# CHAPTER 3: ECOSYSTEM MANAGEMENT

Notable projects from the 2017-2018 reporting year are discussed in the Project Highlights section of this chapter.

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 planned for the five years immediately following its finalization. The ERMUPs are working documents; the Army natural resource program on Oahu (OANRP) modifies them as needed and can provide the most current versions on request. This year, the Pahole, Manuwai, Opaeula Lower, and Kaluaa & Waieli, ERMUPs were revised; 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 ERMUPs for each MU detail specific goals and monitoring expectations for each MU.

**Figure 1.** Staff working in a restoration site at Palikea

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 10,398.5 hours controlling weeds across 528.2 hectares (ha). These figures include both incipient and ecosystem control efforts by staff and volunteers but do not include survey efforts or travel time. Table 1 lists efforts for previous reporting cycles. Note that all reporting periods, including this year, were 12 months in length, except 2014-2015, which covered only nine months.

**Table 1.** Summary Statistics for Weed Control

| Report Year | Effort (hours) | Area (ha) |
|---|---|---|
| 2017-2018 | 10,398.5 | 528.2 |
| 2016-2017 | 9,309 | 593.9 |
| 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. Results of these surveys are discussed in section 3.5 below.

**Figure 2.** Treated invasive trees (brown/gray) at Kahanahaiki

Incipient Control Areas

Incipient control efforts are tracked in Incipient Control Areas (ICAs). Each ICA is drawn to include one incipient taxon; the goal of control is eradication of the taxon from the ICA. ICAs are primarily drawn in or near MUs. Those not located within or adjacent to an MU were selected for control either because they occur on an Army training range (for example, *Cenchrus setaceus* in MMR) or are particularly invasive (*Arthrostema ciliatum* in Kaluaa). Many ICAs are very small and can be checked in an hour or less, and in some MUs multiple small ICAs can be checked in one day. In contrast, a few ICAs, like those for *Schizachyrium condensatum* in SBE or *Chromolaena odorata* in KTA, are quite large and require multiple days to sweep completely. Typically, ICAs are swept repeatedly until eradication has been achieved and staff is reasonably confident there is no remaining seed bank. In the absence of data regarding seed longevity, staff does not consider a site eradicated until ten years after the last sighting. In certain cases, at ICAs where no mature plants were ever seen and total plant numbers were very low, this may be shortened to five years. OANRP currently controls 54 taxa in 281 ICAs.

Of the total 528.2 ha swept, ICA efforts covered 381.9 ha. This year, staff spent 2,645 hours on ICA management, conducted 674 visits to 45 taxa in 234 ICAs, achieved eradication at 3 ICAs, and created 19 new ICAs. This is the greatest effort spent for incipient weeds in a reporting period to date; see Table 2. Also, this is the greatest number of ICA sites visited in one year. Total ICA area treated dropped, returning to 2015-2016 report year levels. ICA work accounted for 72% of the total area weeded and 25% of total weeding effort. This makes sense, as incipient control generally requires less time per acre than habitat restoration weed control.

**Table 2.** Summary Statistics for ICAs

| Report Year | # ICAs | Visits | Effort (hours) | Area (ha) |
|---|---|---|---|---|
| 2017-2018 | 234 | 674 | 2,645 | 381.9 |
| 2016-2017 | 233 | 662 | 2,572.8 | 467.3 |
| 2015-2016 | 175 | 539 | 2,452 | 388.1 |
| 2014-2015 (9 months) | 147 | 333 | 1,537 | 245.6 |
| 2013-2012 | 157 | 389 | 1,753.6 | 196.41 |
| 2012-2013 | 152 | 311 | 1,369.2 | 184.34 |
| 2011-2012 | 115 | 260 | 1,661 | 219.27 |
| 2010-2011 | 130 | 281 | 665.5 | 164 |

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

While the majority of ICAs require minimal amounts of effort to control, 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 *Juncus effusus* and *Crocosmia* x *crocosmiiflora* along the boardwalk at Kaala. 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, often in steep terrain, while maintaining pressure on the less immediate boardwalk ICA taxa threats.

The number of ICAs managed has increased steadily over the years. Part of this is due to 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. Occasionally, if a species or site is determined to no longer be eradicable, the ICA is made inactive and/or addressed only during regular habitat weeding efforts. 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 three ICAs, for a total of 36 eradications ever. These include one *E. stipoides* site (Kaluaa and Waieli), one *Rubus argutus* site (Ohikilolo), and one *Senecio madagascariensis* site (SBE). Unfortunately, 19 new ICAs were also created, see Table 3. Note that OANRP assisted with efforts at the Waimalu *C. setaceus* infestation as part of an interagency project; primary management of this site is conducted by the Oahu Invasive Species Committee (OISC) and Koolau Mountains Watershed Partnership (KMWP). The suspected vector for each ICA is listed in the table. Almost half (eight) of the new ICAs are likely the result of military spread, either via training or maintenance activities, although it is impossible to rule out illegal recreational users as vectors in KTA. One of these is likely the result of a historical landscaping effort by military. It is likely that another six ICAs were introduced via staff, volunteers, researchers, and/or management activities. This emphasizes the need for proper sanitation and decontamination practices, and the importance of monitoring management sites for incipient weed ingress.

**Table 3.** New ICAs Found in 2018

| Taxon | MU | ICA Code | Vector Comments |
|---|---|---|---|
| *Angiopteris evecta* | Pahole | Pahole-AngEve-06 | Natural dispersal |
| *Cenchrus setaceus* | SBE | SBE-CenSet-03 | Military |
| *Cenchrus setaceus* | Waimalu No MU | WaimaluNoMU-CenSet-01 | Unknown |
| *Chromolaena odorata* | Kaluaa No MU | KaluaaNoMU-ChrOdo-01 | Staff |
| *Chromolaena odorata* | KTA No MU | KTA-ChrOdo-30 | Military/Recreation |
| *Chromolaena odorata* | KTA No MU | KTA-ChrOdo-31 | Military/Recreation |
| *Chromolaena odorata* | KTA No MU | KTA-ChrOdo-32 | Military/Recreation |
| *Chromolaena odorata* | KTA No MU | KTA-ChrOdo-33 | Military/Recreation |
| *Chromolaena odorata* | SBW No MU | SBWNoMU-ChrOdo-05 | Military |
| *Ehrharta stipoides* | Kahanahaiki | MMR-EhrSti-10 | Staff |
| *Ehrharta stipoides* | Makaleha West | WestMakaleha-EhrSti-01 | Staff |
| *Erythrina poepiggiana* | Lihue | SBW-EryPoe-04 | Historical (military landscaping) |
| *Pterolepis glomerata* | Palikea | Palikea-PteGlo-02 | Staff |
| *Rhodomyrtus tomentosa* | Kaiwikoele to Elehaha No MU | KLOA-RhoTom-01 | Unknown/Recreation |
| *Schizachyrium condensatum* | Manuwai | Manuwai-SchCon-01 | Staff |
| *Schizachyrium condensatum* | SBW No MU | SBWNoMU-SchCon-01 | Military |
| *Setaria palmifolia* | Kahanahaiki | MMR-SetPal-02 | Staff, researchers, or volunteers |
| *Solanum capsicoides* | Lihue | SBW-SolCap-01 | Unknown |
| *Sphaeropteris cooperi* | Kapuna Upper | UpperKapuna-SphCoo-01 | Natural dispersal |

This year, there was noteworthy decline in total ICA area treated. In all, 114 ICAs showed an increase in area treated, 9 had no change, and 118 had a decrease. Of the ICAs which showed a decrease in treatment area, 21 of these had a decrease of more than 1 ha, including 7 which had decreases greater than 6 ha. Most of the decline is the result of skipping treatment of several *Acacia mangium* sites in KTA this year, in preference for increased effort on *C. odorata*. ICAs eradicated last year account for just 1.47 ha of the total decline in area treated. Of the ICAs which showed an increase in treatment area, 19 of these had an increase of more than 1 ha. However, the largest increases occurred in just a handful of ICAs, including one *S. condensatum* site (SBE), one *C. setaceus* site (Keaau No MU), one *C. odorata* site (KTA) and one

*Alstonia macrophylla* site (SBE). These ICAs were prioritized this past year, with the exception of *A. macrophylla*, which was treated incidentally during other work in SBE. The new ICAs discovered this year account only for only 0.95 ha of treatment area. Of the 381.92 ha treated for ICAs this year, the majority of this, 352.22 ha or 92%, was for just ten taxa: *C. odorata, S. condensatum, R. tomentosa, C. setaceus, A. evecta, Melochia umbellata, A. mearnsii, E. poepiggiana, Miscanthus floridulus,* and *A. macrophylla*.

There was a small increase in total effort this report year. In all, 25 taxa had increases in effort and 20 had decreases in effort. The greatest increases in effort (> 20 hours) were seen for *Sphagnum palustre, S. condensatum,* and *C.* x *crocosmiiflora*, with more modest increases (> 10 hours) seen for *C. odorata, Acacia mearnsii,* and *A. macrophylla*. The greatest decreases in effort (> 20 hours) were seen for *C. setaceus, A. evecta, J. effusus,* and *P. glomerata*. These are discussed in Table 4. Of the 2,645 hours spent on ICA treatment this year, the majority, 2,387 or 90%, were for just eleven taxa: *C. odorata, S. condensatum, S. palustre, C.* x *crocosmiiflora, R. tomentosa, J. effusus, P. glomerata, C. setaceus, A. evecta, M. umbellata,* and *E. stipoides*. While the true measure of success is eradication, staff hope that eventually the effort needed to treat ICAs will decline as fewer individuals are found over subsequent visits.

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.

**Figure 3.** New *Schizachyrium condensatum* infestation at SBW No MU, in the BAX; plants circled in red.

The table below highlights the eleven taxa which required the most control effort in the past year. Effort from report year 2017 is presented for comparison. Note that effort hours do not include travel or trip preparation, or most time spent surveying outside of known ICA boundaries to define infestation areas. See the Invasive Species Update sections (3.6) for more detailed discussion of *C. odorata*.

