presenter, Michael Day (Department of Agriculture, Fisheries and Forestry, Queensland, Australia), recommended that *C. connexa* would be a great fit for Oahu, as it has already been tested extensively for host specificity by a variety of other tropical countries, it disperses well and finds outlying patches of *C. odorata* on its own, and does not require large patches of its host to become established (pers. com). He thought that *C. connexa* would be an invaluable tool in a *C. odorata* eradication effort. This gall fly also was successful in reducing *C. odorata* cover in Guam (Reddy, 2011). OANRP has begun discussions with OISC and other members of the Chromolaena odorata Working Group (COWG) to figure out the steps necessary to release *C. connexa* on Oahu.

Seed Longevity Trial Update

In 2011, staff installed a five-year trial at KTA to determine how long *C. odorata* seeds persist in soil. Seed was collected and placed into packets of 1,250 seed, which were buried 6-8 inches underground at a site outside of, but adjacent to known *C. odorata* areas. Two bags each were removed from the site every three months for the first year of the trial, then once a year for the remaining four years. Staff analyzed trial results at the three-year mark (Appendix 3-9), and found germination declined from 73% at the start of the trial to 36% at three years, and that no seeds germinated in the dark. This suggests *C. odorata* forms a persistent, short-term seed bank. When the fourth year seed packets were opened, staff found only seven seeds, two of which went on to germinate. In contrast, 756 seeds were recovered from the second-year packets, and 356 seeds from the three-year packets. While it is possible that all other four-year seeds had simply decomposed or been predated, the extremely low number of seeds found is suspicious. The final, five-year packets were scheduled to be retrieved in July 2016, but could not be found. In the next months, the staff who installed the trial will visit the site again to locate the packets. Five-year results will be analyzed at that time. Thus far, staff are only confident in stating that *C. odorata* seeds persist at least three years, and possibly as long as five.

Left: germinating *C. odorata* seeds in the lab. Right: seed longevity trial at SBW; each packet is marked with a flag.

Given the peculiar results seen at the four year mark, staff decided to replicate the trial. A second buried seed trial was installed at SBW in May of 2016. Extra seed packets were buried, which means the trial can run as long as ten years, if needed. Sediment barriers or jute matting will be placed around the trial site to delineate it and prevent any packets from eroding out of the ground during heavy rain.

Aerial Spray Equipment

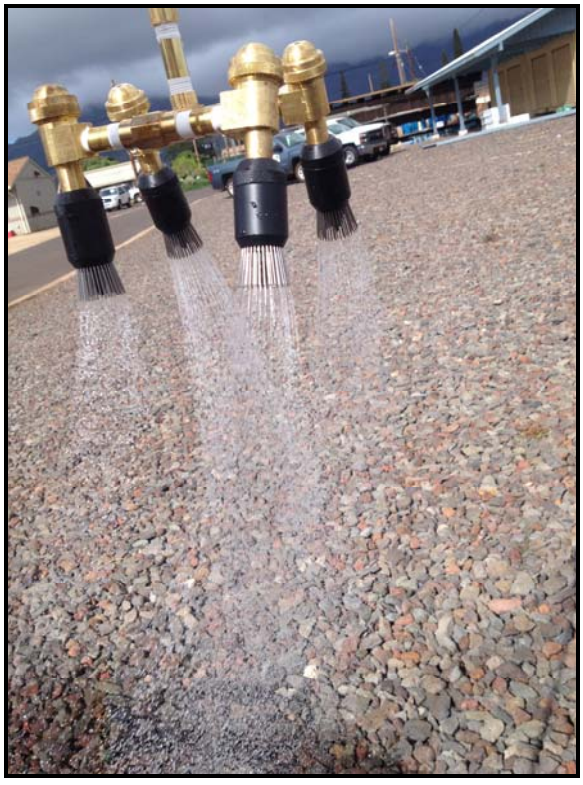
Aerial sprays are an efficient and effective way to control *C. odorata* in challenging terrain, over large areas. Over the past several years, staff worked with several different spray rigs and helicopter companies. Challenges with poorly maintained equipment, finicky parts, and occasionally poor spray coverage lead OANRP to build its own spray rig this year. This has greatly improved operational efficiency, minimizing time spent troubleshooting non-functional gear, improving re-filling time and overall sanitation. As a result, staff aerially sprayed a much larger area than ever before, 14.5 ha. The primary innovations of the system include: gravity fed spray ball (electric pump eliminated); high performance nozzles ($77 each); large filling port on tank; improved bottom drain allowing tank to empty completely; affordably priced irrigation solenoid ($25-35); large door on spray ball; appropriately placed filters; and increased hose diameter from tank to spray ball.

In the coming year, staff will draft a PCSU technical report detailing the design of the spray rig.

Above: the spray rig is attached to the helicopter via the belly hook and cushioning arms. The light colored tank allows staff to gauge how much spray mix is left. A large top port allows for easy filling.

Below left: the sprayer is encased in a 1” thick PVC pipe. The large door allows for easy access to the spray nozzles, solenoid, and other parts. The nozzles are protected by a recycled cutting board.

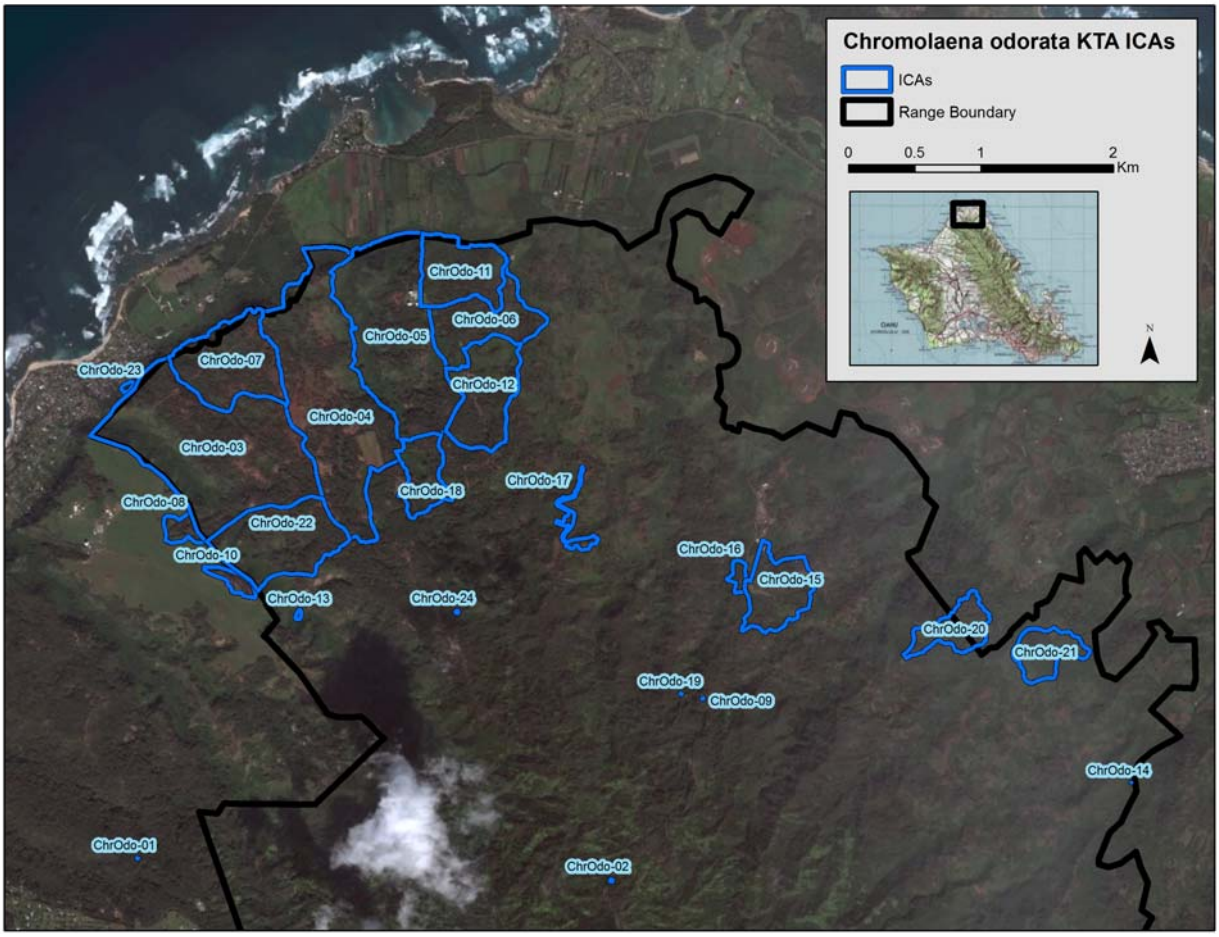
Below right: High quality Accu-Flo™ nozzles create large droplets, reducing potential drift.



KTA Update

Control efforts at KTA account for 33% 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 3-5 and 3-6 for a summary of OISC's work, including maps of areas treated this year.

C. odorata Incipient Control Areas at KTA

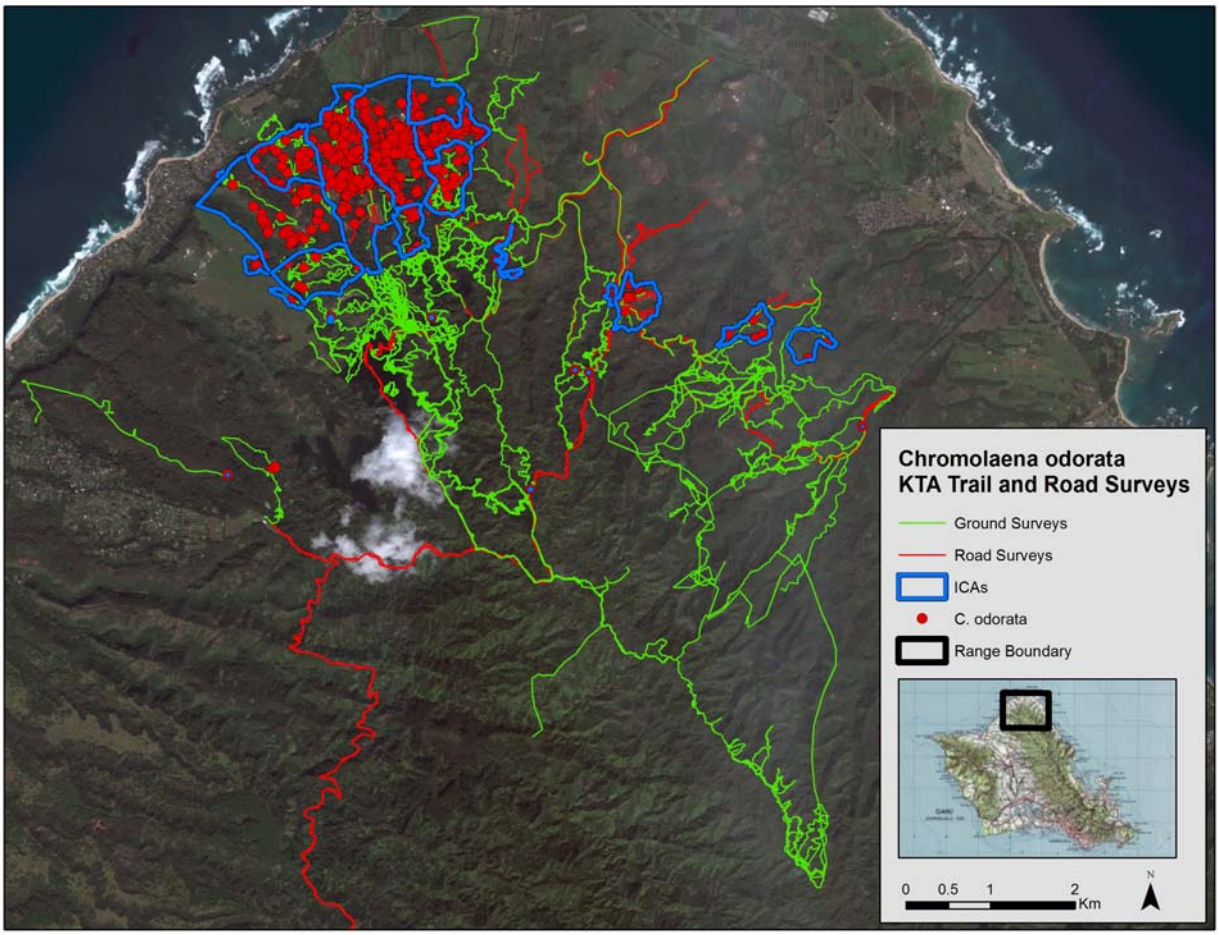


- Over the last few years, staff surveyed almost all of the trails (motocross, Army training, etc.) in KTA; see 'Trail and Road Surveys at KTA' map below. A systematic effort was made to check every loop and side-trail, no matter how convoluted. Since *C. odorata* is known to disperse easily along roads and trails, completing these surveys was a priority for mapping the infestation. From 2014 to June 2016, staff walked 675 km of trail. This effort was complemented by annual road surveys. Several new ICAs were found.
- The lands makai of KTA have *C. odorata*'s preferred open, disturbed habitat, are directly adjacent to the infestation, and have not yet been systematically surveyed. In 2011-2012, HDOA surveyed roads and agricultural fields bordering the highway, but the bluff between the fields and KTA plateau had not been surveyed. Staff completed two surveys in this bluff region this year; see 'Makai Surveys at Kahuku' map below. One was on Waialaee Agricultural Research Station, directly north of ICA #7. The only plants found were at the top of the bluff, near known hotspots; none were seen on the densely vegetated slopes. The other survey was a joint effort with OISC, and took place on private land north of ICA #3. One *C. odorata* location was found in the lower half of the property, but all other plants found were in previously known hotspots. Thick

vegetation limits visibility on ground surveys. In the coming year, staff hope to complete surveys at Waialee and conduct aerial surveys along the entire northern edge of the *C. odorata* infestation.

- Staff also surveyed several small fences installed by the Cultural Resources office around sensitive sites near the CACTF, as they are adjacent to ICAs #15 and 16. No plants were found.