**Table 4.** 2018 ICA Effort by Select Target Taxa

| Taxa | 2018 Control | 2017 Control | Comments |
|---|---|---|---|
| *Chromolaena odorata* | 1,147.50 hrs<br>135.98 ha<br>155 visits | 1,128.75 hrs<br>161.28 ha<br>146 visits | *Chromolaena* continues to be OANRP's top ICA priority. Staff efforts include treatments of hotspots, large sweeps, and aerial spraying; see discussion Sections 3.6. 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. OISC efforts are not included in the totals in this table. |
| *Schizachyrium condensatum* | 284.50 hrs<br>92.63 ha<br>40 visits | 227.65 hrs<br>53.78 ha<br>36 visits | *Schizachyrium* was discovered in two new locations this year: SBW No MU, and Manuwai. The SBW infestation was discovered during annual road surveys, in the Battle Area Complex (BAX) along an unimproved road leading to a target. As staff do not manage this area, the likely vector is military, probably maintenance personnel. Managing this site is challenging, as it is located within the Radiologically Controlled Area (RCA, special procedures required), and within the live fire training area (UXO present). Currently, under SOP staff cannot access this area due to UXO. Aerial sprays may be used to treat this small infestation if ground access cannot be obtained. The risk of further spread across SBW (via mowing) is great. The Manuwai infestation was found in June 2018, and was likely introduced to the area via staff. Delimiting and treating this infestation will be a priority in the coming year. The majority of *S. condensatum* control occurs at SBE (7 ICAs). No new ICAs were found at SBE this year. An aggressive treatment strategy, including more consistent visits to hotspots, regular use of the power sprayer (provides best coverage of target plants), inclusion of Polaris (strong grass suppressant herbicide), and large annual sweeps has led to some progress at SBE. No plants were found at one ICA, while numbers declined dramatically at four ICAs. In the largest ICA, focused hotspot work led to some decline in numbers of plants at some hotspots, but overall plant numbers remained high. The increase in treatment area is due to thorough sweeps at this ICA. Staff likely need to continue aggressive treatment for several years in order to bring SBE *S. condensatum* infestations under control. |
| *Sphagnum palustre* | 227.00 hrs<br>2.66 ha<br>23 visits | 101.85 hrs<br>1.43 ha<br>18 visits | Control efforts have been very successful in removing the majority of the *S. palustre* infestation on the Army side of the Kaala boardwalk. While effort more than doubled this year, the majority of the increase is due to buffer surveys, which are conducted every 3 years, including this report year. No new ICAs were found this year, but buffer surveys slightly expanded the infestation area. More telling is the reduction of moss-killer used over the years. In the first year of control (2012-2013), 2,260 L were used. This quantity has steadily dropped, with 256 L used last report year, and only 213 L used this report year. |
| *Crocosmia* x *crocosmiiflora* | 215.00 hrs<br>1.92 ha<br>30 visits | 165.28 hrs<br>1.49 ha<br>27 visits | Volunteers conduct the majority of *C.* x *crocosmiiflora* control at both Kaala and Palikea, removing the corms by hand, a labor intensive process. Last year there was a reduction in effort, but this year, effort increased back to 2015-2016 report year levels. The increase is primarily due to additional volunteer effort at the boardwalk trailhead at Kaala. The majority of effort was spent at Kaala (81%), where there are 7 ICAs, all of which are located either on the road or directly around the FAA enclosure. This year, staff monitored an informal foliar spray trial based on a mix used in New Zealand; see Appendix 3-7. The trial was successful in reducing leaf biomass dramatically, but one of the herbicides is not labeled for use in forested areas and can only be used adjacent to roads and buildings. In the coming year, both digging and sprays will be used at Kaala. Hopefully, this will increase efficiency, allow for expanded control, and improve efficacy. Unfortunately, the mix cannot currently be used at Palikea. There are 3 ICAs in Palikea, and 2 more just outside. Numbers continue to decline, but full eradication may be difficult without herbicide. Alternate treatments will be investigated for this MU. |

**Table 4** (continued).

| Taxa | 2018 Control | 2017 Control | Comments |
|---|---|---|---|
| *Rhodomyrtus tomentosa* | 98.75 hrs<br>46.60 ha<br>15 visits | 98.00 hrs<br>56.93 ha<br>16 visits | *Rhodomyrtus*, a small tree with bird-dispersed fruit, is locally common on windward Oahu but uncommon elsewhere. Staff manage it at SBE, Pahole, and KLOA. The largest infestation managed is at SBE, where 99% of total *R. tomentosa* effort was spent. The *R. tomentosa* and *S. condensatum* infestations overlap, and include large fields which are regularly mowed to facilitate training. This makes both taxa difficult to spot; mowed *R. tomentosa* can flower when they are less than a meter tall. Fortunately, staff can sweep for both taxa at the same time. Unfortunately, numbers of plants found have remained relatively constant. Staff fear that mowed *R. tomentosa* may be more resilient to standard treatment, and will experiment with manual control (digging out the extensive root system) in the coming year. At Pahole, only one plant was ever seen, in 2013 along the fence. Although short, the plant was mature; staff will monitor the site until 2023. The KLOA site was first discovered during this year's survey of Drum Road. All plants were found on one eroded peak, but delimiting surveys are pending. Given the low level of military training in the area, it seems likely *R. tomentosa* was introduced to the area via recreational users. |
| *Juncus effusus* | 86.63 hrs<br>1.00 ha<br>22 visits | 137.50 hrs<br>0.78 ha<br>26 visits | This rush thrives in wet environments and has very long-lived seeds. OANRP manages infestations at Kaala and Makaleha East. There are nine ICAs at Kaala, all of which were checked in the last year. No plants were found at the five smallest ICAs, and numbers of plants continue to decline at the remaining four. Volunteers conduct the majority of control on this species. The decline in effort this year is due to less work occurring in the two largest ICAs at Kaala, in part because of the decrease in total plants. As numbers continue to decline, this project will no longer be appropriate for volunteers, and will be transitioned to a field team. However, there is a large population of *J. effusus* on the State side of the boardwalk which is currently not a high priority for NEPM management; this likely will act as a seed source for spread in the region. There is one ICA at Makaleha East, and only a handful of plants have ever been found at this site. Preventing further spread of this weed is a priority. |
| *Pterolepis glomerata* | 83.50 hrs<br>1.79 ha<br>82 visits | 108.30 hrs<br>1.34 ha<br>79 visits | This taxon is only a target in the Waianae Mountains, where it is a control priority at Kaala, Kahanahaiki, Makaha, Makaleha, Manuwai, Ohikilolo, Pahole, and Palikea. This year, one new site was found, in contrast to five last year. The new site is located at Palikea in the heavily trafficked North Palikea Snail Enclosure; *P. glomerata* likely was spread to the area via management work. Fortunately, only two plants were found, and the site will be easy to check during the course of other field work. The decrease in total *P. glomerata* control effort seen this year in part is due to past effective control at the smallest ICAs, and in part due to a decrease in effort at the largest Manuwai ICA. Of the 19 ICAs checked this year, no plants were found at eight, and declines in plant numbers were seen at six. In general, control efforts have been most successful on the smallest, newest ICAs, while older and/or larger ICAs have been much more difficult to manage. The oldest ICA in Manuwai, for example, continues to grow in size, despite regular checks. Improved delimiting surveys, increased control of obscuring vegetation, and use of pre-emergent herbicide may assist in improving control, until an effective biocontrol is released. |
| *Cenchrus setaceus* | 74.24hrs<br>28.35 ha | 163.76 hrs<br>33.60 ha | This fire-prone grass is a high priority for control across Training Ranges and in MUs. Previous studies by the OANRP seed lab suggest seeds do not persist in the soil for longer than a year and half. An ICA is deemed |

**Table 4** (continued).

| Taxa | 2018 Control | 2017 Control | Comments |
|---|---|---|---|
| | 27 visits | 34 visits | eradicated after 3 years of regular checks with no plants found. Last year, three ICAs were successfully extirpated, including two at SBE and one at KTA. This year, no plants were found at five ICAs (KTA, MMR, Kahanahaiki), a promising trend. One new ICA was discovered at SBE, with just two plants found; military activity is the most likely vector. Another new *C. setaceus* site was discovered near the 'Kawiwi SanMar' fence; this find was reported to the State and OISC. The majority of *C. setaceus* control effort was spent on the largest infestation, at Ohikilolo Lower. However, due to UXO access limitations, staff were not able to visit the entirety of this ICA starting in February 2018; this accounts for most of the drop in total *C. setaceus* control effort. Once access is restored, control will be a priority. Another ICA runs along Ohikilolo ridge and into Keaau; most of it is located on private land and is managed by OISC. Staff surveyed the ridge portion of the ICA and found plants at higher elevations than ever before. OANRP will continue to control ridgeline plants in this ICA and support OISC efforts as much as possible. In the coming year, OANRP plan to test the efficacy of BurnOut in controlling *C. setaceus*. If effective, this non-EPA regulated organic herbicide will be a useful tool for use on the privately owned portions of the ICA, as the landowner has not approved the use of conventional herbicide. Last year, valley-wide surveys for *C. setaceus* were conducted in MMR. These are planned every 3-5 years, and also account for some of the decline in total effort and area treated this year. OANRP assisted partner agencies with aerial sprays of *C. setaceus* infestations at both Waianae Kai and Waimalu/Aiea, providing the aerial spray rig and staff expertise; OANRP will continue to assist partners with these sites, until they build their own aerial rig. |
| *Angiopteris evecta* | 73.55 hrs<br>12.73 ha<br>24 visits | 126.25 hrs<br>12.13 ha<br>28 visits | This long-lived, widespread fern has the potential to grow almost anywhere, from the wet Koolau summit to mesic Waianae forest. It is targeted for eradication in select MUs. Initial control is complete at all known sites, and no mature plants were found, suggesting the current strategy of annual maintenance checks is sufficient to suppress recruitment. Staff continue to find large numbers of seedlings and immatures at many sites; it is unclear how long gametophytes and spores survive. Since *A. evecta* takes many years to mature, next year staff may begin monitoring ICAs once every two years. Effort at all ICAs decreased this year, particularly at Kapuna Upper, which accounts for 71% of all *A. evecta* control. Despite this, area treated remained constant, suggesting increased efficiency. In all, 18 *A. evecta* ICAs were treated this year. Seven of these were in Kapuna Upper, six at Pahole - including one new ICA, two at Kahanahaiki, two at Kaluaa & Waieli, and one at Kaala. No plants were found at the seven smallest ICAs. The new ICA at Pahole was discovered in a previously un-surveyed area in the back of Gulch 2, where a single immature plant was found. |
| *Melochia umbellata* | 54.00 hrs<br>10.29 ha<br>11 visits | 45.00 hrs<br>35.56 ha<br>15 visits | This species, incipient to KTA, has been controlled by OANRP since 2002. It likely forms a persistent seed bank. Of the seven ICAs, two have had no plants since 2011, and one has had no plants since 2013. The four remaining ICAs encompass the core of the infestation; numbers of plants found at all but one of these have steeply declined over the last 5 years. The largest ICA, running along Kaunala gulch, had a spike in the number of immature plants controlled this year, but no mature plants were found. Last year, staff used aerial surveys to guide control efforts in Kaunala, but no surveys were conducted this year; this accounts for the decline in total area managed. |
| *Ehrharta stipoides* | 42.45 hrs<br>3.26 ha<br>59 visits | 50.55 hrs<br>2.97 ha<br>63 visits | This year, eradication was achieved at one ICA, located in Kaluaa & Waieli adjacent to the snail enclosure. Although *E. stipoides* can be quite cryptic and is easily spread, staff have had some success in achieving eradication at select ICAs in the past couple years. In part, this is because past trials have shown that *E. stipoides* |

**Table 4** (continued).

| Taxa | 2018 Control | 2017 Control | Comments |
|---|---|---|---|
| | | | seeds do not persist longer than one year in soil. Of the 18 other *E. stipoides* ICAs monitored this year, two are primarily monitored by NEPM, no plants were found at three, declining numbers of plants were seen at seven, low but constant numbers were seen at four, and two new sites were found. Both new sites are in heavily managed areas: a restoration site at Kahanahaiki, and the Three-Points exclosure in Makaleha West. While this shows that sanitation continues to be an issue, the encouraging trends at the remaining ICAs suggest the increased focus on regular quarterly visits is having a positive impact. |

The thirteen MUs where the most ICA effort was spent this report year are highlighted in Table 5; they include all MUs with greater than 15 hours of ICA effort. MUs are listed in order of effort. Last year, both Kaluaa & Waieli and Kaleleiki MUs were included on this list. Effort declined greatly at both MUs, as all ICAs at the MUs have entered the maintenance phase, with few or no plants found on most visits.