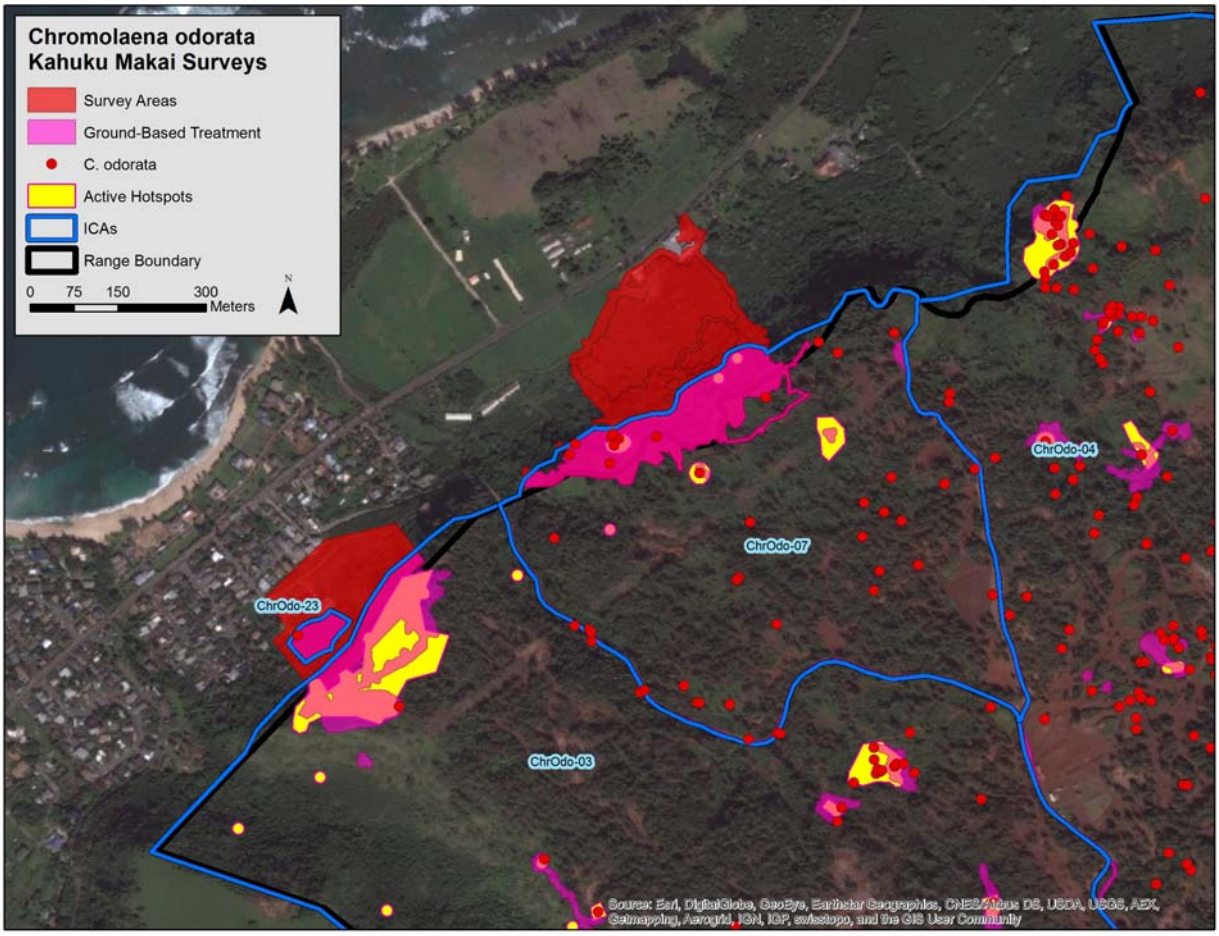
Trail and Road Surveys at KTA



- Four new ICAs were discovered this year, numbers 21-24.
    - ICA #21: Staff found this location during motocross trail surveys. Plants were found along an unsanctioned bulldozed road. Range Control was notified, but OANRP does not know if any investigation was completed. Most of the *C. odorata* were found in one location, with just a few plants located on an adjacent trail. Control efforts are underway.
    - ICA #22: Plants were found during motocross trail surveys at several locations in Kaunala gulch, just south of the official motocross park. The area is heavily used. Treatment has begun, and hotspots will be created at two sites.
    - ICA #23: OISC and OANRP conducted a joint survey of private land makai of the training range, in the Kaunala area. Only a couple plants were found on the makai end of the property; the rest were contiguous with a known hotspot already receiving treatment. OISC will conduct follow-up monitoring with the landowner.
    - ICA #24: A lone mature plant was discovered growing along the Pahipahialua *Eugenia koolauensis* fence. Unfortunately, it had set seed. Motocross trails in the surrounding area

had previously been surveyed, so this is likely a recent dispersal. Staff will scope the surrounding area for additional plants.

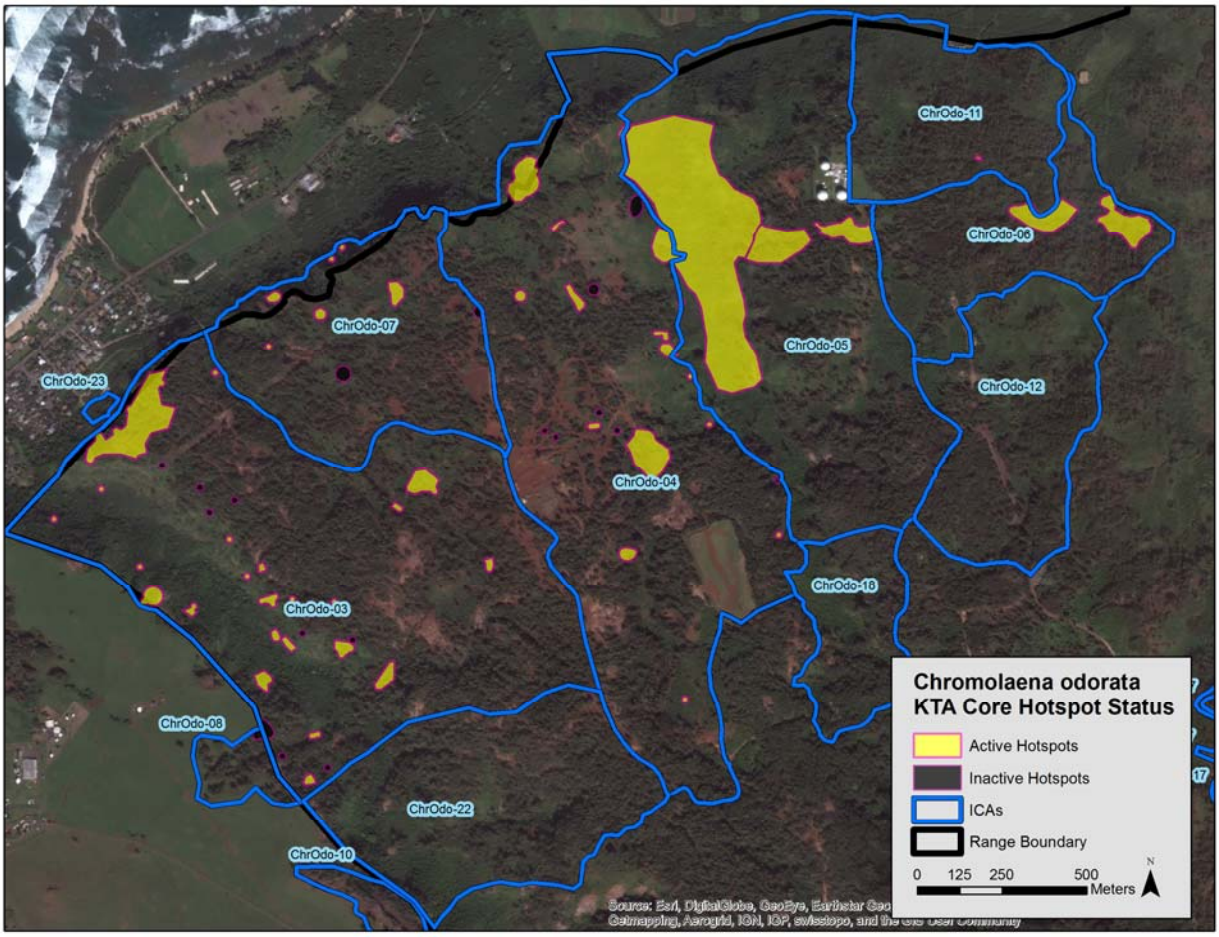
Makai Survey Areas at Kahuku



- The *C. odorata* infestation covers 580 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 priority motocross area. Instead, different strategies are employed in different ICAs. The core of the infestation is divided between ICAs # 3, 4, 5, and 7. The other ICAs are either on the fringes of the core, or represent distinct infestations, or are discrete outliers.
    - ICAs #3, 4, and 7 are swept twice a year by OISC. Hotspots are drawn around high densities of plants and OANRP sprays them with pre-emergent herbicides. OISC and OANRP share updates on these hotspots via a detailed google spreadsheet. This rigorous approach has resulted in several hotspots being deemed inactive (little to no recruitment seen for two years). See 'Active and Inactive Hotspots in Core ICAs' map, below.
    - ICA #5 contains the densest infestation of plants. Parts of it are treated aerially and parts are swept on the ground. The northern section of the ICA still needs to be surveyed.
    - ICA #6 is swept once a year, with hotspots treated once or twice a year, as needed.
    - ICA #11 has few plants. The northeastern section still needs to be swept. Once delineated, the boundary may be redrawn.

- ICA#12, 18 and 22 are large, but have low densities of plants. Staff monitor all trails and roads within them, but do not regularly conduct sweeps across them. This approach is somewhat effective, but record numbers of plants were found in ICA #12 this year. Next year, staff hope to complete aggressive sprays at new hotspots and conduct select sweeps.
- ICAs #15, 16 and 17 all have relatively small but persistent populations. Few plants were found this year. Staff check all roads and trails within these ICAs, but do not sweep them.
- ICAs #20 and 21 also have low densities of plants. Staff monitor known hotspots, trails and roads. Additional sweeps may be conducted as time becomes available.
- ICAs #1, 2, 9, 19, 14, 24, and 13 are small outlier sites. These are monitored regularly. ICA #13 has not received regular attention, due to its remote location.
- ICAs #8, 10 and 23 are on private land. OANRP will assist OISC with surveys and sprays in these areas as requested.

Active and Inactive Hotspots in Core ICAs



- All control efforts are summarized in the 'KTA Control Efforts' table below. Area, effort and number of visits are reported for the 2016 and 2015 report years. Note that the 2016 report year covers twelve months, while the 2015 report year only covers nine months. Numbers of plants controlled this report year are contrasted to the total number of plants removed to date. The number of immatures includes both immature and seedling plants. Note that during all aerial and some ground sprays, the number of plants treated is an estimate.

KTA Control Efforts

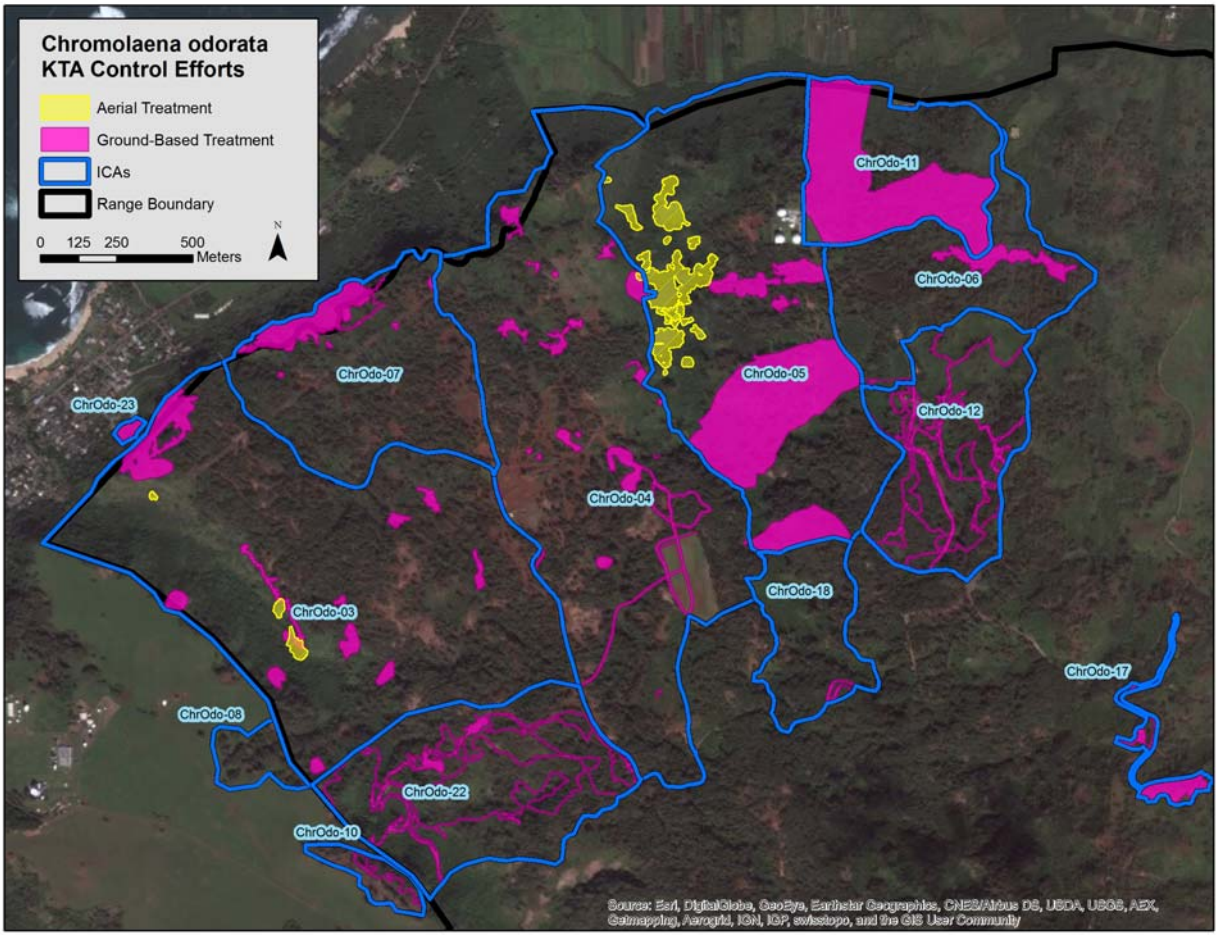
ICA Code	ICA Area (ha)	2016 Report Year			2015 Report Year			2016 # Plants Treated		Total # Plants Treated		Type and Strategy
		Area Weeded (ha)	Effort	# Visits	Area Weeded (ha)	Effort	# Visits	# Mat.	# Imm.	# Mat.	# Imm.	
WaimeaNoMU-ChrOdo-01	64 m²	63 m²	2.5	2	64 m²	1.5	2	0	0	0	1	Outlier
KTA-ChrOdo-02	328 m²	328 m²	0.5	1	328 m²	3	3	0	0	0	1	Outlier
KTA-ChrOdo-03	118.43	7.06	216.5	15	2.23	60.75	5	282	2,857	747	4,237	OISC Contract + OANRP hotspot
KTA-ChrOdo-04	111.63	6.77	107	12	4.56	66.7	6	50	751	864	4,150	OISC Contract + OANRP hotspot
KTA-ChrOdo-05	89.23	25.62	228	17	29.49	177	10	3,745	6,123	6,911	19,112	Sweep + Hotspot + Aerial spray
KTA-ChrOdo-06	29.73	1.9	32.5	2	27.14	92.75	7	37	478	2,292	12,887	Sweep + Hotspot
KTA-ChrOdo-07	41.26	4.72	59.35	6	0.73	13.5	2	55	129	205	273	OISC Contract + OANRP hotspot
AimuuNoMU-ChrOdo-08	4.59	0	0	0	0	0	0	N/A	N/A	N/A	N/A	Private Land. OISC.
KTA-ChrOdo-09	78 m²	78 m²	1.5	2	78 m²	2	2	0	0	1	1	Outlier
AimuuNoMU-ChrOdo-10	3.73	0.36	1	1	78 m²	1.5	1	0	8	0	8	Private Land. OISC.
KTA-ChrOdo-11	28.74	17.98	40	2	0	0	0	29	21	31	38	Sweep + Hotspot
KTA-ChrOdo-12	34.69	6.02	37	3	4.55	12.5	3	272	738	357	1,116	Trails + Roads + Hotspots + Sweep
KTA-ChrOdo-13	0.23	3 m²	0.25	1	0	0	0	1	0	1	0	Outlier/Hotspot
KTA-ChrOdo-14	6 m²	6 m²	1	2	6 m²	2.5	2	0	0	1	0	Outlier
KTA-ChrOdo-15	23.51	3.58	11.25	4	1.48	4	2	1	7	12	63	Trails + Roads + Hotspots
KTA-ChrOdo-16	2.2	0.79	0.75	1	0.13	1.5	2	0	0	1	5	Trails + Roads + Hotspots
KTA-ChrOdo-17	3.14	2.67	4.75	2	1.3	2	2	0	2	2	10	Trails + Roads + Hotspots
KTA-ChrOdo-18	16.43	0.23	2.5	2	275 m²	2.5	2	0	9	3	52	Trails + Roads + Hotspots
KTA-ChrOdo-19	78 m²	0	0	0	0	0	0	N/A	N/A	0	1	Outlier