**Table 5.** 2018 ICA Effort in Select MUs

| MU | # of Taxa | Taxa List | # of Visits | Effort (hrs) | Comments |
|---|---|---|---|---|---|
| KTA No MU | 6 | *Acacia mangium*<br>*Cenchrus setaceus*<br>*Chromolaena odorata*<br>*Melochia umbellata*<br>*Miscanthus floridulus*<br>*Senecio madagascariensis* | 123 | 922.60 | 35% of all ICA effort was spent at KTA this year. KTA is a high priority for incipient control efforts because it is one of the most heavily used Ranges and hosts several ecosystem-altering weeds, including the largest population of *C. odorata* in the State. For part of the year, access to KTA was limited as UXO concerns were addressed. This accounts for some of the 90 hour decline in effort from last year. *C. odorata* control accounts for 92% 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, or hours spent surveying trails in un-infested portions of KTA. See Section 3.6 for more discussion of *C. odorata* control. While all other ICA taxa require comparatively less effort, both *M. umbellata* and *A. mangium* infest large areas (37.7 ha and 83.7 ha, respectively) and have long-lived seeds. The strategy for both taxa is to survey/treat each ICA annually, with twice a year checks at *M. umbellata* hotspots. However, this year one *M. umbellata* and several *A. mangium* ICAs were missed, as teams chose to prioritize *C. odorata* work. Most of the *A. mangium* work conducted this year occurred at a site where it overlaps with *C. odorata*; several mature, fruiting trees were controlled at this location. The *M. floridulus* ICA is large and encompasses part of Pahipahialua gulch. Regular checks of the most accessible portions of the ICA have paid off, with declining numbers of plants seen. However, part of the infestation is located in a steep gulch, and work needs to expand in this region. Control efforts at both the *S. madagascariensis* and *C. setaceus* ICAs have been successful, with no plants found at either site this year. |

**Table 5** (continued).

| MU | # of Taxa | Taxa List | # of Visits | Effort (hrs) | Comments |
|---|---|---|---|---|---|
| SBE No MU | 9 | *Alstonia macrophylla*<br>*Cenchrus setaceus*<br>*Chromolaena odorata*<br>*Heterotheca grandiflora*<br>*Rhodomyrtus tomentosa*<br>*Schizachyrium condensatum*<br>*Senecio madagascariensis*<br>*Smilax bona-nox*<br>*Vitex trifolia* | 68 | 411.45 | Located next to residential Wahiawa and heavily used for training, SBE is home to a diverse array of weeds not found on other Army lands. This year, 16% of all ICA effort was spent at SBE. Of this, 68% was spent on *S. condensatum* and 24% was spent on *R. tomentosa*; both taxa are discussed in Table 3. There was a 20% increase in total effort at SBE, due primarily to increased effort on *S. condensatum*. One new *C. setaceus* ICA was found this year, along Centerline road. Only two plants were found and none have been seen since. This likely was introduced via military training. Happily, no plants have been seen at the *C. odorata* ICA since 2015, suggesting the infestation was removed before creating a seed bank. No *H. grandiflora* have been seen at any of the 3 ICAs since 2014; staff will monitor these sites annually until 2024. The single *S. madagascariensis* ICA was eradicated this year; no plants were seen since 2008. The *S. bona-nox* ICA continues to persist, with little decline in numbers of plants found this year. The plants appear to spread clonally and may be resistant to traditional herbicide control techniques. Alternative options, like digging or using Milestone, will be tried in the coming year. The two *V. trifolia* ICAs continue to be low priority, with few plants found. Similarly, *A. macrophylla* is also a low priority, and staff will continue to control it opportunistically during other field work. |
| Kaala Army | 8 | *Angiopteris evecta*<br>*Anthoxanthum odoratum*<br>*Crocosmia* x *crocosmiiflora*<br>*Diplazium esculentum*<br>*Festuca arundinacea*<br>*Juncus effusus*<br>*Pterolepis glomerata*<br>*Sphagnum palustre* | 64 | 305.57 | There was about a 25% increase in total effort spent at Kaala Army this year. This is primarily due to increased control of *S. palustre*. *Sphagnum* control made up 63% of ICA effort and was mostly conducted by OANRP staff. *Juncus* control was 20% of total effort, and *C.* x *crocosmiiflora* control was 11%; both were conducted primarily by volunteers. There are two *P. glomerata* ICAs at Kaala Army; no plants have been seen at either since 2014 and 2015, which is very encouraging. For more discussion of *S. palustre*, *J. effusus*, *C.* x *crocosmiiflora*, and *P. glomerata*, see Table 3. No plants have been seen at the single *A. evecta* ICA since 2013, or at the single *A. odoratum* ICA since 2016. This year, declining numbers of plants were found at the *D. esculentum* ICA. The single *S. palmifolia* ICA was skipped this year; only one more check is needed before this site is considered eradicated. One of the most difficult species to detect is *F. arundinaceae* (4 ICAs). While declining numbers were seen at two ICAs, and no plants were found at two ICAs, this cryptic grass may be well-established within the FAA fence; further surveys and discussion is needed to determine if eradication is feasible. |
| Kaala NAR | 5 | *Crocosmia* x *crocosmiifolia*<br>*Diplazium esculentum* | 29 | 202.08 | There was also about a 25% increase in ICA effort at Kaala NAR this year. This is mostly due to increased control of *S. palustre* by staff and *C.* x *crocosmiiflora* by volunteers. The majority of effort (69%) was spent on the three *C.* x *crocosmiiflora* ICAs. Staff and volunteers focused on plants along the forest edge, and saw a decline in numbers of plants found within the boardwalk fence. Experimental sprays were conducted at the third ICA, as described in Table 3. *Sphagnum* |

**Table 5** (continued).

| MU | # of Taxa | Taxa List | # of Visits | Effort (hrs) | Comments |
|---|---|---|---|---|---|
| | | *Juncus effusus* | | | efforts accounted for 17% of total effort. They focused along the boardwalk corridor, to reduce the likelihood of spread by staff and hikers, and also along the radio tower road. Efforts on the three *J. effusus* ICAs declined this year, in part because efforts have been successful at two of the ICAs. No plants were found this year at both the radio tower road and USGS marker sites. Numbers haven't declined significantly at the boardwalk site, the largest of the ICAs, but given that this species is known to form a persistent seed bank, this is expected. Volunteers continue to conduct most *J. effusus* control. No plants were found at the roadside *D. esculentum* ICA; but regular checks are still needed as this fern is cryptic when it is small. Small numbers of plants continue to be found at the *P. glomerata* ICA at the Kaala Shelter; this site remains a high priority |
| | | *Pterolepis glomerata* | | | |
| | | *Sphagnum palustre* | | | |
| SBW No MU | 3 | *Chromolaena odorata* | 41 | 182.25 | ICA effort increased at SBW this year by 23%. Most of this is due to increased effort on *C. odorata*, which accounts for 87% of ICA efforts at SBW. One new site was found this year, in the Kolekole Range portion of Schofield. See Section 3.6 for further discussion. There are two *E. poepiggiana* ICAs at SBW, an outlier, and a more established patch along Trimble road. No plants have been seen at the outlier site since 2016. Staff completed delimiting surveys at the Trimble site, and control is on-going. Large trees continue to be difficult to kill with conventional herbicide methods. As discussed in Table 3, a new taxon was found at SBW, *S. condensatum*. Located in a grassy field in the RCA portion of the live-fire range, this ICA is a priority for control once UXO issues are resolved. |
| | | *Erythrina poepiggiana* | | | |
| | | *Schizachyrium condensatum* | | | |
| Manuwai | 4 | *Chromolaena odorata* | 32 | 160.70 | ICA effort doubled at Manuwai this year. This is entirely due to time spent surveying buffers for the *C. odorata* discovered last year. Fortunately, no additional sites were found. See Section 3.6 for further discussion. One ICA was not checked this year, *C. decapetala*, as the site was off-limits due to UXO for part of the year. No plants have been seen at this site since 2013. The single *D. iridioides* ICA was checked regularly and plant numbers again declined, however staff still found between 50-300 plants on any given visit. Staff will experiment with herbicide sprays to see if any result in greater suppression. *Pterolepis* continues to present the greatest management challenge at Manuwai. While control at the two smallest ICAs has been effective, with no plants seen at the West fenceline site since 2015, and major declines seen at the Kamaohanui site, plant numbers increased at the East fence line site, and the Manuwai/Alaiheihe ridge site continued to increase in size. Alternate strategies must be considered for the Manuwai/Alaiheihe site. Unfortunately, as discussed in Table 3, a new taxon was found at Manuwai this year, *S. condensatum*. Delimiting surveys will be conducted in the coming year. |
| | | *Dietes iridioides* | | | |
| | | *Pterolepis glomerata* | | | |
| | | *Schizachyrium condensatum* | | | |
| Kahanahaiki | 9 | *Acacia mearnsii* | 56 | 56.32 | Total effort at Kahanahaiki dropped by almost half this year. In part, this is due to four ICAs being eradicated and the completion of *C. setaceus* buffer surveys last year, actions not conducted this year. The majority of time (38%) was spent controlling *A. mearnsii*. Unfortunately, mature trees were found at one of the two ICAs. Most plants found were immature, recruits from a persistent seed bank. Annual surveys will be prioritized to prevent plants from maturing in the |
| | | *Angiopteris evecta* | | | |

**Table 5** (continued).

| MU | # of Taxa | Taxa List | # of Visits | Effort (hrs) | Comments |
|---|---|---|---|---|---|
| | | *Casuarina glauca*<br>*Cenchrus setaceus*<br>*Ehrharta stipoides*<br>*Elephantopus mollis*<br>*Pterolepis glomerata*<br>*Setaria palmifolia*<br>*Sphaeropteris cooperi* | | | future. The *A. evecta* and *S. cooperi* ICAs overlap, and both are centered on the gulch bottom. No mature plants were found of either species, but immatures continue to recruit throughout the gulch. No plants have been seen at the Ethan's outlier *A. evecta* ICA since 2015. There is one *C. glauca* ICA on the edge of Maile Flats. It has been a low priority, as it is not spreading quickly, and therefore has not received regular control. The entire walkable portion of the ICA was swept this year and about 300 plants treated. Part of the ICA is on a cliff and will be controlled on rappel in the coming year. No plants have been seen at the single *C. setaceus* ICA since 2016. This site is approaching eradication. Previously, staff identified a new, potential *C. setaceus* site on a cliff just west of Kahanahaiki. After surveying the site with binoculars, a drone, and via helicopter, staff determined that the plant was a native grass, kawelu, and not *C. setaceus*. Staff continued to make *E. stipoides* treatment a high priority. Although one new ICA was found in the Shire restoration site, regular checks were conducted at all six ICAs, and total plant numbers were low. No plants were seen at either *E. mollis* site this year. Since one of the sites only ever had 1 immature (2015), the criteria for eradication was halved to five years with no plants seen (2020). There are two *P. glomerata* ICAs. No plants have been seen at the Chipper Site ICA since 2012. More surprising, no plants were found at the Kahanahaiki II ridge site either, suggesting past aggressive control was successful in suppressing germination. Last year, a *S. palmifolia* ICA was discovered in Maile Flats. While no plants were found at it this year, a new ICA site was found elsewhere in Maile Flats. This species likely was introduced to the area via staff or volunteers. |
| Palikea | 4 | *Crocosmia* x *crocosmiiflora*<br>*Dicliptera chinensis*<br>*Pterolepis glomerata*<br>*Setaria palmifolia* | 36 | 52.40 | Effort spent at this MU did not change from last year. The majority of time (74%) was spent on *C.* x *crocosmiiflora* control and utilized volunteer labor. However, volunteer efforts have been so successful that many of the remaining plants are located in areas too steep for future volunteer trips. OANRP field staff will take over the largest, steepest ICA in the coming year. Although plant numbers declined dramatically since control began, they have plateaued in recent years. This reflects the difficulty of removing each corm by hand. Foliar sprays may help push this taxon closer to eradication, as discussed in Table 3. About 15% of MU effort was spent on four *S. palmifolia* ICAs. No plants have been seen at one since 2013, another since 2014, and a third since 2016. A small spike in immature plants was seen early in the year at the fourth, but overall, this species appears well managed. No plants were seen at either of the *D. chinensis* ICAs. Last year, one new *P. glomerata* site was discovered on the summit fence trail, but no plants have been seen since. This year a new site was discovered in the Palikea North Snail Enclosure. However, all plants found were immature, suggesting a seed bank may not have formed. |
| Kapuna Upper | 4 | *Angiopteris evecta* | 15 | 46.85 | ICA effort at Kapuna Upper halved this year, falling back to 2015-2016 levels. This is entirely due to reduced effort at all seven *A. evecta* ICAs. *Angiopteris* effort declined in part because of increased efficiency at some ICAs, and decreased coverage at two of the largest ICAs. |

**Table 5** (continued).

| MU | # of Taxa | Taxa List | # of Visits | Effort (hrs) | Comments |
|---|---|---|---|---|---|
| | | *Ehrharta stipoides*<br>*Rubus argutus*<br>*Sphaeropteris cooperi* | | | *Angiopteris* accounts for 88% of MU effort. The annual check strategy is effective, with no mature plants found anywhere, and no plants seen at two ICAs; ICAs may be checked every other year in future. No plants have been seen at either of the *R. argutus* ICAs since 2010, suggesting these sites are approaching eradication. However, staff did find a new *R. argutus* location during belt plot monitoring. As the site is distant from OANRP-managed resources, the location is being managed by NEPM. One new *S. cooperi* ICA was found this year, for a total of three ICAs. There is a large infestation to the west of the Kapuna fence, which may be the source for these plants. All *S. cooperi* locations will be shared with NEPM. As two of the ICAs are distant from OANRP resources, they are a low priority for control. NEPM leads control efforts on the *E. stipoides* ICAs. This year, staff controlled plants found in the trailside ICA during the course of other fieldwork, and monitored another ICA on a side ridge (no plants found). |
| Ohikilolo Lower | 1 | *Cenchrus setaceus* | 5 | 45.50 | Total effort dropped significantly from 120.16 hrs last year. As discussed in Table 3 above, much of this decline is due to access limitations, and periodic valley-wide surveys conducted last year. Staff were able to treat the *C. setaceus* infestation in the first half of the year. Unfortunately, no aerial sprays were conducted this year, due to personnel limitations. This has been rectified and aerial sprays will resume in fall/winter 2018. |
| Pahole | 9 | *Angiopteris evecta*<br>*Axonopus compressus*<br>*Dicliptera chinensis*<br>*Ehrharta stipoides*<br>*Elephantopus mollis*<br>*Pterolepis glomerata*<br>*Rhodomyrtus tomentosa*<br>*Setaria palmifolia*<br>*Tecoma capensis* | 37 | 41.86 | ICA effort almost doubled from last year, primarily due to do an increase in effort for *A. evecta* and *P. glomerata*. Work on *A. evecta* ICAs accounts for 55% of ICA effort at Pahole. One new *A. evecta* ICA was found, for a total of 6 ICAs. All were checked this year, and no plants were found at two. While no matures were found anywhere, immature plants continue to recruit, and annual maintenance checks will be required for years. The single *P. glomerata* ICA is located along the well-used Kahanahaiki-Pahole trail, and has been managed since 2007. The ICA was somewhat overgrown the last couple of years, hampering detection. General habitat weed control is planned in this area, which should assist in future ICA efforts. Control effort increased at the *T. capensis* site, with plants found for the first time since 2013. This vine is challenging to spot due to thick surrounding vegetation, and appears to grow from bits of root left in the soil. If numbers do not decline, Milestone may be used to improve efficacy. Regular checks at the *A. compressus* ICA resulted in a decline in number of plants found this year. Only one *E. stipoides* ICA remains in Pahole, in/around the State Snail Enclosure. No plants were found here for the first year ever, and hopefully the site can be declared eradicated next year. Both the *D. chinensis* and *R. tomentosa* ICAs are on the path to eradication, with no plants seen since 2013. Similarly, no plants have been found at the *S. palmifolia* or *E. mollis* ICAs since 2016. Most encouraging, no new ICAs were found along the well-traveled Pahole-Kahanahaiki fenceline, in contrast to the past couple years. |
| Ohikilolo | 4 | *Cirsium vulgare* | 34 | 34.35 | Effort at Ohikilolo remained relatively constant from last year to this year, and no new ICAs were found. The majority of ICA time at Ohikilolo (45%) was spent on *E. stipoides* control. Regular |

**Table 5** (continued).

| MU | # of Taxa | Taxa List | # of Visits | Effort (hrs) | Comments |
|---|---|---|---|---|---|
| | | *Ehrharta stipoides* | | | checks at *E. stipoides* sites are finally paying off, with declining numbers of plants seen at the largest and oldest ICA. No plants were seen at the single *C. vulgare* ICA; it is challenging to check due to its large size and dense vegetation. No plants were seen at either *P. glomerata* ICA, which is very encouraging, particularly as one ICA is located on the high-traffic main LZ. Staff doubled the effort spent on *R. argutus* control. One ICA was eradicated, with no plants found for more than ten years. Declines were seen at the two other *R. argutus* ICAs, in part due to a new control technique (foliar spray of 5% Milestone in water). This technique appears much more effective than Garlon 4 Ultra control, likely because Milestone translocates into the spreading root/rhizome system of the *R. argutus*, rather than acting as a chemical girdle. |
| | | *Pterolepis glomerata* | | | |
| | | *Rubus argutus* | | | |
| Ekahanui | 2 | *Acacia mearnsii* | 11 | 17.05 | ICA effort increased from last year, due entirely to an increase in time spent controlling *A. mearnsii*. The *A. mearnsii* ICA is large and requires better delimitation to guide control efforts. Since this tree takes several years to mature, annual surveys are sufficient. Effort at *E. stipoides* ICAs remained constant this year. While declines in plant numbers were seen, the infestation at one ICA spread downslope. This ICA is difficult to check due to very steep terrain and the cryptic habit of *E. stipoides*. Quarterly checks will be continued. |
| | | *Ehrharta stipoides* | | | |

**Figure 4**. Examples of incipient taxa. Left: *P. glomerata* in the North Palikea Snail Enclosure. Center: Cryptic immature *E. stipoides* at Kahanahaiki. Right: *C. setaceus* near Kawiwi.

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

**Table 6.** Summary Statistics for WCAs

| Report Year | Visits | Effort (hours) | Area (ha) |
|---|---|---|---|
| 2017-2018 | 951 | 7,753 | 146.3 |
| 2016-2017 | 727 | 6,736 | 126.6 |
| 2015-2016 | 713 | 5,995 | 151.3 |
| 2014-2015 (9 months) | 352 | 3,117 | 80.4 |
| 2013-2014 | 526 | 5,846 | 90 |
| 2012-2013 | 532 | 5,620 | 83.4 |
| 2011-2012 | 443 | 4,199 | 57 |
| 2010-2011 | 409 | 5,123 | * |
| 2009-2010 | 353 | 3,256 | * |
| 2008-2009 | 267 | 2,652 | * |

*Data not comparable

This year, WCA efforts covered 146.3 ha. Staff spent 7,753 hours over 951 visits at 193 WCAs. WCA work accounted for 28% of the total area controlled and 75% 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. Table 6 compares this report year's efforts to previous report years. The 2015-2016 reporting period covered only nine months, but all other reporting periods cover twelve months each. Area data from 2008 through 2011 was not collected as accurately as current practices and is not presented for comparison.

Overall area weeded increased from last year. Looking at a finer scale, area weeded increased at 34 MUs and decreased at 21 MUs. Changes of 2 ha or more are summarized in Table 7. Only a handful of MUs had noteworthy declines in area treated. At both Kaala Army and Kaluaa & Waieli, the decrease is due to reductions in targeted canopy or single species sweeps. At Kaala Army, sweeps targeting *H. gardnerianum* in the bog flats ideally are conducted every 3-5 years; the bulk of these were conducted last year, with much less area requiring treatment this year. At Kaluaa & Waieli, targeted sweeps for select canopy weeds were conducted both last year and this year, but efforts this year focused on smaller, steeper areas in the mauka portion of the MU. Last year, staff cleared rat management trails at Lihue to facilitate rodent management and experimental trials. These trails were not re-cleared this year. The

decline at Haili to Kealia No MU is due to a lack of treatment of *S. cooperi* on the Kuaokala road. As this area is distant from MUs, it is a low priority for OANRP. Many more MUs showed noteworthy increases in area treated, and of those listed in Table 7, increases were seen in the majority of WCAs rather than just a select few. In part, this is the result of increased team staffing and increased focus on weed actions this year. Targeted canopy and single-species sweeps account for portions of the increase at Kahanahaiki (*Grevillea robusta* searches), Kaluakauila (*A. mearnsii* along the fence), Kaluanui No MU (*Psidium cattleianum* sweeps), Manuwai (canopy weed sweeps), Ohikilolo (canopy sweeps in valley WCAs and *Clidemia hirta* sweeps in ridge WCAs), Opaeula (*P. cattleianum* sweeps), Palawai No MU (*S. cooperi* sweeps adjacent to the north end of the Palikea fence), and Pahole (*Montanoa hibiscifolia* sweeps). Targeted grass control increased at a handful of MUs, including Kahanahaiki, Kaluakauila, and Ohikilolo. Heavy spring rains contributed to high grass cover this year, and staff prioritized grass treatment. Several MUs had a large increase fencelines and trails maintained, including Kahanahaiki, Kapuna Upper, Makaha I, Ohikilolo, Palikea, and Pahole. Work around rare taxa sites, including both new and old reintroduction sites, expanded at Ohikilolo, Palikea, and Pahole. Work on restoration sites expanded at Kahanahaiki, Kaluakauila, Makaha I, and Palikea. Lastly, staff assisted partner agencies at with general weed control at Kapuna Upper (NEPM) and Kaluanui No MU (KMWP).