ICA Code	ICA Area (ha)	2016 Report Year			2015 Report Year			2016 # Plants Treated		Total # Plants Treated		Type and Strategy
		Area Weeded (ha)	Effort	# Visits	Area Weeded (ha)	Effort	# Visits	# Mat.	# Imm.	# Mat.	# Imm.	
KTA-ChrOdo-20	14.72	3.07	10.25	4	N/A	N/A	N/A	3	64	3	64	Trails + Roads + Hotspots
KTA-ChrOdo-21	13.93	11.38	23	4	N/A	N/A	N/A	51	120	51	120	Trails + Roads + Hotspots
KTA-ChrOdo-22	43.8	4.8	24.5	4	N/A	N/A	N/A	15	164	15	164	Roads + Trails + Hotspots
KahukuLaie-ChrOdo-23	0.48	0.48	2.75	2	N/A	N/A	N/A	2	0	2	0	Private Land. OISC manage?
KTA-ChrOdo-24	63 m²	18 m²	0.1	1	N/A	N/A	N/A	1	0	1	0	Outlier
TOTALS	**580.57**	**98.1**	**807**	**90**	71.72	443.7	51	**4,544**	**11,471**	11,500	42,303	

Left: surveying dense *Schinus terebinthifolius* slopes with binoculars. Right: aerial spray in progress in Pahipahialua gulch.

- This year, 6.36 ha were sprayed aerially and 91.89 ha were treated on the ground, for a total of 98.24 ha of *C. odorata* controlled. The map below shows aerial and ground control efforts across the primary infestation. Last year, only 3.98 ha was aerially sprayed. Improved aerial spray equipment contributed to this increase, as less time was needed to troubleshoot gear. The new spray rig provided better herbicide coverage and thus better control. Staff were able to treat much of the core in ICA #5 more than once, and have effectively knocked it down. About 6.1 ha were aerially treated in ICA #5. Remote hotspots in ICA #3 were also aerially sprayed; about 0.3 ha were treated. These locations are very difficult to reach with spray equipment from the ground. In the coming year, staff plan to expand aerial treatment of remote hotspots and maintain pressure on the core. To facilitate this, staff and OISC will mark remote hotspots with orange flagging to make them easier to locate from the air.

Aerial and Ground Treatment in the KTA Core Infestation



- Control efforts at most of the outlier ICAs have been successful. No plants were found at ICAs #1, 2, 9, or 14 this year. All have been monitored regularly over the years, since discovery, with no additional plants found. At ICAs #1 and 2, one immature plant was found at each site in 2011. At ICA #9, one mature and one immature were found 2013 and at ICA #14 one mature was found in 2014. Staff will monitor these sites once year, for at least five to seven years after the last plant was seen, or until more information is known about seed longevity. More regular checks at ICAs #13 and 19 are needed.

Gray-brown dead *C. odorata* and alien grasses, treated via aerial spray. Patches of blue indicate freshly treated areas.

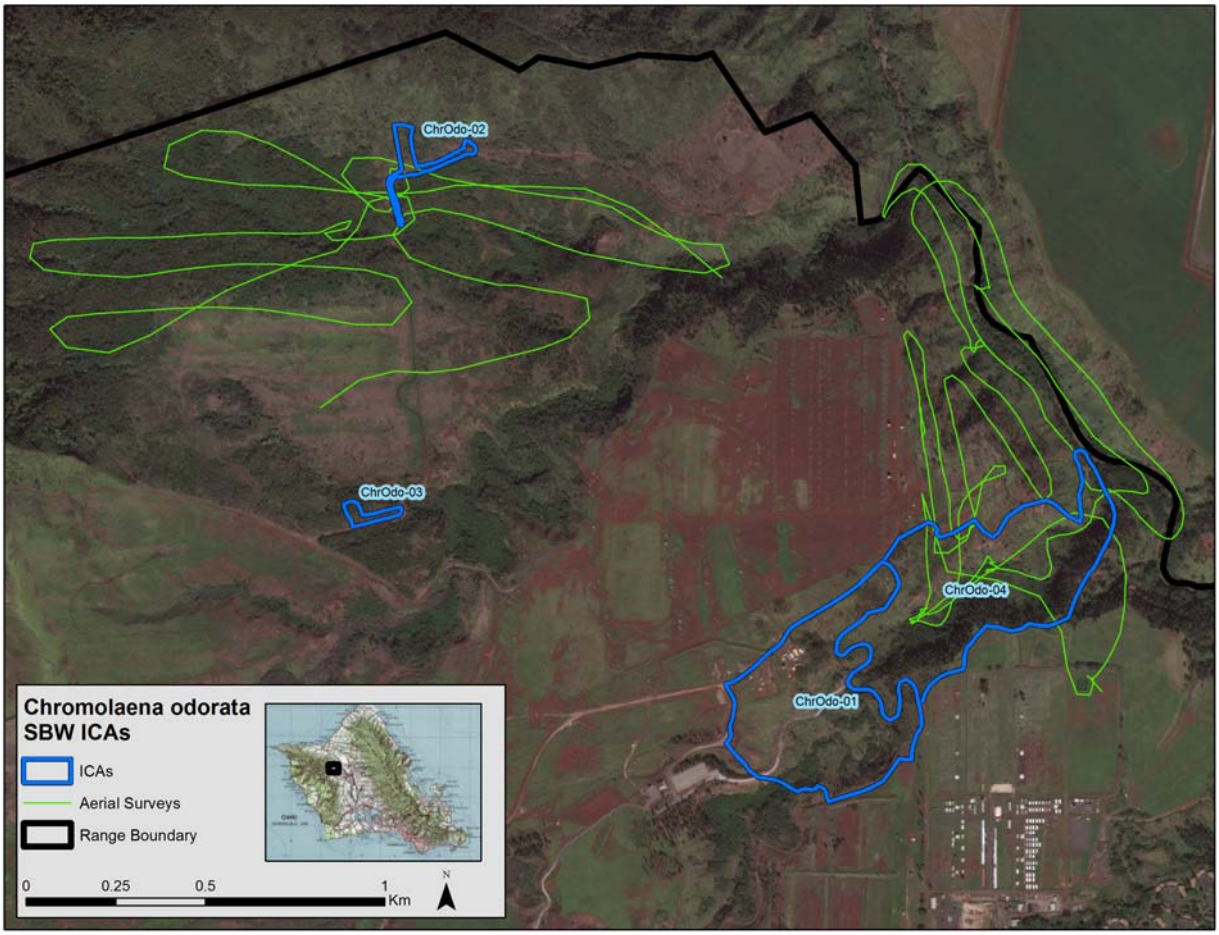
SBW Update

Control efforts at SBW are limited by range availability and the need for a 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 2016 and the map below shows the locations of the ICAs.

SBW Control Efforts

ICA Code	2016 Report Year				2015 Report Year		
	ICA Area (ha)	Area Weeded (ha)	Effort (hours)	# Visits	Area Weeded (ha)	Effort (hours)	# Visits
SBWNoMU-ChrOdo-01	19.52	14.77	56	9	1.23	23	5
SBWNoMU-ChrOdo-02	1.10	0.73	7.5	4	0.70	5	3
SBWNoMU-ChrOdo-03	0.49	0.40	6.5	4	0.49	20	3
SBWNoMU-ChrOdo-04	23.34	11.66	140.5	19	3.66	24.5	5
TOTAL	**44.45**	**27.56**	**210.5**	**36**	6.1	72.5	16

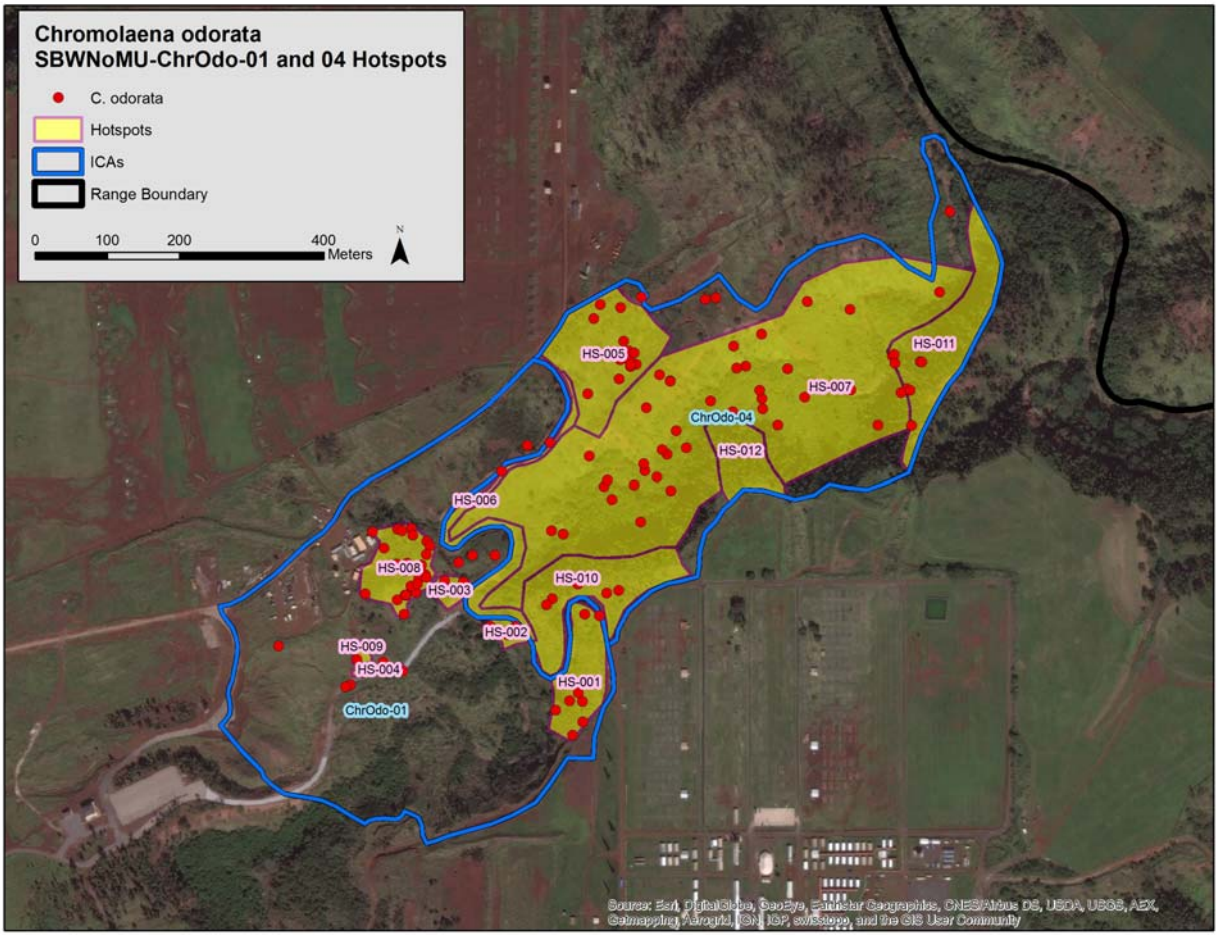
C. odorata Incipient Control Locations and Aerial Surveys at SBW



- No new *C. odorata* sites were found on SBW this year. All training roads were surveyed across SBW, SBS, and Wheeler. This is the first ever survey for Wheeler, and the first complete survey of SBS in over five years, and the most complete coverage of the greater Schofield Barracks area to date. One aerial survey was conducted; all plants seen were already in ICAs.

- As described in section 3.3, signage was installed in ICA #4 to prevent soldiers from entering infestation areas. Staff also maintained 'no mowing' signs and cones in ICA #1; these reduce the likelihood of *C. odorata* spread via road maintenance work.
- ICA #1 encompasses the western portion of the primary *C. odorata* infestation. Most of it is dominated by tall, dense stands of *Urochloa maxima*. This grass appears to be so thick in the area that *C. odorata* does not readily colonize it, unless some type of disturbance creates bare ground. Instead, most *C. odorata* is clustered along roads, around stands of *Eucalyptus* and *Casuarina*, or on open slopes. To facilitate control, geographic hotspots were designated around concentrations of plants, see maps below. These areas were surveyed and treated regularly and aggressively with pre-emergent herbicide. Staff scoped the remaining grass slopes via ground-based binocular surveys. This strategy appears to be effective, with 38 mature, and 452 immatures and seedlings removed this year. A total of 178 mature and 1,294 immature/seedling plants have been removed since discovery in 2013. The northernmost finger of the ICA was not treated this year; this is a priority for control next year, as incidental observations suggest plants are present.