**Table 7.** Changes in Area Weeded between Report Year 2018 and 2017

| IP Management Unit | Increase in Area (ha) | IP Management Unit | Decrease in Area (ha) |
|---|---|---|---|
| Kapuna Upper | +8.63 | Kaala Army | -10.95 |
| Pahole | +7.63 | Kaluaa and Waieli | -6.41 |
| Kahanahaiki | +5.26 | Lihue | -5.29 |
| Kaluanui No MU | +5.16 | Haili to Kealia No MU | -2.50 |
| Opaeula | +4.96 | | |
| Kaluakauila | +3.31 | | |
| Palikea | +3.00 | | |
| Manuwai | +2.99 | | |
| Makaha I | +2.67 | | |
| Ohikilolo | +2.38 | | |
| Palawai No MU | +2.22 | | |

**Table 8.** Changes in Weeding Effort between Report Year 2018 and 2017

| IP Management Unit | Increase in Effort (hrs) | IP Management Unit | Decrease in Effort (hrs) |
|---|---|---|---|
| Palikea | +349.6 | Kaala Army | -161.6 |
| Kahanahaiki | +339.6 | Lihue | -112.3 |
| Oahu South Central No MU | +152.0 | Ohikilolo Lower | -78.0 |
| Makaleha West | +142.0 | Makaha II | -76.7 |
| Kapuna Upper | +130.5 | Kaluaa and Waieli | -45.5 |
| Pahole | +114.9 | Manuwai | -40.2 |
| Opaeula | +89.0 | Pualii North | -25.9 |
| Kaluanui No MU | +83.0 | | |
| Haili to Kealia I | +73.5 | | |
| Waimea No MU | +73.0 | | |
| SBW No MU | +56.5 | | |
| Opaeula Lower | +51.0 | | |
| Ekahanui | +38.95 | | |
| Koloa | +27.0 | | |
| Keaau Hibiscus | +26.0 | | |
| Ohikilolo | +24.3 | | |
| Keaau No MU | +20.0 | | |

Total effort spent weeding again increased this year. Effort increased at 31 MUs, but decreased at 24. Changes of 20 person hours or more are summarized in Table 8. Of the MUs which saw declines, access issues affected both Lihue and Ohikilolo Lower. Perhaps because of this, fence/trail maintenance and rare taxa site weeding also declined at Lihue. Volunteer effort is responsible for much of the decline at Pualii North; this is not a concern, as volunteer time was shifted to other, higher priority projects. Team staffing issues likely contributed to declines at Makaha II and Kalua & Waieli, as effort dropped at most WCAs in these MUs. The declines at both Kaala and Manuwai are due to changes in single-species or canopy weed sweeps; while these projects continued, they shifted to different, smaller WCAs and required less effort. For the MUs which saw increases, a variety of factors are responsible. The Greenhouse staff greatly stepped up maintenance of all living collections this year; this includes sites at Waimea No MU (Waimea Valley), Oahu South Central No MU (Koko Crater, Kapolei), and SBW No MU (Kahua). Management of trails and fences increased greatly at Ekahanui, Kahanahaiki, Kapuna Upper, Keaau Hibiscus, Keaau No MU, Opaeula Lower, Pahole, and Palikea. Weed control at rare taxa sites, both wild and reintroduced, increased at select sites in Ekahanui, Haili to Kealia, Kahanahaiki, Kapuna Upper, Keaau Hibiscus, Opaeula Lower, Pahole, and Palikea. Restoration projects accounted for some of the increase at Kahanahaiki and Palikea. Targeted single-species/canopy sweeps account for some of the increase at Kahanahaiki, and all of the increase at Koloa, Opaeula, and Kaluanui No MU; the latter two were swept in conjunction with KMWP. Lastly, preparation for the new snail enclosure at Makaleha West accounts for much of the increase at this MU.

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

The 20 MUs where the most effort was spent this reporting year are summarized in Table 9. Most of these MUs are large, host multiple rare IP taxa, contain large swaths of native forest, and are readily accessible; these include Kahanahaiki, Palikea, Pahole, Kaala Army, Makaha I, Kaluaa and Waieli, Kapuna Upper, Ohikilolo, Ekahanui, Manuwai, and Lihue. One exception is Opaeula, which is difficult to access due to its location in the northern Koolaus, and which primarily hosts Tier 3 OIP species, making it a low priority for control efforts. Several of other MUs in the table are significantly smaller, but support several IP taxa and include patches of native forest; these include Makaleha West, Opaeula Lower, Makaha II, Kaluakauila, and Pualii North. Three MUs on the list are located in severely degraded habitat and host one or two IP taxa; these include Ohikilolo Lower, Keaau Hibisucs, and Haili to Kealia. Ohikilolo Lower is completely dominated by alien grasses. Maintaining the fuel reduction areas around the rare taxa is a high priority and requires consistent, large inputs of time. Similar habitat is found in Keaau Hibiscus. While no large fuel breaks are maintained here, reducing fuel cover close to the rare taxa requires regular maintenance. Lastly, Haili to Kealia is located along the public Kealia trail, passes through some remnant native forest patches, and is dominated by steep grassy cliffs. Efforts focus on improving habitat and reducing fuel loads directly around rare taxa.

All MUs are managed by an assigned field team which is responsible for the bulk of weed control efforts, particularly any weed control at rare taxa sites. Other factors which contribute to overall effort in an MU include: targeted canopy or single species sweeps not focused around IP taxa (carried out by the assigned field team or roaming EcoRest team), active volunteer projects (led by the Outreach team), and active restoration projects incorporating aggressive weed control coupled with native taxa restoration (often, but not always, implemented by the EcoRest team). These three factors are included in Table 9, and provide some insight into the levels of effort spent at various MUs. Team weeding efforts at Kahanahaiki, for

example, are bolstered by targeted sweeps for priority weeds, volunteer work at two different sites, and five separate restoration projects. In contrast, management of Makaha II this year focused solely on rare taxa sites and was carried out by the field team. Note that only restoration projects associated with proactive weed control which occurred this year were included in the table.

**Table 9.** Top Twenty MUs with Highest WCA Control Effort

| IP Management Unit | Hours | Visits | Area Weeded (ha) | Targeted Canopy or Single Taxa Sweeps Conducted? | Volunteer Projects Present? | Restoration Project On-going? |
|---|---|---|---|---|---|---|
| Kahanahaiki | 1,571.70 | 168 | 11.61 | Yes (*Grevillea robusta*, invasive grasses) | Yes | Yes |
| Palikea | 1,345.25 | 157 | 5.86 | Yes (invasive grasses) | Yes | Yes |
| Pahole | 459.65 | 78 | 12.43 | Yes (*Montanoa hibiscifolia, Spathodea camplanulata, Toona ciliata, Triumfetta semitriloba*) | No | No |
| Kaala Army | 453.28 | 46 | 9.77 | Yes (*Hedychium gardnerianum, Odontonema cuspidatum, Psidium cattleianum*) | Yes | No |
| Makaha I | 447.25 | 42 | 3.92 | No | Yes | Yes |
| Kaluaa and Waieli | 331.00 | 33 | 6.67 | Yes (*Grevillea robusta, Toona ciliata*) | Yes | No |
| Makaleha West | 328.25 | 25 | 0.82 | No | Yes | Yes |
| Kapuna Upper | 288.00 | 32 | 9.86 | No | No | No |
| Ohikilolo | 268.25 | 41 | 6.77 | Yes (*Clidemia hirta, Grevillea robusta, Lantana camara, Psidium cattleianum, Schinus terebinthifolius, Syzigium cumini, Toona ciliata*, invasive grasses) | No | No |
| Ekahanui | 262.20 | 27 | 3.61 | No | No | No |
| Ohikilolo Lower | 249.50 | 22 | 3.44 | Yes (*Leucaena leucocephala*) | No | Yes |
| Manuwai | 144.81 | 24 | 16.42 | Yes (*Acacia confusa, Aleurites moluccana, Grevillea robusta, Schinus terebinthifolius, Spathodea campanulata, Syzigium cumini, Toona ciliata, Trema orientalis*) | No | No |
| Opaeula Lower | 118.75 | 18 | 1.24 | No | No | No |
| Lihue | 118.25 | 17 | 5.21 | No | No | No |
| Makaha II | 113.00 | 11 | 0.23 | No | No | No |
| Haili to Kealia I | 96.00 | 9 | 0.30 | No | No | Yes |
| Opaeula | 95.00 | 4 | 4.97 | Yes (*Psidium cattleianum)* | No | No |
| Kaluakauila | 92.00 | 18 | 5.32 | No | No | Yes |
| Pualii North | 91.80 | 19 | 1.91 | No | Yes | No |
| Keaau Hibiscus | 87.00 | 10 | 0.69 | No | No | Yes |

Control efforts for all MU are summarized in Table 10. The table lists all MUs where WCA control was conducted in the past year. This year, new WCAs were drawn to specifically track weed control along fencelines and trails. For these visits, the intent is simply to maintain infrastructure, as opposed to improve habitat. These new WCAs generally encompass an entire MU, overlapping other WCAs, and explain why the total WCA area is double the MU area. These infrastructure maintenance WCAs have not yet been created at all MUs. Data from the 2017 report is included for reference. This year's data is shaded and in bold. For each year, the total actual area weeded is reported; for example, if a one acre rare plant site was swept on three separate occasions, the area weeded is reported as one acre, not three acres. The number of separate weeding trips is recorded as number of visits, and the effort is recorded in person hours spent weeding (travel and set-up time is not included). While these statistics are not a replacement for vegetation monitoring, they detail the investment OANRP has made over the years.

**Table 10.** MU WCA Weed Control Summary, Report Years 2018 and 2017.

| Management Unit | MU area (ha) | Total WCA area (ha) | 2018 Report Year | | | 2017 Report Year | | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Area weeded (ha)** | **# Visits** | **Effort (person hours)** | Area weeded (ha) | # Visits | Effort (person hours) | |
| Alaiheihe No MU | N/A | 11.35 | **1.97** | **1** | **10.00** | 3.72 | 2 | 6.00 | This area includes the Lower Kaala NAR access road. Staff sprayed roadside weeds, focusing on *Urochloa maxima* and other weedy grasses. The road beyond Manuwai remains impassable. |
| Ekahanui | 87.5 | 91.65 | **3.61** | **27** | **262.20** | 4.77 | 35 | 223.25 | Efforts in this large, highly degraded MU are centered on select, small rare taxa locations. While efforts did not increase at all WCAs, additional effort was spent at the *Abutilon sandwicensis* site, as well as on fenceline maintenance. Staff continued to maintain trails for the rodent control grid; this accounts for 29% of all effort. |
| Ekahanui No MU | N/A | 15.27 | **0.07** ***(655 m²)*** | **2** | **0.50** | 0.01 *(133 m²)* | 1 | 1.15 | Staff sprayed grasses along part of the Honouliuli contour trail, and controlled an outlier site of the invasive herb *Achyranthes aspera* on the primary Ekahanui access trail. |
| Haili to Kealia I | 7.91 | 1.03 | **0.30** | **9** | **96.00** | 0.10 | 4 | 22.50 | Weed control targeted woody weeds and grasses around the *Hibiscus brackenridgii* subsp *mokuleianus* reintroduction and associated common native outplants along the Kealia trail. |
| Haili to Kealia No MU | N/A | 3.37 | **0** | **0** | **0** | 2.50 | 2 | 11.00 | This area encompasses the Kuaokala access road. No control was conducted either along the road or the *S. cooperii* hotspot. |
| Helemano | 60.63 | 61.86 | **0** | **0** | **0** | 0.37 | 7 | 12.50 | Helemano is a low priority MU due to the small number of Tier 1 taxa, and is challenging to access due to weather. Last year staff monitored the fenceline for *S. palmifolia*, but no management was conducted this year. |
| Honolulu East No MU | N/A | 1.85 | **1.85** | **15** | **150.00** | 0.90 | 1 | 9.00 | Weed control was conducted around rare plant living collections at Koko Crater Botanical Garden. OANRP Greenhouse staff weeded this site more consistently and aggressively this year. |

**Table 10** (continued).

| Management Unit | MU area (ha) | Total WCA area (ha) | 2018 Report Year | | | 2017 Report Year | | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Area weeded (ha)** | **# Visits** | **Effort (person hours)** | Area weeded (ha) | # Visits | Effort (person hours) | |
| Huliwai | 0.12 | 0.20 | **0.15** | **3** | **4.00** | 0.12 | 3 | 6.00 | This small MU is centered at an *A. sandwicensis* population. Weed control was targeted directly around the rare plants and along the fenceline. |
| Huliwai No MU | N/A | 9.53 | **0.24** | **2** | **6.25** | 0.08 *(801 m²)* | 1 | 3.00 | Staff conducted weed control around a *Cenchrus agrimonioides* var. *agrimonioides* site during a monitoring trip, and also sprayed grass on the ridgeline leading up to the site. |
| Kaala Army | 49.02 | 51.63 | **9.77** | **46** | **453.28** | 20.73 | 51 | 614.85 | *Hedychium gardnerianum* continues to be the primary weed target at Kaala, along with *P. cattleianum*. This year, staff wrapped up sweeps at the largest WCA, Kaala-01, and began treatment at neighboring Kaala-02. Remaining weed effort occurred at rare taxa sites, the *Odontonema stricta* site, and along trails. |
| Kaala NAR | 20.03 | 22.14 | **0.71** | **6** | **10.00** | 0.01 *(69 m²)* | 1 | 0.50 | Effort focused on *H. gardnerianum* treatment along the State side of the boardwalk and adjacent to the radio tower road at a *Labordia cyrtandrae* site. Staff continued to maintain the area around the shelter/campsite as well. |
| Kaena | 10.06 | 3.28 | **0.19** | **1** | **10.00** | 0.02 *(190 m²)* | 3 | 11.50 | The vegetation matrix at Kaena appears to be relatively stable and requires little effort to maintain. This year, efforts focused the far western and central *Euphorbia celastroides* var. *kaenana* patches. |
| Kaena East of Alau | 14.51 | 1.11 | **0.70** | **2** | **14.00** | 0.17 | 4 | 23.75 | Weed control focused around the small *E. celastroides* var. *kaenana* site, as well as along the access trail. Both grasses and invasive trees were controlled to reduce fuels. |

**Table 10** (continued).

| Management Unit | MU area (ha) | Total WCA area (ha) | 2018 Report Year | | | 2017 Report Year | | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Area weeded (ha)** | **# Visits** | **Effort (person hours)** | Area weeded (ha) | # Visits | Effort (person hours) | |
| Kahanahaiki | 37.7 | 82.58 | **11.61** | **168** | **1571.70** | 6.35 | 124 | 1232.13 | Effort spent weeding again increased at this MU. In part, this is due to continued emphasis on restoration sites; one new site was added near Ethan's, the Schweppes site was expanded, and a full-staff weeding day was held at the Maile Flats Chipper Site. In addition, control expanded at select rare taxa sties, a concerted effort was made to conduct grass control across Maile Flats, and Kahanahaiki I was swept to treat any *G. robusta* missed during 2015-2016 surveys. Volunteers continue to contribute greatly to weed control and habitat restoration at this MU. |
| Kaleleiki | 0.12 | 0.80 | **0** | **0** | **0** | 0.14 | 1 | 9.00 | This *Eugenia. koolauensis* population has been heavily impacted by the *Austropuccinia* rust. Staff did not conduct weed control at this enclosure this year, as weed control is a low priority until new options for *E. koolauensis* management are discovered. |
| Kaluaa and Waieli | 80.97 | 83.00 | **6.67** | **33** | **331.00** | 13.10 | 48 | 376.50 | Control efforts declined at almost every WCA in this MU this year. In part, this is because of team staffing challenges. Control efforts continue to focus on rare taxa sites and targeted canopy weed sweeps. These canopy sweeps account for most of the area treated this year. |
| Kaluaa No MU | N/A | 14.23 | **0** | **0** | **0** | 0.32 | 5 | 12.50 | Staff effort outside the MU is limited to trail, road, parking site and LZ maintenance, as well as management in a small TNC exclosure home to several rare taxa. This year, no infrastructure maintenance work was required. |

**Table 10** (continued).

| Management Unit | MU area (ha) | Total WCA area (ha) | 2018 Report Year | | | 2017 Report Year | | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Area weeded (ha)** | **# Visits** | **Effort (person hours)** | Area weeded (ha) | # Visits | Effort (person hours) | |
| Kaluakauila | 42.73 | 11.70 | **5.32** | **18** | **92.00** | 2.01 | 16 | 76.00 | For the second year in a row, weed control effort expanded at Kaluakauila. This increase occurred at all three WCAs. Efforts focused on rare taxa sites, restoration outplanting areas, grass control across rare plant and restoration areas, fenceline maintenance, and treatment of *A. mearnsii* along the northeastern fence. |
| Kaluanui No MU | N/A | 209.57 | **5.16** | **3** | **83.00** | 0 | 0 | 0 | Staff assisted KMWP in sweeps for *P. cattleianum* and *A. evecta* in the State Kaluanui enclosure. |
| Kamaileunu No MU | N/A | 0.96 | **0.04** ***(375 m²)*** | **3** | **10.00** | 0.04 *(428 m²)* | 1 | 7.00 | All control was conducted at the LZ and campsite. The LZ requires regular maintenance as it quickly becomes overgrown. |
| Kamaili | 2.57 | 3.92 | **0.68** | **6** | **42.5** | 0.85 | 4 | 38.00 | This MU is divided into mauka and makai fences. Potential restoration sites were swept in the mauka fence, while weed control focused on rare taxa reintroductions in the makai one. Fence vegetation maintenance was conducted at both. |
| Kapuna Upper | 172.35 | 177.57 | **9.86** | **32** | **288.00** | 1.23 | 19 | 157.50 | The large increase in effort this year can be attributed to expanded efforts around select rare taxa sites, a joint weeding effort with NEPM in the lama band, regular maintenance of the fenceline, and improved team staffing. |
| Kaunala | 1.98 | 2.24 | **0** | **0** | **0** | 0 | 0 | 0 | Until effective techniques to combat *Austropuccinia* rust in the field are found, OANRP is hesitant to commit resources to habitat restoration at any *E. koolauensis* sites, including all three MUs in KTA: Kaunala, Oio, and Pahipahialua (not listed again in this table). |
| Keaau and Makaha | 1.19 | 0.18 | **0.09** ***(869 m²)*** | **1** | **3** | 0 | 0 | 0 | This small enclosure protects a *Sanicula mariversa* population. Invasive grasses, shrubs, and woody weeds were carefully handpulled around this sensitive rare taxon. |

**Table 10** (continued).

| Management Unit | MU area (ha) | Total WCA area (ha) | 2018 Report Year | | | 2017 Report Year | | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Area weeded (ha)** | **# Visits** | **Effort (person hours)** | Area weeded (ha) | # Visits | Effort (person hours) | |
| Keaau Hibiscus | 3.64 | 3.67 | **0.69** | **10** | **87.00** | 0.21 | 6 | 61.00 | All weeding effort focused around wild and reintroduced *H. brackenridgei* subsp. *mokuleianus*, common native outplantings, and along the fenceline. Both herbaceous weeds and grasses were controlled as a priority. |
| Keaau No MU | N/A | 0.46 | **0.46** | **4** | **20** | 0 | 0 | 0 | The trail leading to the Keaau Hibiscus enclosure was maintained for easy access. All grasses, especially *U. maxima*, were cut and sprayed. |
| Koloa | 71.54 | 72.95 | **1.20** | **8** | **86.50** | 2.15 | 5 | 59.50 | Located at the summit of the Koolau Mountains, weather poses a major challenge to conducting effective weed control. One camp trip occurred this year. Staff conducted several sweeps targeting *P. cattleianum*, which accounts for the majority of effort and area, and also weeded a rare plant reintroduction site. |
| Lihue | 711.92 | 714.91 | **5.21** | **17** | **118.25** | 10.50 | 32 | 230.55 | Access issues have plagued Lihue this year, and account for much of the reduction in area and effort. In addition, no rodent grid trail maintenance occurred this year, unlike last year. 2018 efforts were split between control at rare taxa sites and fenceline maintenance. |
| Makaha I | 34.20 | 71.20 | **3.92** | **42** | **447.25** | 1.25 | 38 | 451.50 | Effort stayed constant at Makaha I this year. The majority of effort was spent on restoration projects on Camp Ridge, 49%. These sites responded well to *P.cattleianum* removal, and are actively being restored with outplants, transplants and seedsows. The rodent control grid was expanded this year, and fence/trail maintenance accounts for 27% of MU effort. Volunteer efforts on Flag City Ridge account for 16% of weed effort. Only 8% of effort was spent on rare taxa sites, in part because of team staffing challenges. |