Hotspots in SBW Core ICAs

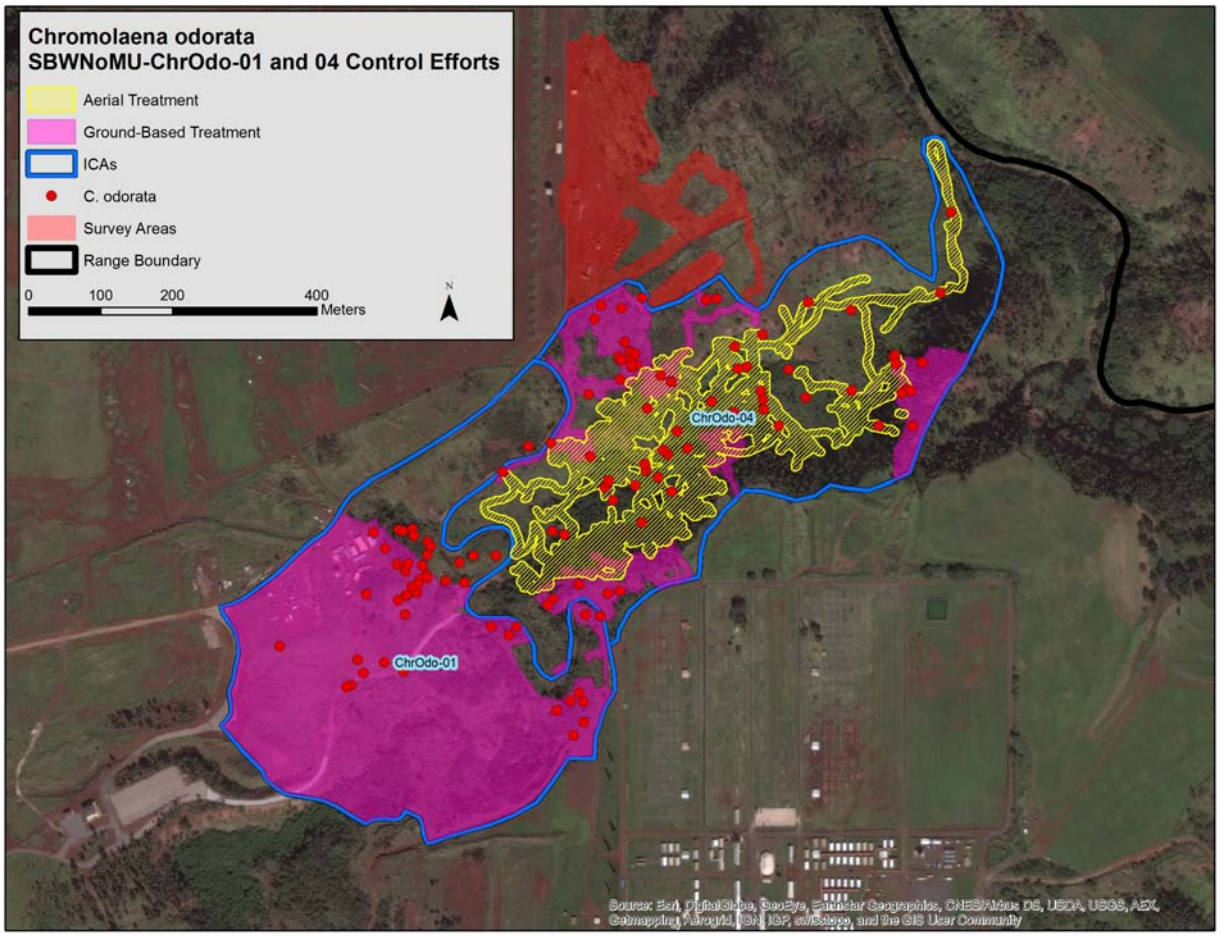


- ICA #2 is a discrete, outlier infestation. This site continues to have a small but persistent population, with 3 mature, 17 immature, and 8 seedling plants controlled this year. A total of 15 mature, 39 immature, and 11 seedlings have been removed since initial discovery in 2014. This suggests a seed bank formed at the site. Last year, two immature plants were found along the road, expanding this ICA. No plants were found along the road this year. Staff used pre-emergent herbicide twice a year from 2014-2016; more frequent application may be needed.

Also, more aggressive grass control may help by allowing staff to more easily survey the entire ICA and improve confidence that all plants present have been treated.

- ICA #3 is also a discrete, outlier infestation. When discovered in 2014, this site had tall *C. odorata* twining into the canopy. Despite this, relatively little recruitment has been seen. This year, 31 immature and 12 seedlings were controlled. A total of 7 mature, 42 immature, and 12 seedlings have been removed since 2014. The last mature was found in December 2014. Control efforts have been successful in suppressing maturation thus far. Additional grass control in the area will allow staff to more easily survey the area.

Aerial and Ground Treatment in SBW Core Infestation



- ICA #4 covers the eastern portion of the primary *C. odorata* infestation, including the core. The terrain here is difficult, as the area is a steep-sided gulch dominated by dense grass, with a high UXO hazard. As in ICA #1, hotspots were drawn around concentrations of plants. Some of the hotspots are treatable from the ground, but the largest, Hotspot 7 is best treated via aerial sprays. The strategy at ICA #4 was to treat all accessible areas from the ground, while aerially spraying and surveying the remainder of the area. This year, 8.14 ha were aerially sprayed, and 4.38 ha were treated on the ground. In contrast, only 4.1 ha were aerially sprayed last year. All known *C. odorata* were sprayed at least once this year; this is a big milestone. The map above shows both ground and aerial control for the past year. In the coming year, staff plan to continue aerial sprays and scout new routes into the ICA from the south.

Above: brown, aerially sprayed areas are sandwiched between *Casuarina* trees and green grass.

Below: dead *C. odorata* and grass on the slope seen in the photo above.

Above: dead, aerially sprayed grass is visible through a stand of *Eucalyptus*.

Below: dead *C. odorata* and other invasive shrubs on the slope in the photo above.

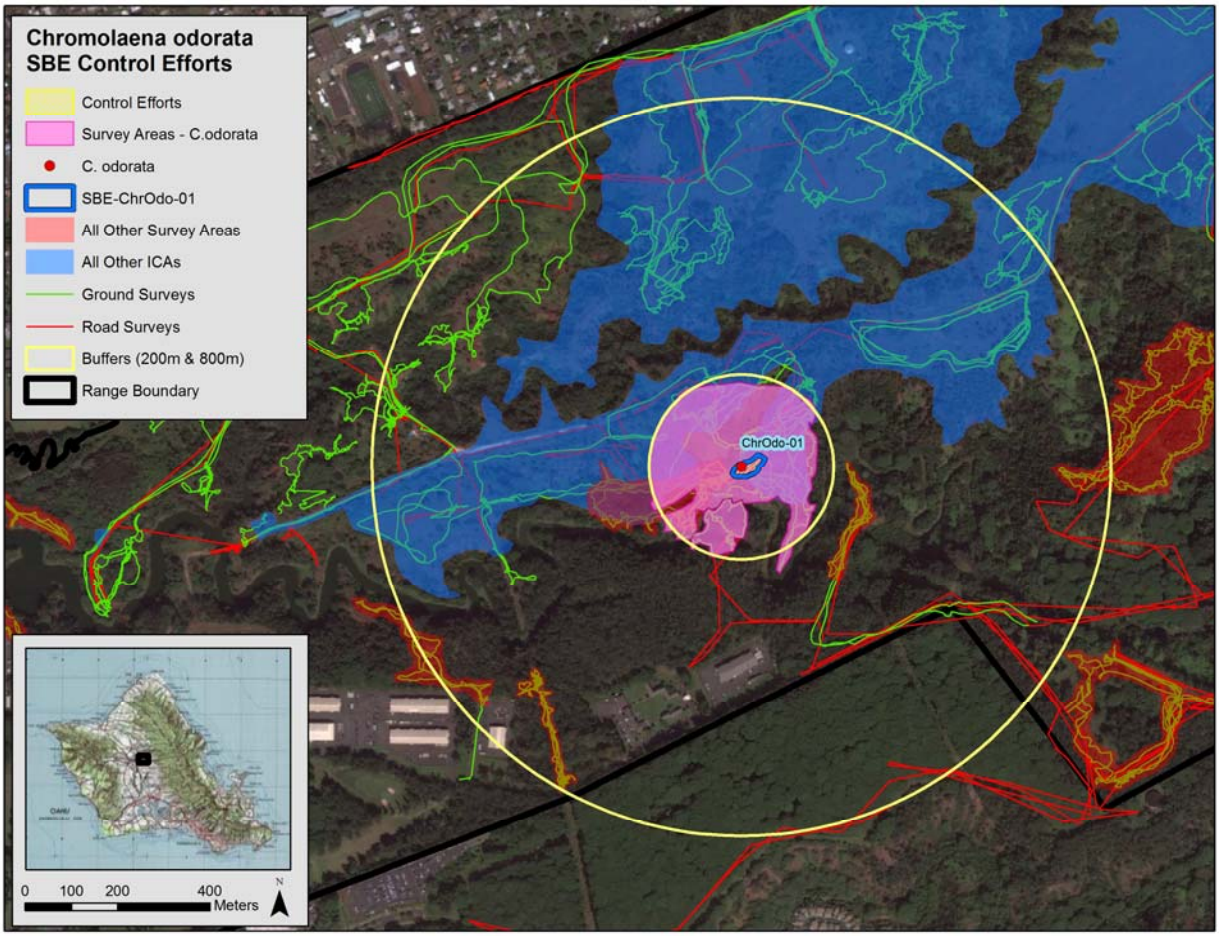
SBE Update

In October 2014, while conducting surveys for another incipient target at SBE, *Schizachyrium condensatum*, staff stumbled upon a small patch of immature *C. odorata*. This is the third Army Training Range with a *C. odorata* infestation. Control efforts are summarized in the table below.

ICA Code	2016 Report Year				2015 Report Year		
	ICA Area (ha)	Area Weeded (ha)	Effort (hours)	# Visits	Area Weeded (ha)	Effort (hours)	# Visits
SBE-ChrOdo-01	0.18	0.18	12.25	7	0.14	8.4	3

No additional plants were found in the last year. Only 15 plants have been seen at the site: 14 immatures in October of 2014 and 1 mature in February 2015. A 200 meter buffer around the infestation site was completed last year. The map below details survey and control efforts at the site. Since no plants were found, additional surveys in the 800 meter buffer were not necessary. Much of SBE is surveyed or swept regularly. Road surveys are conducted once a year and include all drivable trails. Large areas are regularly surveyed in the course of ICA control work on *S. condensatum* and *R. tomentosa*. The map below shows areas swept and survey tracks completed following the discovery of *C. odorata* in 2014; while *C. odorata* was not the primary target of these efforts, it is likely any large patches of plants would have been discovered. Staff are confident that there currently are no other *C. odorata* sites at SBE.

***C. odorata* Control Efforts at SBE**



This ICA is located near powerline poles. Along with OISC, staff met with HECO representatives to discuss invasive species sanitation concerns. HECO indicated that their crews did wash vehicles after working in SBE. HECO is looking into making policy changes which will require their field crew and vegetation management contractors to follow sanitation guidelines, but indicated that this would take some time to institute.

This ICA will continue to be monitored regularly for at least five years after the date of the last mature plant found. Given no recruitment has been seen, it is possible the site was controlled before a seed bank was formed.

References Cited

Day MD, Winston RL (2016); Biological control of weeds in the 22 Pacific island countries and territories: current status and future prospects. In: Daehler CC, van Kleunen M, Pyšek P, Richardson DM (Eds), Proceedings of 13th International EMAPi conference, Waikoloa, Hawaii. NeoBiota 30: 167–192. doi: 10.3897/neobiota.30.7113

Reddy, G.; Kikuchi, R.; and Muniappan, R. The impact of *Cecidochares connexa* on *Chromolaena odorata* in Guam. Proceedings of the Eighth International Workshop on Biological Control and Management of *Chromolaena odorata* and other Eupatorieae, Nairobi, Kenya, 1-2 November 2010.

Managing *C. odorata* requires patience and optimism

3.7 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 several IP taxa dwell. 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 Appendix 3-9). The trial, installed at MMR, adjacent to the *C. setaceus* infestation, found that while initial germination of seeds was high (92%), after ten months germination had declined to 0%. A simultaneous lab trial showed that the seeds germinate in the absence of light, confirming that the seed bank is transient. This means that the taxon is eradicable, particularly from discrete infestations, and OANRP has indeed successfully eradicated it from three separate sites, one each at DMR, KTA, and now SBE. 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. The table below summarizes control efforts for this year. Not included in the table is ICA KeaauNoMU-CenSet-03, which is on private land and is managed by OISC. OANRP assists with control at this ICA as requested by OISC; no OANRP time was spent here this report year.

C. setaceus Control Efforts

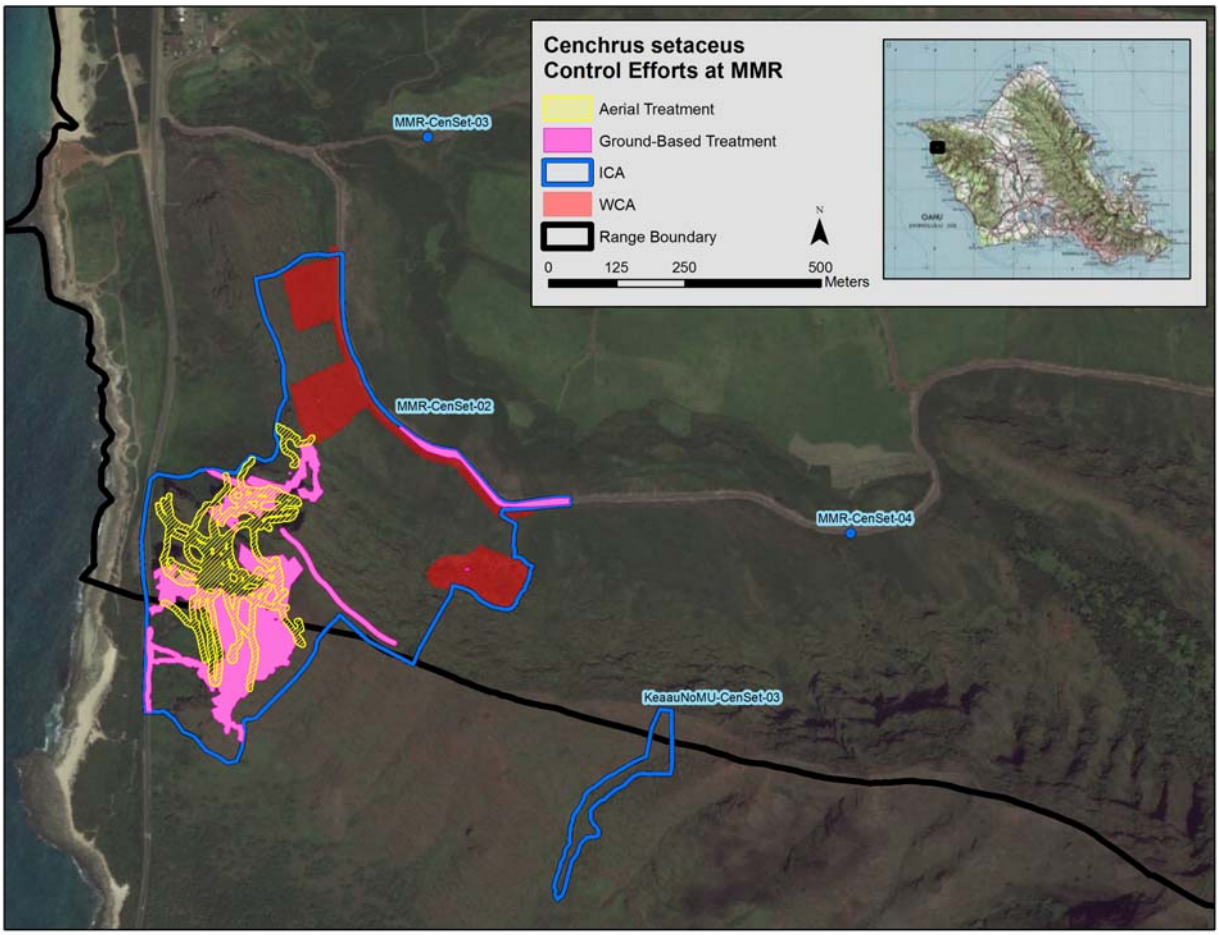
ICA	ICA Total Area (ha)	Area Weeded (ha)	Effort (hours)	# Visits	Comments
KTA-CenSet-02	0.1 (960m^2)	0.1 (960m^2)	4	2	Last plants were seen in 2013. This is a small site, with only small numbers found following initial discovery and control of 16 matures and 63 immatures. If no additional plants are found, this site will be declared eradicated in early 2017.
KTA-CenSet-03	0.77	0.38	3.75	2	Last plants were seen in February 2015. Quite a few plants were found here when it was first discovered: 84 mature and 42 immature. Fortunately, few plants were found on follow-up visits. The entire ICA needs to be swept thoroughly in the coming year.
MMR-CenSet-02	31.7	8.39	78.52	9	This is the largest infestation on Army land, and the largest in the Waianae Mountains.
MMR-CenSet-03	0.01 (78m^2)	0.01 (78m^2)	1.75	2	Three mature and nine immature plants were discovered and removed in January 2016. Plants may have been dispersed here by wind or vehicle.
MMR-CenSet-04	0.01 (78m^2)	0.01 (78m^2)	1	2	Discovered and removed in January 2016. Only 1 mature plant was seen, growing in the mowed area bordering the firebreak road. Plants may have been dispersed here by wind or vehicle.
SBE-CenSet-01	0.001 (15m^2)	0.001 (15m^2)	0.25	1	Eradicated. Staff monitored it this year anyway. This site is along a well-used training road. The likely dispersal source was a contaminated vehicle from PTA
SBE-CenSet-02	0.01 (98m^2)	0.01 (98m^2)	1	2	No plants have been found since 2012. Since monitoring intervals have not always been regular, one more check is needed before declaring this ICA eradicated. This site is along a well-used training road. The likely dispersal source was a contaminated vehicle from PTA.
TOTAL	**32.62**	**8.9**	**90.27**	**20**	

Of the remaining six active *C. setaceus* infestation sites, two are within six months of being declared eradicated (SBE-CenSet-02 and KTA-CenSet-02). The remaining KTA site, 03, is on track for eradication, with no plants found this report year. Given that *C. setaceus* is widespread at PTA, and well-established along at least two popular Oahu hiking trails on the southeastern part of the island, it is likely future infestations will be found. Sanitation measures are in place to clean military vehicles leaving PTA, but there is currently no effective way to sterilize recreational hikers.

MMR Status

The bulk of *C. setacus* management time and effort this year were spent at the MMR infestation.

Incipient Control Area Locations and Aerial and Ground Control Treatment in MMR

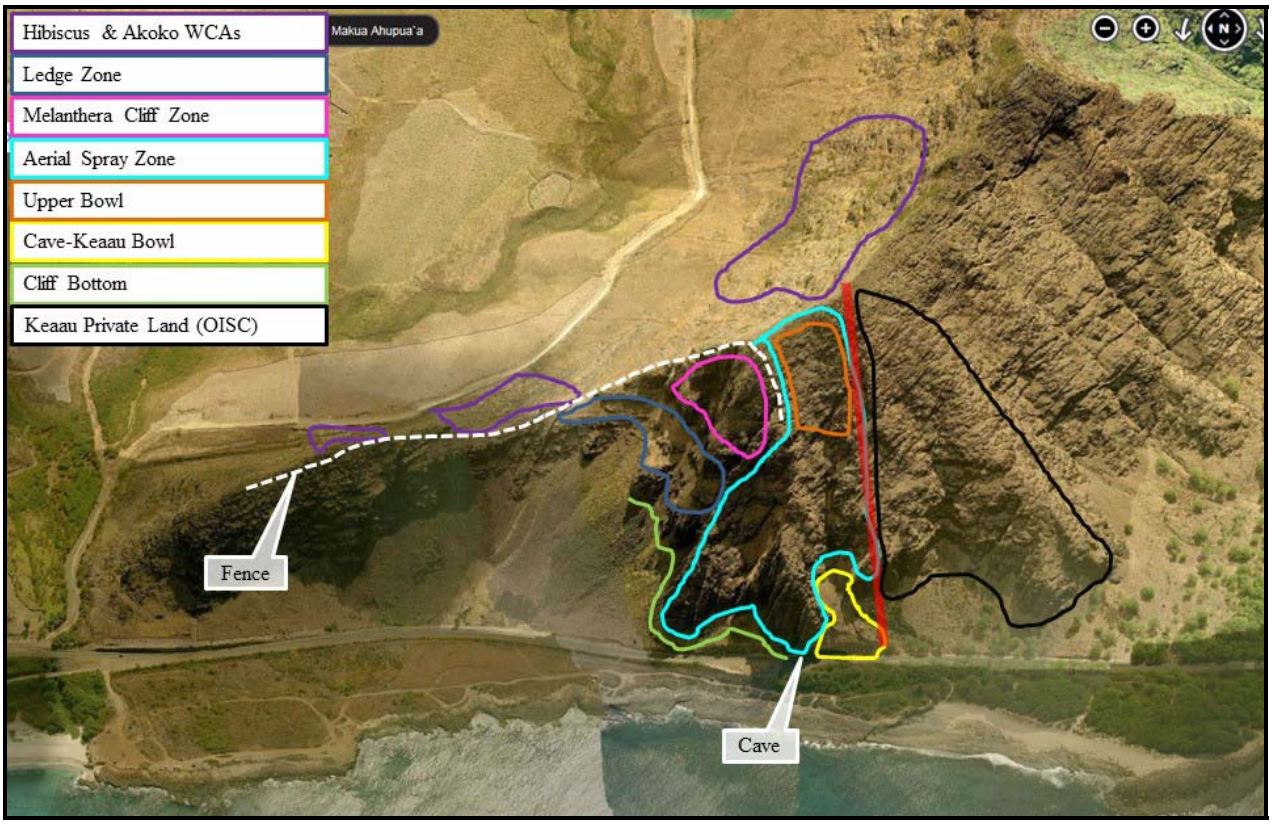


- Unfortunately, two new outlier sites were discovered, ICAs #3 and 4, see map above. Both are located in areas along roads which are regularly mowed and sprayed to reduce fire risk. While discouraging, it is unsurprising that *C. setaceus* is taking advantage of open, disturbed areas. Staff have seen this before, with plants regularly found in the Ohikilolo Lower WCAs, where grass and other herbaceous weeds are managed around rare taxa. It is ironic that clearing creates areas readily colonized by *C. setaceus*, but fortunately open areas also are easier to survey and monitor. OANRP reached out to the contractors who do the mowing, and learned that their equipment stays on site, and also that the mowed areas are sprayed with herbicide. OANRP decided there was limited risk of further spread due to contractor work at the new ICAs, due to the aggressive control they perform and the potential for *C. setaceus* to germinate in any

disturbed area. Photos of *C. setaceus* were sent to the contractor and OANRP requested they report any sightings.

- In the coming year, OANRP plans to conduct aerial and ground-based surveys across MMR, to ensure there are no additional *C. setaceus* outliers. It has been five years since similar surveys were completed following the discovery of *C. setaceus* at MMR in late 2011.
- The primary *C. setaceus* infestation is entirely within ICA #2. 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. The photo below details different Control Regions within ICA #2 which require different actions. The red line estimates the boundary between MMR and private land in Keaau. The control strategy at ICA #2 is as follows:
    - Treat the core of the infestation, which is in the Aerial Spray Zone (light blue), focusing on the densest clusters of *C. setaceus* first to maximize total number of plants killed and pilot efficiency (top priority). Where feasible, follow-up with ground-based control, particularly in the Upper Bowl (orange). Once numbers have been reduced in the core, aerially treat plants throughout this zone. Spotters were not useful in initial knockdown, but will be useful during follow up control.

MMR-CenSet-02 Control Regions



- From the ground, treat all walkable portions of the infestation. This includes the Ledge Zone (dark blue), Cave-Keaau Bowl (yellow), and Cliff Bottom (light green). Also, any plants seen along the fenceline.
- During the course of WCA control work, treat any *C. setaceus* found in the Hibiscus and Akoko WCAs (purple).

- Monitor the Melanthera Cliff for *Melanthera tenuifolia*, an IP taxon which dies back seasonally. Treat *C. setaceus* from the ground or aerially, ensuring minimal risk to *M. tenuifolia*.
- Survey the grassy zones between the WCAs, between the fence and highway, and all other areas not in a Control Region once a year. Seek out vantage points and use binoculars to get thorough survey coverage.
- Assist OISC, as requested, in the Keaau Private Land area (black). No herbicide may be used in this area, per landowner directive.
- Develop alternative technologies to reach *C. setaceus* that cannot be treated either from the ground or with the aerial spray rig.

- Management was conducted in almost all of the Control Regions this year, with the exception of the Melanthera Cliff and Cliff Bottom. These regions were lower priority than other regions due to the comparatively fewer number of plants present in them. Also, the grassy area outside of the Control Regions was not surveyed, with the exception of the area between Farrington Highway and the fence, from the Melanthera Cliff in the south to the Akoko WCAs in the north. Binocular surveys of this roadside area revealed a couple plants growing along the illegal trail to the upper cave; these plants were removed. No other outliers were seen.
- Both ground-based control and aerial sprays were conducted at ICA #2 this year and are shown in the map above ('Incipient Control Area Locations and Aerial and Ground Control Treatment in MMR'). This year, 8.39 ha were treated in ICA #2. Of this, 4.11 ha were treated from the air and 5.89 ha were swept on the ground (ground and aerial treatments overlapped). Last year, 3.81 ha were swept, with 2.80 ha of aerial treatment and 2.42 ha of ground treatment (control areas overlapped). 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 last year, but expanded into outlying areas this year. The radiating extensions on the southern end of the aerial treatment shape represent surveys rather than sprays. 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 a survey across the Keaau Private Land region with OISC.

Aerial sprays at MMR

- One survey was conducted on private land on the southern end (Keaau Private Land) of the ICA, in conjunction with OISC. The landowner has prohibited the use of herbicides in this area, thus eliminating aerial sprays as a tool and limiting all control to hand-pulling. Prior to the survey, OANRP analyzed Gigapan® images of the Keaau area and used them to identify areas with suspected *C. setaceus*. Since this Keaau area is broken up by numerous ledges and cliffs, preventing systematic sweeps, the Gigapan analysis was helpful in directing ground work. OANRP will provide OISC with additional images as requested. In addition, OANRP will support OISC by providing rappel-trained staff to reach plants on cliffs, as OISC personnel do not currently have this training. Unfortunately, OISC faces challenges in securing funding for work on *C. setaceus* in the Waianae Mountains.

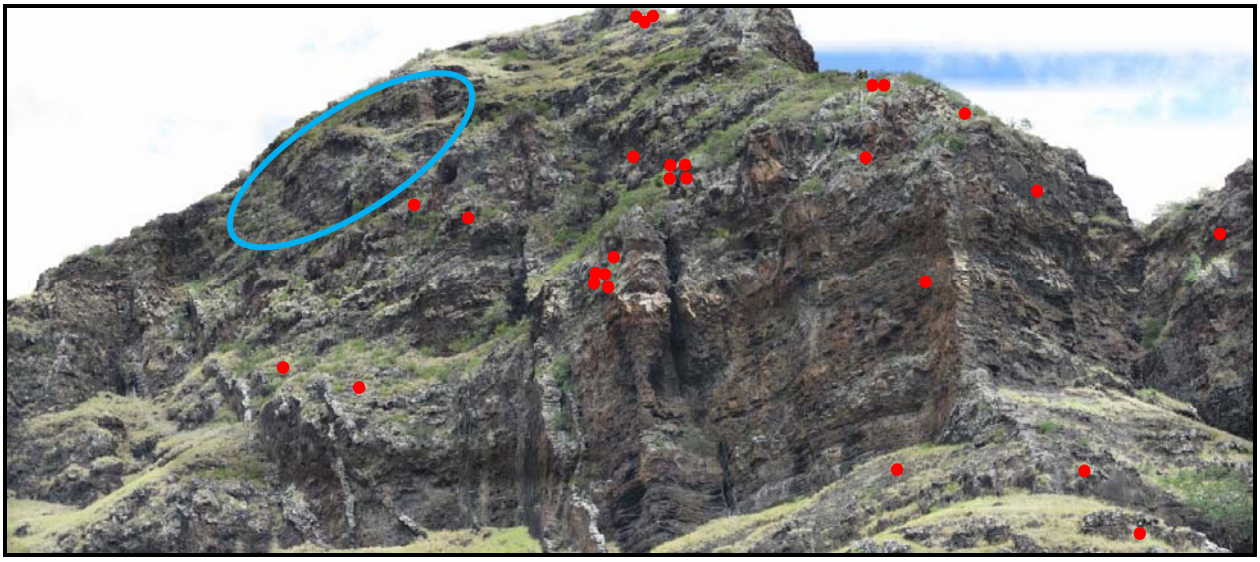
Taking a Gigapan of the *C. setaceus* infestation. The Gigapan unit must be close enough to the target area to zoom in and positively identify *C. setaceus*, but also far enough away to provide a landscape view.

- The efficacy of control in the core was analyzed using Gigapan® technology, and is discussed in Appendix 3-12. Overall, there has been a 78% reduction in *C. setaceus* cover in the core since control efforts began. The successful treatment of plants in the core has been an essential step towards controlling the population and reducing seed sources. However, in the monitored areas directly adjacent to the core, plant numbers did not decline significantly. While the monitored area represents only a small portion of the total infestation, these results jibe with staff observations, and make sense, given that the core has been the primary focus of aerial treatment efforts thus far.

- To achieve eradication, the entire ICA must be treated consistently. Now that the core is under control, in the coming year staff will continue to expand aerial control efforts across all steep zones. Spotters on the ground and in the helicopter will facilitate the identification and treatment of small and isolated plants. Multiple treatments of the same area will be necessary, as the detectability of isolated plants is low, even with spotters. After treated plants succumb to herbicide, aerial surveys and GigaPan imagery taken in conjunction with a GPS enabled rangefinder may provide helicopters and/or ground crews with GPS locations of any visible remaining living plants. While aerial sprays are an important tool, *C. setaceus* is much easier to detect on the ground than from the air. Wherever possible, ground-based surveys will be conducted to complement aerial efforts.

- In June 2016, GigaPan imagery (without GPS rangefinder) of the Melanthera Cliff region revealed dozens of *C. setaceus* scattered along the cliffs; see photo below. The imagery was reviewed by staff familiar with the *M. tenuifolia* population, and it was determined that no *C. setaceus* were in its immediate vicinity (circled in blue). Very little control has been performed in this region; some *C. setaceus* at the top of the cliffs were treated during initial surveys in 2011-2012. With assistance from a knowledgeable spotter, the pilot could spray the cliff areas adjacent

to the wild plant population, with limited risk of unintended negative impacts. If left untreated, the population of widely scattered *C. setaceus* along the adjacent cliffs will likely grow and may expand into the *M. tenuifolia* population area.