**Table 10** (continued).

| Management Unit | MU area (ha) | Total WCA area (ha) | 2018 Report Year | | | 2017 Report Year | | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Area weeded (ha)** | **# Visits** | **Effort (person hours)** | Area weeded (ha) | # Visits | Effort (person hours) | |
| Makaha II | 26.69 | 6.85 | **0.23** | **11** | **113.00** | 0.59 | 18 | 189.70 | Weed control efforts dropped this year, in part due to team staffing challenges. While efforts continued to focus on rare taxa reintroduction sites and fenceline maintenance, time and area declined for both. |
| Makaleha East | 111.99 | 3.59 | **0** | **0** | **0** | 0.01 (133 *m²)* | 1 | 0.60 | Last year, staff opportunistically controlled high priority weeds while monitoring rare taxa. No similar effort occurred this year. |
| Makaleha East West Branch | 1.14 | 1.23 | **0** | **0** | **0** | 0.00 (28 *m²)* | 1 | 1.00 | Last year, staff controlled weeds around the *Kadua degneri* var. *degneri* site during a regular monitoring trip, but as no rare plant monitoring trip was scheduled this year, no weed control was performed either. |
| Makaleha West | 38.04 | 1.50 | **0.82** | **25** | **328.25** | 0.64 | 16 | 186.25 | This MU has two widely separated WCAs. Most effort took place at the 3-Points WCA. About 30% of all effort was spent clearing the new snail enclosure. The remaining staff effort focused around rare taxa locations and on grass control, while volunteer effort focused on the fenceline and in a patch of *P. cattleianum*. For the first time since 2015, weed control was conducted at the northern WCA. This small enclosure protects a *Schiedea obovata* site, and requires more weed management. |
| Makaleha West No MU | N/A | 0.52 | **0** | **0** | **0** | 0.11 | 2 | 7.00 | Staff maintain the access trail as needed. No control was required this year. |

**Table 10** (continued).

| Management Unit | MU area (ha) | Total WCA area (ha) | 2018 Report Year | | | 2017 Report Year | | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Area weeded (ha)** | **# Visits** | **Effort (person hours)** | Area weeded (ha) | # Visits | Effort (person hours) | |
| Manuwai | 122.49 | 127.44 | **16.42** | **24** | **144.81** | 13.43 | 24 | 185.00 | Effort at Manuwai was split between large landscape sweeps for canopy weeds, control around discrete rare taxa sites, fenceline maintenance, grass control, and habitat weed control. While landscape sweeps account for the majority (83%) of area treated, they account for just 41% of effort. Rare taxa habitat weed control accounts for 49% of MU effort, but less than 10% of area. This year, staff conducted one trip weeding a native forest patch, and hope to expand this effort in future. Maintenance of grass cover on the northern end of the MU is important for fuels reduction, and options to expand this will be investigated in future. |
| Manuwai No MU | N/A | 4.17 | **4.17** | **6** | **19.00** | 3.90 | 5 | 25.00 | Staff cleared vegetation, primarily *U. maxima*, other grasses, and shrubs, along both access roads and the western access trail. |
| MMR No MU | N/A | 20.24 | **1.24** | **9** | **46.50** | 1.03 | 4 | 35.00 | The majority of time was spent maintaining grasses along the Makua-Kuaokala fenceline. Weeds were also controlled along the C-Ridge and Puaakanoa-Farrington Highway fences. |
| Moanalua No MU | N/A | 86.33 | **0** | **0** | **0** | 0.37 | 1 | 15.00 | Last year, staff cleared trails in Moanalua to facilitate rodent control and Elepaio monitoring. No similar effort was needed this year. |
| Nanakuli No MU | N/A | 6.01 | **1.57** | **1** | **17.50** | 2.16 | 2 | 32.00 | This leeward facing bowl stretches between the Palikea and Palikea IV MUs. Staff swept it for *S. cooperi*, to reduce ingress into neighboring MUs. |
| Napepeiaoolelo | 0.75 | 0.48 | **0.07 *(651 m²)*** | **1** | **2** | 0.13 | 2 | 5.00 | The *Hesperomannia oahuensis* protected by this fence has been dead since 2013. Staff continue to monitor and maintain the fenceline. |

**Table 10** (continued).

| Management Unit | MU area (ha) | Total WCA area (ha) | 2018 Report Year | | | 2017 Report Year | | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Area weeded (ha)** | **# Visits** | **Effort (person hours)** | Area weeded (ha) | # Visits | Effort (person hours) | |
| Oahu South Central No MU | N/A | 10.46 | **0.67** | **1** | **11.00** | 0 | 0 | 0 | There is a living collection of *H. brackenridgii* subsp *mokuleianus* in Kapolei. OANRP Greenhouse staff controlled grasses and weedy shrubs once. Staff have not decided whether this site will be maintained as a living collection. |
| Ohikilolo | 232.79 | 139.17 | **6.77** | **41** | **268.25** | 4.39 | 24 | 244.00 | In the Lower Makua portion of the MU (11% of effort), effort was divided equally between rare taxa sites and sweeps of native-forest dominated ridges. In the Ohikilolo Ridge portion of the MU (89% of effort), efforts increased greatly over last year. In part, this is due to increases at select rare taxa sites, more grass control, and large sweeps targeting *C. hirta* (per MU belt transect monitoring recommendation). |
| Ohikilolo Lower | 28.75 | 4.54 | **3.44** | **22** | **249.50** | 3.84 | 35 | 327.50 | Work at this MU is focused in 3 WCAs centered on rare taxa. The goal of weed control is to reduce fuels while increasing native vegetation cover. Effort was hampered by a range closure, which is still not fully resolved. Despite this, staff were able to sweep all WCAs in their entirety several times. Restoration plantings are surviving and hopefully will reduce weed control effort required in future. |
| Opaeula | 50.93 | 50.42 | **4.97** | **4** | **95.00** | 0.01 *(61 m²)* | 1 | 6 | This MU hosts primarily Tier 2 taxa, and thus is a low priority for weed control. KMWP and OANRP staff conducted one camp trip to the area, focusing on landscape sweeps of *P. cattleianum*. |
| Opaeula Lower | 10.15 | 13.96 | **1.24** | **18** | **118.75** | 0.50 | 10 | 67.75 | Effort increased this year, in part due to improved team staffing. Control focused around wild and reintroduced rare taxa sites, native forest patches, and fenceline maintenance. |

**Table 10** (continued).

| Management Unit | MU area (ha) | Total WCA area (ha) | 2018 Report Year | | | 2017 Report Year | | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Area weeded (ha)** | **# Visits** | **Effort (person hours)** | Area weeded (ha) | # Visits | Effort (person hours) | |
| Pahole | 88.02 | 193.61 | **12.43** | **78** | **459.65** | 4.79 | 40 | 344.75 | This is the second year in a row where effort and area treated has increased at Pahole. This improvement cannot be attributed to one specific project, but represents an across the board increase at most WCAs. Efforts continue to focus on rare taxa sites and surrounding habitat, and along the Kahanahaiki-Pahole access trail. |
| Pahole No MU | N/A | 14.92 | **8.58** | **12** | **53.00** | 8.05 | 7 | 47.00 | Staff continues to control weeds along the Pahole road, around the Nike greenhouse and LZ, and on the access trail to the main gulch. |
| Palawai No MU | N/A | 5.97 | **2.24** | **1** | **13.50** | 0.02 *(187 m²)* | 2 | 4.25 | This area immediately abuts the Palikea MU. Staff swept it for *S. cooperi* to reduce ingress of this highly invasive fern into the enclosure. No maintenance of the LZ was conducted this year. |
| Palikea | 9.95 | 22.14 | **5.86** | **157** | **1345.25** | 2.85 | 83 | 995.65 | Last year, clearing for the Palikea North Snail Enclosure accounted for 45% of 2017 effort. Despite the completion of this project, weed control effort again increased this year. Effort increased at most WCAs, in part due to the expansion of existing - and creation of new - restoration sites across the MU. In particular, efforts increased dramatically at the 'Fern Gully' restoration site (222.75 hrs). In addition, weed management around rare taxa sites expanded, fence and trail maintenance increased, and volunteer efforts were maintained. Though relatively small, this MU is a high priority due to the density of high quality native forest patches, presence of priority IP species, and accessibility. |
| Palikea V | 1.40 | 0.02 | **0.02 *(176 m²)*** | **1** | **6** | 0 | 0 | 0 | Staff cleared a new landing zone in this MU to facilitate access for gear-heavy rare plant rappelling trips. |

**Table 10** (continued).

| Management Unit | MU area (ha) | Total WCA area (ha) | 2018 Report Year | | | 2017 Report Year | | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Area weeded (ha)** | **# Visits** | **Effort (person hours)** | Area weeded (ha) | # Visits | Effort (person hours) | |
| Poamoho North | 257.77 | 202.77 | **0** | **0** | **0** | 3.99 | 3 | 192 | This MU is of moderate priority, as it contains few MFS IP taxa and is actively managed by two other agencies. Last year, OANRP assisted NEPM and KMWP on one weed control camp trip targeting *A. evecta*. OANRP will continue to participate in joint trips in future, as time permits |
| Puaakanoa | 10.7 | 1.56 | **0.48** | **4** | **10.00** | 0.21 | 3 | 17.00 | Efforts focused on grass and herbaceous weed control around *C. celastroides* sites. Weed control efforts were again hampered by the closure of MMR due to UXO issues. |
| Pualii North | 7.99 | 10.98 | **1.91** | **19** | **91.80** | 1.53 | 14 | 117.75 | This year, staff weeded at wild and reintroduced rare taxa sites (including potential *Drosophila* sites), around native forest patches, and along the fenceline. Most of the decline in effort from last year is due to a reduction in volunteer work in the lower part of the gulch. |
| SBE No MU | N/A | 4.16 | **0.15** | **5** | **10.00** | 0.06 *(602 m²)* | 2 | 5.00 | Weeds were maintained at East Base to reduce the potential for staff and volunteers to act as vectors. In addition, the sediment disposal site was sprayed to keep it open. In the coming year this site will be abandoned in favor of a more secure location on the old Schofield landfill. |
| SBW No MU | N/A | 2.61 | **1.68** | **27** | **71.00** | 1.33 | 10 | 14.50 | This year, staff continued controlling weeds at the Kahua Living Collection site; this accounts for the increase in effort. Staff also continued to regularly maintain weeds at West Base to reduce the potential for staff to act as vectors. |
| Waianae Kai | 3.66 | 1.14 | **0.11** | **3** | **7** | 0.06 *(580 m²)* | 2 | 2.50 | Staff conducted limited weed control in this small MU, focusing around rare taxa sites and along fencelines. |
| Waimanalo to Kaaikukai No MU | N/A | 2.35 | **0.51** | **4** | **3.25** | 0.98 | 2 | 2.50 | This area encompasses the Palikea access trail. Staff controlled alien grasses along the trail to reduce the potential for weed spread, and treated some woody weeds at the Meadow site. |

**Table 10** (continued).

| Management Unit | MU area (ha) | Total WCA area (ha) | 2018 Report Year | | | 2017 Report Year | | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Area weeded (ha)** | **# Visits** | **Effort (person hours)** | Area weeded (ha) | # Visits | Effort (person hours) | |
| Waimea No MU | N/A | 0.27 | **0.27** | **18** | **73.00** | 0 | 0 | 0 | The rare plant living collections at Waimea Valley were maintained throughout the year. Increased effort and attention were given to all living collections this year. |
| TOTAL | N/A | 3028.04 | **146.30** | **951** | **7,753.44** | 126.64 | 727 | 6,735.9 | Total effort, visits, and area increased this year. These increases can be attributed to expansion of restoration sites, increased focus on weeding around many rare taxa sites, continued single-species and canopy weed control sweeps, and increased maintenance around infrastructure and living collections. |