GigaPan image showing the area containing *Melanthera tenuifolia* (in blue), and surrounding cliffs with scattered *Cenchrus setaceus* (red dots). No *C. setaceus* control has occurred on these cliffs.The three red dots on the bottom right of the image in the Ledge Zone, and are controlled from the ground.

- The most recent complete census (2009; seven years ago) of the *M. tenuifolia* population found only 1 remaining live plant, which was in poor condition. Staff plan to re-monitor the *M. tenuifolia* site via rappel in the coming year. If *M. tenuifolia* plants are found, any *C. setaceus* spotted in the wild plant population would have to be treated by hand, on rappel. If no *M.tenuifolia* are found, aerial sprays will be considered if *C. setaceus* is spotted in the wild plant population site.
- 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 hope to 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.
- Surveying the grassy areas between Control Regions in ICA #2 is a priority for the coming year. A combination of aerial surveys, GigaPan images, binocular surveys, and GPS enable rangefinders will be used to ensure that outlying *C. setaceus* are not being missed. These surveys may be done in conjunction with the MMR-wide surveys also planned for next year.
- The illegal trail running from Farrington Highway to the upper Makua cave continues to be popular with hikers, despite 'No Trespassing' signage. Hikers may spread *C. setaceus* from MMR to other regions, or re-introduce it to MMR from other regions.
- With aggressive treatment, *C. setaceus* may still prove eradicable at MMR, as other incipient populations of have been successfully extirpated by OANRP.

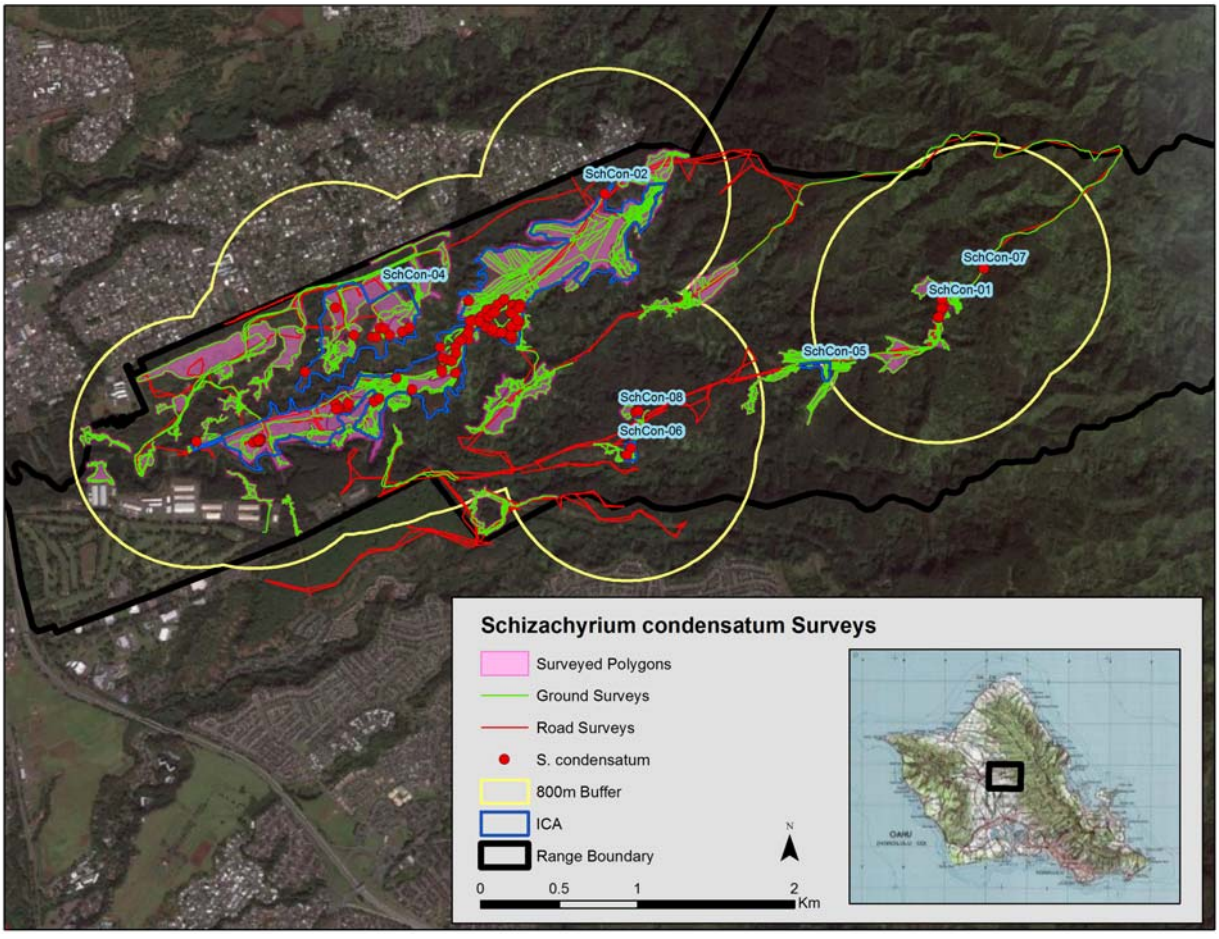
3.8 INVASIVE SPECIES UPDATE: *SCHIZACHYRIUM CONDENSATUM*, BUSH BEARDGRASS

The greatest challenges of managing *Schizachyrium condensatum* have been defining the size of the infestation, and preventing the taxon's spread via training and range maintenance activities.

Surveys

Defining the size of the *S. condensatum* was a priority this report year. Initially, 200m and 800m buffers were drawn around known plant points. These buffers covered much of SBE, and as additional plants were found, the buffers continued to grow. At the same time, staff conducting buffer surveys on the ground noted that *S. condensatum* was not observed growing in dense shade or banks of native fern *Dicranopteris linearis*. Rather, its preferred habitat was open and either grass-dominated or bare ground. Using digital imagery, this type of habitat was mapped across all of SBE, and these priority habitat zones were surveyed. This was more effective and time-efficient than trying to sweep across the entire 800m buffer. Surveys were documented using polygon and track shapefiles on ArcGIS. In addition, all SBE roads were driven as part of normal annual training road inspections. The map below depicts all surveys conducted and the current locations of *S. condensatum* ICAs. Four new ICAs were discovered during the surveys. Due to the high potential for *S. condensatum* to spread, even with on-going control, these surveys may be repeated in 3-5 years. In the meantime, staff will continue annual road and LZ surveys.

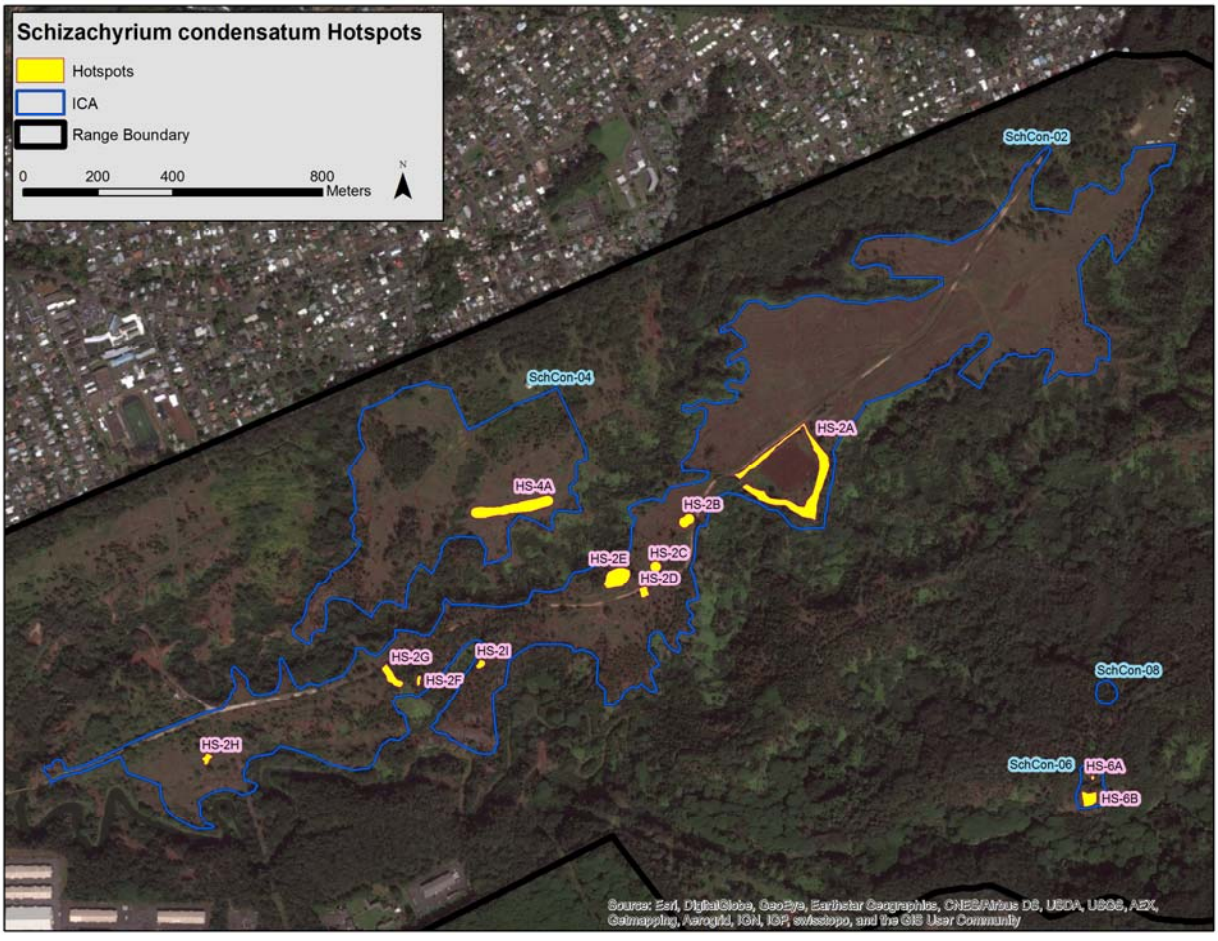
S. condensatum Surveys and Incipient Control Areas at SBE



Control Efforts

A new strategy was implemented this year. Due to the large size of the ICAs and cryptic nature of *S. condensatum*, it was decided that complete sweeps of the largest two ICAs were not feasible. Instead, using field notes and plant location data, hotspots were drawn around concentrations of plants. These hotspots are comparatively small, quickly monitored and surveyed, and help staff to monitor and treat the areas most likely to see recruitment. Hotspots were drawn in most of the ICAs, even the small ones; the map below shows the hotspots in the largest ICAs. As discussed in section 3.4 above, a lot of progress was made in improving communication with ITAM and contract mowers this year. Signs and cones were installed around all hotspots in mowed areas. Contractors have been directed to avoid the cones; hopefully the cones will also discourage soldiers from walking through them.

Hotspots in Core ICAs



Control efforts are summarized in the table below. Note that the areas listed do not include surveyed areas found outside ICAs. Staff continue to find high numbers of plants. A seed sow trial was installed to determine whether *S. condensatum* forms a persistent seed bank; this is the second trial, as the first ended early due to seed packets eroding out the ground in heavy rain. Unfortunately, the new trial appears to have been run over by military vehicles, despite being tucked well off any roads. It will be monitored and all packets pulled if additional training disturbance is seen. More frequent visits may be needed to achieve eradication. Other options, such as increased use of pre-emergent herbicides or habitat modification, may also be considered.

S. condensatum Control Efforts

ICA	ICA Total Area (ha)	Area Weeded (ha)	Effort (hours)	# Visits	Comments
SBE-SchCon-01	0.23	0.23	13.5	6	First site discovered. Well-separated from the other ICAs and bordered by uluhe and thick forest, staff regularly find plants on the road margins.
SBE-SchCon-02	85.95	54.99	122	18	This is the largest ICA, and spans several large LZs and two zones used heavily by training engineers with large machinery. Staff continue to find high numbers of plants.
SBE-SchCon-04	25.84	14.98	43	7	This is the second largest ICA, and overlaps almost entirely with a *Rhodomyrtus tomentosa* ICA. There is one hotspot in this ICA.
SBE-SchCon-05	0.93	0.69	15	6	New this year. Outlier site. This ICA includes one patch of plants along the main road, and another on the edge of a frequently used military landing zone.
SBE-SchCon-06	0.79	0.79	10.55	5	New this year. Outlier site. There are several patches of plants along a navigation trail leading away from the road.
SBE-SchCon-07	0.01 (78**m²**)	0.01 (78**m²**)	1	1	New this year. Outlier site. Site is east of ICA-01, along a main road. It may be the result of a recent dispersal, as the road has been surveyed several times before.
SBE-SchCon-08	0.28	0.25	5.75	2	New this year. Outlier site. Site is adjacent to the heavily used Confidence Course.
TOTAL	**114**	**71.93**	**210.8**	**45**	

Brown, treated grass in Hotspot 2E, the densest concentration of *S. condensatum*.

3.9 NOVEL WEED CONTROL TECHNIQUE DEVELOPMENT: INCISION POINT APPLICATION

OANRP continues to collaborate with Dr. James Leary on various Incision Point Application (IPA) weed control projects. For a complete description of IPA, please see the 2009, 2010, 2011, 2012, 2013 and 2014 MIP and OIP Status Reports.

Work continued on development of IPA as an effective management tool this year. Staff completed monitoring of twenty-three efficacy trials. Installed by Dr. Leary and OANRP staff, the trials tested the efficacy of four different herbicide active ingredients on invasive trees. While most of the trials were conducted on Army lands, some were located on Forest Reserves, at Waimea Valley and at the Puu Ohulehule Conservancy. Partner assistance in hosting and reading trials is greatly appreciated. Due to the slow action of the herbicides tested, the trials ran for two years, or until the treated trees clearly died or recovered. The status of these trials is summarized in the "Status of IPA Efficacy Trials" table below. Also included in the table are the results of the earliest trials OANRP worked on with Dr. Leary. Some of these early trials tested only one product, Milestone© (aminopyralid); others included a product Dr. Leary was using under an Experimental Use Permit (aminocyclopyrachlor), and still others were joint projects with NARS staff. The active ingredient imazapyr was effective on the widest range of taxa, while triclopyr was the least effective. Some species, such as *Citharexylum caudatum* and *Syzygium cumini*, resisted all treatments. For these, higher dose rates, different application methods, or different chemistries may lead to effective control.

While an effective chemistry has been identified for *Grevillea robusta*, staff noted poor control of very large trees (diameter >150-200 cm) treated during weed sweeps across several MUs. Large trees may simply be protected by their size; it is likely these individuals did not receive enough herbicide to kill them. Trials will be installed to test additional chemistries and doses on large *G. robusta.* Last year, staff saw promising results from a technique similar to IPA, involving drilling holes around the trunk of a tree and filling the holes with undiluted glyphosphate. This technique may be tested on *S. cumini*, a priority target weed; large *S. cumini* have resisted all IPA control trials to date, despite doubling herbicide dosage. In the coming year, staff plan to collaborate with Dr. Leary to install several new trials, including one on *G. robusta*, update the table, and create a reference detailing which chemistries work on which taxa.

Over the past couple years, staff conducted sweeps across large areas of a few MUs, targeting select canopy weeds for control using IPA. The goal of the project was to expand the reach of the weed control program beyond the compact borders of restoration sites, rare taxa outplantings, and remnant native forest patches. However, there is concern that altering light levels across large acreages in this manner will lead to increased weed cover, without a corresponding increase in native plant cover. To address this concern, baseline monitoring was conducted at Palikea around treated *Morella faya* this year; this study is detailed in Appendix 3-13. In addition, areas treated with IPA are analyzed in the vegetation monitoring analyses of Manuwai MU (Appendix 3-11) and Kaluaa and Waieli MU (Appendix 3-10).

Status of IPA Efficacy Trials

Species; Family	Date Installed; Status	Average Time to Death	Comments	Recommended Treatment, Dose + Active Ingredient	
				Preferred	Alternatives
Acacia confusa; Fabaceae	2011-09-06; Complete	ACP: 100% (4) trees dead at 30 months. 50% dead at 6 months. AMP: Half (2) of trees 100% defoliated at 30 months.	Last reading at 30 months. Results poor for all chemistries but ACP (all trees dead) and AMP (no trees dead, 2 defoliated, 2 partially foliated). More trials needed.	1 cut/10cm, AMP	
Aleurites moluccana; Euphorbiaceae	2013-11-22; Complete	IMZ: major defoliation at 6 months; 40% dead at 10 months, 100% dead at 30 months. AMP: major defoliation at 6 months, 20% dead at 10 months, 80% dead at 30 months.	Last reading at 30 months. IMZ: 5 of 5 dead; this was the most effective treatment. AMP: 4 of 5 trees dead; largest tree had minor defoliation and recovered by 30 months. GLY: 1 of 5 dead (smallest tree), rest showed minimal defoliation, ineffective. TCP: none dead, some defoliation at 30 months, possibly due to other factors.	1 cut/15-25cm, IMZ	1 cut/15cm, AMP
Araucaria columnaris; Araucariaceae	2011-11-07; Complete	State	OANRP assisted NARS with installation of trial only. At last reading at 16 months, TCP was not effective, but AMP, GLY, and IMZ all showed some efficacy. Results were not definitive.		
	2013-11-07; Complete	AMP: 100% defoliation and 1 of 5 dead at 21 months. 2 more dead by 31 months. IMZ: 2 of 5 dead at 21 months.	Last reading at 31 months. No herbicide killed all trees. All dead trees were in smaller end of trunk size. AMP: 3 of 5 dead, largest tree had 1 dose/43cm and maintained 100% defoliation at 31 months. IMZ: 2 of 5 dead. GLY: 1 of 5 dead. TCP: completely ineffective.	1 cut/15-20cm, AMP	1 cut/10-15cm, IMZ
Ardesia elliptica; Myrsinaceae	2013-11-15; Complete	IMZ: 5 of 5 dead at 15 months, almost all defoliated by 6 months.	Last reading at 26 months. IMZ: 5 of 5 dead and partially rotted. AMP: 1 of 5 dead, results mixed, some recovering. GLY: results mixed, some trees recovering, TCP: ineffective, plants recovering.	1 cut/15-20cm, IMZ	
Callitris columellaris; Cupressaceae	2012-01-08; Complete	N/A	No effective control at 21 months.		
	2013-12-06; Complete	AMP: major defoliation at 6 months; 40% dead at 14 months; 60% dead at 27 months; largest trees recovering at 14 and 27 months. GLY: major defoliation at 6 months, 20-40% dead at 14 months, and recovery of 60% of plants at 27 months.	Last reading at 27 months. AMP: 3 of 5 dead, with 2 largest trees starting to recover; higher dose likely more effective. GLY: 1 of 5 dead, with some of remaining trees continuing to decline and some beginning to recover. IMZ and TCP: some initial defoliation, but all trees recovered by 27 months.	1 cut/10-15cm, AMP	cut/10-15cm, GLY

Species; Family	Date Installed; Status	Average Time to Death	Comments	Recommended Treatment, Dose + Active Ingredient	
				Preferred	Alternatives
Casuarina glauca; Casuarinaceae	2012-01-08; Complete	N/A	No effective control at 7 months. Trial disturbed before 21 months; results inconclusive.		
	2013-12-06; Complete	No trees died until 14 months, for any chemistry. Results inconsistent.	Last reading at 27 months. No clear winners. GLY: major defoliation at 6 months, continuing through 14 months, 2 of 5 trees dead at 27 months; oddly, largest trees died. TCP: major defoliation at 6 and 14 months, with 2 of 5 trees dead at 14 months. 3 trees recovered at 27 months. IMZ: defoliation at 6 months, with health declining for all plants through 27 months, and 1 of 5 dead. AMP: defoliation at 6 months, 1 of 5 dead at 27 months and 3 recovering. Not a good match with this application method, unless increase dose.		
Chrysophyllum oliveforme; Sapotaceae	2013-09-20; Reinstall	N/A	Last reading at 6 months; all trees alive. Difficult to read trial, due to thick canopy. Need to reinstall.		
Citharexylum caudatum; Verbenaceae	2013-10-25; Reinstall	N/A	Last reading at 11 months. TCP not effective. While others were somewhat effective, data suggest that no plants were going to die at dose give. Plan to reinstall at higher rate.		
Coffea arabica; Rubiaceae	2013-11-08; Complete	IMZ: 80% dead at 21 months.	Last reading at 31 months. IMZ the most effective killing all trees by trial end. Small to high levels of recovery seen among trees with all other herbicides.	1 cut/10cm, IMZ	
Cordia alliodora; Boraginacea	2013-08-30; On-going	IMZ: 1 dead at 22 months, major defoliation at 7 months.	Last reading at 22 months. Species is somewhat deciduous (per Waimea staff), so results inconclusive thus far. AMP: 0 of 5 dead, major defoliation seen at 22 months, but not earlier. IMZ: 1 of 5 dead, major defoliation seen at 7 months; this is most promising treatment thus far. GLY: none dead, plants defoliated, recovered, then defoliated again. TCP: none dead, major defoliation. Waiting for one more reading to conclude this trial	1 cut/15-20cm, IMZ	
Corymbia citriodora; Myrtaceae	2011-09-06; Complete	N/A	No effects seen by 11 months. Trees all very large. Conduct trial on smaller trees or use higher doses.		

Species; Family	Date Installed; Status	Average Time to Death	Comments	Recommended Treatment, Dose + Active Ingredient	
				Preferred	Alternatives
Cryptomeria japonica; Cupressaceae	2014-01-07; Complete	Some trees dead in 8-13 months, while rest showing defoliation. AMP: 5 of 5 dead at 19 months. GLY: 4 of 5 dead at 27 months.	Last reading at 27 months. AMP: 5 of 5 dead. GLY: 4 of 5 dead. IMZ: 2 of 5 dead, with larger size classes recovering. TCP: little effect, all trees healthy	1 cut/15-20cm, AMP	1 cut/15-20cm, GLY
Elaeocarpus grandis; Elaeocarpaceae	2013-12-13; Complete	IMZ: 3 of 5 dead, anywhere between 6-12 months or 2 years.	Last reading at 26 months. IMZ: 3 of 5 dead; largest trees were recovering. AMP: 2 of 5 in poor health, but all were flushing with new leaves. All TCP and GLY trees recovered.	1 cut/10-15cm, IMZ	
Fraxinus uhdei; Oleaceae	2013-11-08; Complete	IMZ: 100% defoliated at 7 months, 1 of 5 dead at 31 months. Highest levels of defoliation for all herbicides observed at 21 months.	Last reading at 31 months. IMZ: 1 of 5 dead, all 100% defoliated at 7 months, only largest 1 showed any recovery by 31 months. AMP and GLY: trees recovered at 31 months. TCP: mixed results, 1 of 5 died at 21 months, 2 100% defoliated and 2 fully recovered by 31 months.	1 cut/20cm, IMZ	
Grevillea robusta; Proteaceae	2010-11-16; Complete	AMP: 17% dead and 92% defoliated at 3 months. All dead when next checked at 29 months.	Trial only tested AMP, not other chemistries. Of 12 plants treated, 9 were relocated after 29 months, and all were dead. Dr. Leary conducted trials using all chemistries, and recommends AMP for this taxon. 2016 update: Staff using IPA to weed note that many larger trees are not dying. Additional trial will be conducted to determine best dose for larger trees.	1 cut/15cm, AMP	
Heliocarpus popayensis; Tiliaceae	2013-11-22; Complete	For IMZ: 100% defoliation and 20% mortality at 6 months; 80% dead at 10 months; 100% dead at 30 months.	Last reading at 30 months. IMZ: 5 of 5 dead; this is the most effective treatment. AMP: 2 of 5 dead; little difference between results at 10 months and 30 months. GLY: 1 of 5 dead; perhaps a higher dose would have been effective. TCP: 1 of 5 dead (smallest tree); ineffective.	1 cut/10-20cm, IMZ	1 cut/10-15cm, AMP
Leptospermum scoparium; Myrtaceae	2014-01-14; Complete	All chemistries: plants dead within 1 year.	Last reading at 26 months. IMZ: 5 of 5 dead. GLY: 5 of 5 dead. AMP: 1 of 5 dead. TCP: all trees alive.	1 cut/15-30cm, GLY or IMZ	
Leucaena leucocephala; Fabaceae	2010-11-16; Complete	AMP: 65% dead and 100% defoliated at 3 months.	Trial tested AMP only, not other chemistries. Trees 1-3 m tall were used. At 3 months, 13 of 20 trees were dead and all were 100% defoliated. At 29 months, 8 of 20 were relocated, and all were dead; others suspected to have fallen down	1 cut/10cm, AMP	

Species; Family	Date Installed; Status	Average Time to Death	Comments	Recommended Treatment, Dose + Active Ingredient	
				Preferred	Alternatives
	2011-11-07; Complete	State	OANRP assisted NARS with installation of trial only. Trial tested all chemistries. Short stature plants with trunk 'brains' were used. Last reading at 16 months. 5 of 5 AMP trees were dead. Other chemistries ineffective.	2 cuts/brain, AMP	
Melaleuca quinquenervia; Myrtaceae	2013-10-04; On-going	AMP: defoliation at 5 months, 3 dead at 13 months, 1 more at 20 months. AMP: major defoliation at 5 months, 3 dead at 13 months.	Last reading at 20 months. IMZ: 4 of 5 dead, major defoliation; this is most effective treatment. AMP: 3 of 5 dead, major defoliation, largest tree not affected, higher dose may be better. GLY: 2 of 5 dead, rest likely recovering, some defoliation; not effective. TCP: none dead, little defoliation; not effective.	1 cut/15-20cm, IMZ	1 cut/15-20cm, AMP
Morella faya; Myricaceae	2014-01-07; Complete	IMZ: 20% dead at 7 months, 80% dead at 13 months, 100% dead at 19 months. AMP: major defoliation evident at 7 months, 80% dead at 19 months.	Last full reading at 19 months. IMZ: 4 of 5 dead, 1 tree 100% defoliated. AMP: 4 of 5 dead, smallest 1 recovering. GLY: 2 of 5 dead, rest showing major defoliation. TCP: none dead, some defoliation on smallest tree but recovering. Final partial reading at 27 months; 11 trees were accidentally retreated with IMZ at 22 months. Data suggests IMZ still best, followed by AMP. GLY only partially effective on smaller sizes. TCP ineffective	1 cut/10-20cm, IMZ	1 cut/10-20cm, AMP
Pimenta dioica; Myrtaceae	2013-11-07; Complete	IMZ: all defoliated at 7 months; 4 of 5 dead and 1 tree 100% defoliated at 21 months. AMP: 2 dead at 21 months, major defoliation by 7 months.	Last reading at 31 months. IMZ: 4 of 5 dead at 21 months and the remaining tree stayed completely defoliated until the trial end. AMP: 2 of 5 dead, 1 tree 100% defoliated at 31 months. May be effective at a higher dose. GLY and TCP: ineffective, no trees died and most recovered.	1 cut/15-20cm, IMZ	1 cut/20cm, AMP
Psidium guajava; Myrtaceae	2013-09-27; Complete	IMZ: 100% defoliated and 20% dead at 10 months. 40% dead at 19 months. 60% dead at 30 months. GLY: 20% dead at 19 months, 40% dead at 30 months.	Last reading at 30 months. IMZ: 30 5 dead; most effective. Largest 2 trees re-sprouting; suspect too low of dose. GLY: 2 of 5 dead, 2 recovering; somewhat effective. Again, higher dose may be more effective. AMP: none dead, although all had major defoliation. TCP: 1 of 5 dead (smallest tree), rest partially defoliated, then recovered.	1 cut/15cm, IMZ	1 cut/15cm, GLY
Schefflera actinophylla; Araliaceae	2011-03-09; Complete	State	OANRP assisted NARS with installation of trial only. Last reading at 15 months. 4 of 4 trees dead for GLY, IMZ, and AMP. TCP not effective.	1 cut/15-20cm, GLY	1 cut/15-20cm, IMZ or AMP

Species; Family	Date Installed; Status	Average Time to Death	Comments	Recommended Treatment, Dose + Active Ingredient	
				Preferred	Alternatives
Spathodea campanulata; Bignoniaceae	2013-08-23; Complete	IMZ: 100% defoliation at 11 months and 3 apparently dead at 18 months, although 2 recovered by 37 months. 2 dead at 37 months, rest slowly recovering. GLY: some defoliation at 11 months.	Last reading at 37 months. IMZ: 2 of 5 dead, 2 very poor, largest recovering. AMP: none dead, major defoliation, but all recovering. GLY: none dead, major defoliation, all recovering. TCP: none dead, inconsistent defoliation, all recovered. Likely doses were too low. Puu Ohulehule Conservancy: GLY effective at very high doses.	1 cut/10-15cm, IMZ	1 cut/5cm, GLY
Syzygium cumini; Myrtaceae	2010-08-17; Complete	AMP: 0 of 6 dead, rest had varying defoliation at 6 months. 5 of 6 dead at 29 months.	Trial tested AMP only, not other chemistries. 2 doses were tested, 0.5mL per cut and 1mL per cut. 2 size classes of trees were used, small (11-15cm dbh) and large (30-55cm dbh), 6 trees of each size. Trial was compromised when several of large trees were bulldozed. No strong results on any of large trees. Stats are for small size classes only. At 6 months, 0 of 6 trees were dead, 2 of 6 were 100% defoliated, and 4 of 6 were more than 50% defoliated. At 32 months, 5 of 6 were dead, and 1 was poor. No major differences between high and low dose.	1cut/5-10cm, AMP (small size trees only)	
	2011-03-09; Complete	State	OANRP assisted NARS with installation of trial only. Last reading at 15 months. No treatment effective except experimental product, ACP.		
	2013-11-15; Complete	Some defoliation at 15 months.	Trial targeted large trees. Last reading at 26 months. IMZ: most promising, 3 of 5 in poor health (smallest trees) at 15 and 26 months; other 2 trees recovered. AMP: 4 of 5 recovered, smallest in poor health. TCP: 1 of 5 (smallest) dead, remainder recovered. GLY: 5 of 5 recovered. Recommend experimenting with higher doses or drilling with IMZ or GLY.		
Toona ciliata; Meliaceae	2011-09-06; Complete	IMZ: 25% dead at 3 months, 50% dead at 6 months, 100% defoliated at 11 months, 75% dead at 16 months, 100% dead at 30 months	Last reading at 30 months. IMZ: 4 of 4 dead. TCP: 3 of 4 dead. AMP: 1 of 4 dead, remainder re-sprouting.	1 cut/15cm, IMZ	1 cut/15cm, TCP or 1 cut/10cm, AMP
Trema orientalis; Cannabaceae	2013-12-18; Complete	IMZ: 2 dead at 8 months, rest at 15 months. AMP: 1 dead at 8 months (smallest), 3 more at 15 months.	Last reading at 15 months. AMP: 4 of 5 dead, largest still alive. IMZ: 4 of 5 dead, 1 recovered. GLY: 2 of 5 dead, rest recovered. TCP: 4 of 5 recovered, 1 died.	1 cut/20cm, IMZ or AMP	

ACP = Aminocyclopyrachlor, AMP = Aminopyralid, GLY = Glyphosate, IMZ = Imazapyr, TCP = Triclopyr

3.10 RESTORATION ACTIONS UPDATE

This year, restoration actions ramped up to target high priority Weed Control Areas. Restoration activities aim to compliment 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.

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.

The 'Restoration Action Summary' table below describes restoration efforts for this report year. Restoration actions are tracked within the WCAs because this existing subunit system, which is used to track weed control efforts, is conveniently already in place. Restoration actions are tracked as two types: outplantings, and seed sows/ divisions/ transplants (SDT). Outplantings require a higher level of staff input and planning, where SDT actions are sometimes opportunistic in the field, sometimes planned. SDT activities require low effort as compared to outplantings. 'Area' for each restoration type is calculated by merging all the overlapping efforts into a single geographic footprint within a given WCA for the year (overlapping efforts are not counted more than once). Total merged area of both types of restoration actions is also calculated and displayed at the bottom of the table.

Outplanting common native species accounted for the bulk of the restoration efforts. In some of the more active restoration sites, where complete removal of alien vegetation took place, seed sows were also frequently used. Both fresh and stored seed was used in these efforts.

In the past year, previously established vegetation monitoring methods were continued, and new techniques were initiated to track vegetation change within small restoration sites, which are often under 1 acre. In the past year, vegetation monitoring at restoration sites in Kahanahaiki was conducted at Maile Flats chipper site (results for five years post-initial clearing, Appendix 3-8), and at the "Shire" and "Schwepps" sites (photopoint monitoring). Monitoring of native shrub cover change at Ohikilolo Lower restoration areas was initiated using Gigapan imagery (Appendix 3-2A). Point-intercept vegetation monitoring was initiated to track vegetation change at the new snail enclosure site at Palikea (Appendix 3-7). 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 be observed in the large-scale MU vegetation monitoring conducted across MUs.

In the coming year, restoration actions will continue at sites in the following Management Units: Ohikilolo Lower, Ohikilolo, Kahanahaiki, Palikea and Makaleha West. Additionally, new restoration actions are planned for Makaha. Outplantings will be conducted in select locations where weed control is ongoing weed control around rare plants, and also in a new restoration site on 'Camp Ridge' where a dense stand of *Psidium cattlianum* will be removed. Baseline point-intercept vegetation data will be established at this site, so more rigorous monitoring data will be available for this restoration project.

Restoration Action Summary Table

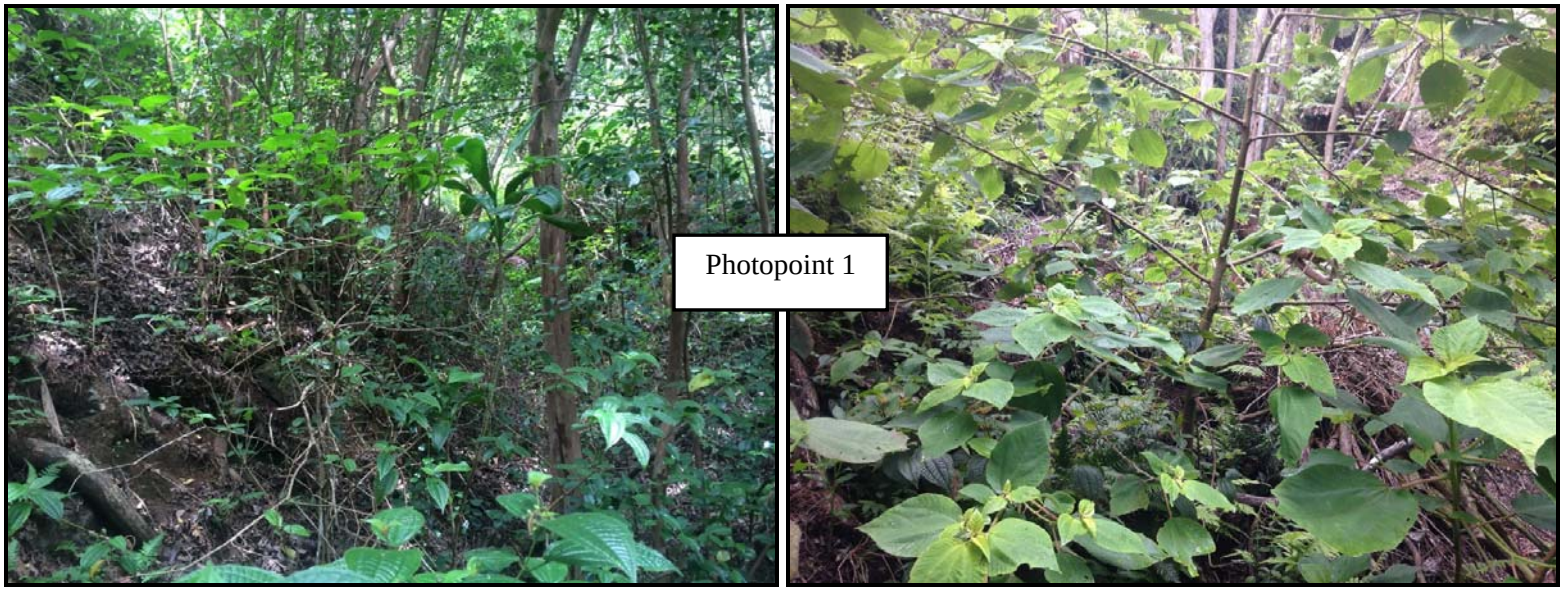
MU	WCA code	Restoration Action	# of plants	Area (m2)	Taxa	Comments
Kaala	Kaala-01	Outplanting	35	86	*Kadua centranthoides*	*K. centranthoides* was planted on the Army side of the boardwalk in an open area where *Juncus effusus* removal is ongoing. This location is particularly wet (isolated patches of standing water) and it is unclear how quickly plants will grow or fill in. No significant efforts will be conducted here in the coming year.
	Kaala-06	Outplanting	34	9	*K. centranthoides*	Planted in an open area where *J. effusus* removal is ongoing on the State managed side of the boardwalk.
MU Outplanting Total:			**69**	**95**		
Kahanahaiki	Kahanahaiki-04	Outplanting	299	2427	*Acacia koa, Hibiscus arnottianus subsp. arnottianus, Pisonia spp., Planchonella sandwicensis*	A significant amount of time has been dedicated to the 'Shire' restoration site (~.75 acre site) in this WCA by staff. Three reintroductions with the same suite of species were conducted this year.
		SDT	n/a	2298	*Bidens torta, Dianella sandwicensis, Pipturus albidus*	Multiple seed sow and transplanting efforts were conducted at the 'Shire' restoration site. Impressive amounts of cover were established with *P. albidus* and *B. torta* seed sows and can be seen in the photopoints below.
	Kahanahaiki-16	Outplanting	59	1212	*A. koa, Bidens torta, H. arnottianus subsp. arnottianus Pisonia spp.*	A significant amount of time has been dedicated to the 'Schwepps' (~.5acre site) restoration site in this WCA by staff. Two outplanting efforts were conducted there this year.
		SDT	n/a	938	*B. torta, D. sandwicensis, P. albidus*	Native cover was also established at the 'Schwepps' restoration site with *P. albidus* and *B. torta* seed sows (photopoints below). *D. sandwicensis* transplants were scattered throughout the site.
MU Outplanting Total:			**358**	**3,639**		
MU SDT Total:			**n/a**	**3,236**		
Kaluaa and Waieli	KaluaaandWaieli-02	Outplanting	28	193	*Freycenetia arborea, Lobelia yuccoides*	Plants were outplanted inside the Hapapa snail enclosure. Staff observations suggest that native canopy cover inside the enclosure is sufficient, and future reintroductions will only be conducted as needed to increase diversity or to establish more important snail host species such as *Freycinetia arborea.*
	KaluaaandWaieli-02	SDT	n/a	138	*B. torta*	Seeds were sowed on the 'Hapapa Bench' area post weed control effort.
	KaluaaandWaieli-04	Outplanting	19	64	*Urera glabra*	All outplantings at this location are to establish higher levels of *Drosophila montgomeryi* host vegetation as a means towards

MU	WCA code	Restoration Action	# of plants	Area (m2)	Taxa	Comments
						stabilization. See Chapter 7 for additional *D. montgomeryi* stabilization details.
	KaluaaandWaieli-08	Outplanting	35	318	*Urera glabra*	All outplantings at this location are to establish higher levels of *Drosophila montgomeryi* host vegetation as a means towards stabilization. See section Chapter 7 for additional *D. montgomeryi* stabilization details.
	KaluaaandWaieli-09	SDT	n/a	46	*Pisonia spp.*	Opportunistic transplanting with volunteers during weed control rainout.
MU Outplanting Total:			**82**	**575**		
MU SDT Total:			**n/a**	**184**		
Ohikilolo Lower	LowerOhikilolo-02	Outplanting	546	2907	*Dodonea viscosa, Myoporum sandwicense, Erythrina sandwicensis*	Restoration was conducted around a managed population of *Euphorbia celestroides* var. *kaenana* to suppress weeds and fire-prone grasses, and improve habitat. *D. viscosa* was planted densely on a shelf above the wild *E. celestroides* (see photo below), *E. sandwicensis* was planted across the rocky center of the patch, and *M. sandwicensis* was planted at the bottom of the patch, near with *Scaevola taccada* outplanted last year. This coming year, similar outplantings will continue, especially in the flat, weed dominated areas, until native cover reaches a density that shades out weeds and ultimately reduces amount of herbicide and weed control necessary.
	LowerOhikilolo-03	Outplanting	32	447	*E. sandwicensis*	*E. sandwicensis* was planted on the top edge of a managed population of *Hibiscus brackenridgei*. This coming year additional species will be planted in areas with continual weed ingress.
MU Outplanting Total:			**578**	**3,354**		
Ohikilolo	Ohikilolo-10	Outplanting	138	909	*Metrosideros polymorpha, Myrsine lessertiana*	Outplantings were conducted to fill in canopy gaps in the Forest Patch Enclosure where they occur along the fence. Additional plantings here should not be necessary next year.
	Ohikilolo-13	Outplanting	112	377	*D. viscosa, M.s polymorpha, M. lessertiana*	Outplantings were conducted to fill in canopy gaps in the forest patch around the cabin, where significant alien canopy weed removal has occurred. In the future, restoration efforts will continue in this WCA, focusing on connecting native patches in the eastern region, and expanding native cover towards the western end of the WCA.
MU Outplanting Total:			**250**	**1,286**		
Palikea	Palikea-03	Outplanting	56	47	*Cheirodendron trigynum, D.*	Outplantings were conducted to shade out grasses on an open

MU	WCA code	Restoration Action	# of plants	Area (m2)	Taxa	Comments
					viscosa	slope along the crestline, adjacent to known snail populations.
	Palikea-03	SDT	n/a	46	*D. sandwicensis*	*D. sandwicensis* divisions were transplanted into the open area described in the comment above.
	Palikea-06	Outplanting	226	823	*C. trigynum, Coprosma longifolia, Kadua affinis, M. polymorpha, Pisonia spp., Psychotria hathewayi, Urera glabra*	Plantings were done in two locations where active weed control (canopy and understory) is taking place: shallow bowls and slopes just off the crestline (photo below), and a gulch where *Drosophila montgomeryi* was observed in the past. In the latter site, 23 *U. glabra* were planted along with *Pisonia umbellifera* and *P. brunoniana* to restore *Drosophila* habitat.
	Palikea-06	SDT	n/a	20	*D. sandwicensis*	*D. sandwicensis* divisions were planted around the outplanting site described above.
	Palikea-09	Outplanting	41	350	*D. viscosa*	*D. viscosa* was outplanted at a location where a monotypic stand of *Psidium cattleianum* had been removed in 2013 (photo below). *A. koa* recruitment is occurring on site, but supplemental plantings here will be necessary to prevent continued weed ingress.
MU Outplanting Total:			**323**	**1,220**		
MU SDT Total:			n/a	66		
Makaleha West	WestMakaleha-02	Outplanting	83	751	*Clermontia kakeana, Luzula hawaiiensis, Metrosideros polymorpha, Perrottetia sandwicensis*	These taxa were planted in locations where canopy weed control has taken place.
	WestMakaleha-02	SDT	n/a	238	*Alyxia stellata, Antidesma platyphyllum, Canavalia galeata, C. longifolia, K. acuminata, Melicope spp., M. polymorpha, Scaevola gaudichaudiana*	Staff worked with the Youth Conservation Core group to transplant a diversity of plants into open areas where *P. cattleianum* was removed.
MU Outplanting Total:			83	751		
SDT Total:			n/a	238		
OUTPLANTING YEAR END TOTAL:			1,743	10,920	2.7 acres	
SEEDSOW, DIVISIONS, TRANSPLANTS YEAR END TOTAL:			n/a	3,724	0.92 acres	
ALL RESTORATION EFFORTS YEAR END TOTAL:			n/a	11,750	2.9 acres: An overlap of SDT and outplanting efforts in some more intensive restoration areas accounts for the reduction of total area in this calculation.	

The photopoints below document change from July 31, 2014 (left) to June 14, 2016 (right) at the ‘Shire’ site in Kahanahaiki-04.

The photopoints below document change from July 31, 2014 (left) to June 14, 2016 (right) at the ‘Schwepps’ site in Kahanahaiki-16.



D. viscosa (circled) in Palikea-09, planted to supplement natural recruitment at a location where an isolated patch of *Psidum cattleianum* was removed.

Above: Over 400 *D. viscosa* (Aalii) were planted one meter apart in rows two meters apart across a grassy flat in Lower Ohikilolo-02 to shade grasses and re- establish native cover (x's approximate locations of plants in the foreground).

Below: Outplants in Palikea-06 were planted to connect patches of native vegetation.