**Figure 5.** Fruiting *Acacia mangium* at KTA

## 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. Similarly, much remains to be learned about restoration techniques. Collaboration is critical in achieving progress. OANRP supports, and is supported by, a variety of partner agencies in addressing weed control and restoration issues. In alphabetical order, they include, but are not limited to:

- Bishop Museum. Plant samples were submitted to and identified by the Bishop Museum Herbarium staff. Noteworthy finds are discussed in Section 3.5.
- Board of Water Supply (BWS). BWS reviews OANRP weed control actions in Makaha Valley.
- Coordinating Group on Alien Pest Species (CGAPS). The Federal Biologist participates in the CGAPs working groups on mosquitoes and coconut rhinoceros beetle.
- Hawaii Agricultural Research Center (HARC). This year, OANRP began assisting HARC with their project to develop fungus-resistant *Acacia koa* stock for the Waianae Mountains. Staff received an overview of the *A. koa* project and collections needs, shared *A. koa* seeds from previously banked collections, and collected from new locations. Once fungus-resistant stock is developed, OANRP will be able to use it in restoration projects.
- Hawaii Department of Agriculture (HDOA). OANRP maintains positive working relationships with HDOA staff.
- Hawaiian Electric Company (HECO). OANRP shared invasive weed location information with HECO. HECO is currently working on sanitation/weed decontamination protocols for themselves and their contractors, and the invasive weed information will assist them in this effort.
- Hawaii Army National Guard (HIARNG). OANRP shared invasive plant information with the HIARNG Conservation Manager, in support of her efforts to better educate National Guard soldiers on invasive species issues.
- Koolau Mountains Watershed Partnership (KMWP). OANRP is a member of the partnership. The EcoRest Team joins one KMWP camp trip per year, targeting priority weeds in Poamoho. This year, due to scheduling issues, staff assisted with weed control sweeps at Kaluanui and Opaeula instead of Poamoho.
- NAVFAC Marianas. OANRP staff met with NAVFAC biosecurity program staff to discuss weed control and biosecurity issues.
- Oahu Invasive Species Committee (OISC). OANRP serves on the OISC steering committee and attends all OISC meetings. In June 2018, the OANRP Ecosystem Restoration Program Manager completed two years as the OISC Chair. In the past year, joint projects and collaborations included:
    - OANRP reported finds of OISC target species: *Nassella tenuissima* (private residence in Whitmore Village), *C. setaceus* (Puu Kawiwi/Waianae Kai), and *C. odorata* sites off of Army Training lands (Climbworks Keana Farms, Kaluaa, Pupukea-Paumalu State Park Reserve, and Kamaili).
    - OANRP assisted with aerial ball sprayer treatments of *C. setaceus* at Aiea/Waimalu and *Tibouchina herbacea* on the windward slopes of the Koolau Mountains near Poamoho. Planned aerial sprays of *C. setaceus* at Waianae Kai and *C. odorata* at Kahana were cancelled due to weather and scheduling issues.

  - OANRP shared aerial ball sprayer rig specifications with OISC, in support of OISC pursuing construction of their own rig.
  - OANRP continues to collaborate with OISC on a variety of *C. odorata* issues, including contracting OISC to conduct control on KTA, collaborating on overall management strategy, and pursuing a biocontrol.
  - OANRP also collaborates with OISC on *C. setaceus* management on the Waianae coast, particularly in the Ohikilolo Ridge and Waianae Kai regions.

- State of Hawaii: Dept. of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW), Natural Area Reserve System (NARS), Forest Reserves (FS), Native Ecosystems Protection and Management (NEPM), and State Parks. Several OANRP MUs are located on State land. In the past year, collaborations with State staff included the following:
  - OANRP and NEPM staff shared discoveries of new invasive weed locations and discussed new and existing weed control/restoration projects. OANRP continues to assist with NEPM *S. palustre* control efforts at Kaala by treating both sides of the boardwalk corridor. Following an incident where OANRP staff mistakenly conducted weed control at one of the State release sites for *Tectococcus ovatus* (the *P. cattleianum* biocontrol), NEPM staff shared GIS locations of all the release sites with OANRP; all OANRP staff were directed to avoid these areas.
  - OANRP continues to assist NEPM with 80 person hours of weed control effort per year, as part of a work swap agreement. This year, staff fulfilled the hours via assisting with sweeps of a high-quality *Diospyros* spp. patch in Kapuna Upper.
  - OANRP shared aerial ball sprayer rig specifications with NEPM, in support of NEPM pursuing construction of their own rig.
  - OANRP reported the discovery of *C. setaceus* on Forest Reserve land at Puu Kawiwi in Waianae Kai.
  - OANRP provided a letter of support to DOFAW for the release of *Syphraea uberabensis*, a biocontrol which targets *T. herbacea* and *P. glomeratus*.
- Dr. Cliff Morden, University of Hawaii. OANRP is collaborating with Dr. Morden and OISC on genetic testing of *C. odorata*; see Section 3.6 for details.
- College of Tropical Agriculture and Human Resources (CTAHR), University of Hawaii. OANRP continues to collaborate with Dr. James Leary on research into novel weed control techniques, in particular, Incision Point Application (IPA) and Herbicide Ballistic Technology (HBT). For a complete description of IPA and HBT, and a history of these projects, please see the 2009–2014 and 2016 MIP and OIP Status Reports. This year, staff monitored two IPA trials on *Citharexylum caudatum* and *Psidium cattleianum* var. *lucidum*. These trials are designed to run for two years, and results will be discussed when they are complete. In addition, staff assisted Dr. Leary's efforts in obtaining a Special Local Needs label for Fusilade DX use in natural areas. The SLN was issued this year; this greatly assists OANRP, as it allows staff to use a grass-specific product and thus reduce non-target impacts during alien grass control efforts.
- Waianae Mountains Watershed Partnership (WMWP). OANRP is a member of the partnership.
- Waimea Valley. OANRP manages two rare taxa living collection sites at Waimea.

This year, OANRP participated in two conferences related to weed control and restoration issues. The Fifth Annual Oahu Natural Areas Restoration and Weed Management Forum was held on March 22, 2018 at Aloha Stadium. The interagency hui Priority Oahu Native Ecosystems (Priority ONE) organizes and

hosts this annual workshop. The Forum is a valuable way to share information, data, and control techniques among local agencies conducting active weed control management and habitat restoration work, and is structured to encourage discussion. The first two-thirds of the Forum consisted of short talks, each of which was followed by ample time for questions. The last third of the Forum was dedicated to group discussions on native plant restoration and vegetation monitoring. OANRP continues to be an active participant in this event. Jane Beachy served on the organizing committee, provided a short update on the 'Weed Control by Species' reference document maintained by Priority ONE, and assisted in facilitating group discussions. Taylor Marsh presented a talk entitled 'Native Ecosystem Restoration as Weed Control.'

**Figure 6.** The 5th Annual Oahu Natural Areas Restoration and Weed Management Forum scored big!

The second Hawaii Native Seed Conference was held May 16-18, 2018 at the University of Hawai'i at Mānoa. The conference began with a full day of short presentations related to the conservation of seed, the use of seeds in ecological restorations, social aspects of seed conservation, and seed ecology, followed by two days of paired lecture/workshops focusing on four areas central to seed conservation; germination and breaking seed dormancy, optimal harvest time and seed collection methods, post-harvest handling and processing, and seed storage and longevity. Eighty-five people attended the conference including delegates from the Millennium Seed Bank Partnership, Royal Botanic Gardens, Kew, the Cincinnati Zoo and Botanical Garden, the New Zealand Indigenous Biosecurity Network, and the Southwest Seed Partnership. OANRP staff were significantly involved in this year's conference. Tim Chambers served on the conference's organizing committee, while Michelle Akamine, Makanani Akiona, Julia Gustine Lee, and Tim Chambers presented at the conference.

## 3.3 VEGETATION MONITORING

This year, vegetation belt transect monitoring was conducted and analyzed for the Kahanahaiki and Kapuna Upper MUs, and analysis was completed for last year's monitoring of Palikea MU (Appendices 3-8 to 3-10). The results of these studies will be used to modify weed control plans at these MUs. Vegetation monitoring options for Pahole MU were researched and discussed with the State. Belt transect monitoring will be installed at Pahole in 2020. Staff aided NEPM and a researcher in re-reading the Welton plots in Pahole and Kapuna gulches; unfortunately, the original methodology cannot be replicated. Point-intercept vegetation monitoring was conducted at the Makaha 'Giant Ohia' Restoration Area and North Palikea Snail Enclosure, Gigapan imagery was taken at Keaau Hibiscus, and drone utilization protocols for capturing vegetation change over time were developed; results of these efforts are not presented this year, but will be compiled and presented at a later date. Gigapan imagery was taken of cliff-side portions of the *C. odorata* infestation; since these images were used to guide OISC control efforts, no formal analysis was conducted.

## 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 the Range Division, Directorate of Public Works (DPW), and contractors to increase the Army's awareness of alien weed threats and improve sanitation-related protocols, practices, and policies. Highlights are summarized here.

**Soldier Training**

- OANRP regularly participates in conducting Officer in Charge/Range Safety Officer (OIC/RSO) briefs, which are held about three times a month. The OICs and RSOs for each unit are required to attend this brief before they can schedule or conduct any training on Army lands. This is the most direct way for staff to highlight natural resources concerns to soldiers, particularly the need to clean vehicles and gear and report fires. This year, OANRP staff split briefing duties with DPW Cultural Resources staff, with each office presenting a joint natural/cultural resources message in alternate months. In addition, OANRP staff continued to update the briefing slides to keep them current.
- Prior to any training at MMR, units receive a joint brief from Range Control, DPW Cultural Resources, and DPW Natural Resources. In the Natural Resources portion of the brief, staff emphasize prevention of invasive species spread and washrack use. This year, briefings were held a handful of times, including once to a unit from the Air Force.
- The Federal Natural Resource Manager and Biologist regularly attend and present at quarterly USARHAW Environmental Quality Control Committee (EQCC) meetings. These meetings are the primary way environmental concerns, from clean water to natural resources to hazardous waste, are conveyed to unit commanders. This year, EQCC meetings incorporated hands-on elements. At one meeting, attendees toured the OANRP baseyard to learn about natural resources issues. At another, attendees viewed a Humvee cleaned as a demonstration; DPW staff pointed out problem areas and showed how the Humvee did not meet inspection standards. Unit leaders saw firsthand how detailed washing needs to be in order to pass inspection. An informational video was created by the Garrison for soldiers to watch before using the Central Vehicle Wash Facility (CVWF), and was publicized at the EQCC; https://vimeo.com/117847345.

**Figure 7.** Still from the CVWF video, showing soldiers cleaning a stryker with water cannons during the pre-wash bath.

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

- Last year, staff noted a number of uncommon weeds growing out of a sediment pile on Wheeler Army Airfield. After discussing the location with other DPW divisions, DPW decided to rehabilitate this area to better meet clean water requirements. Once work is complete the area will function as a safe stockpile for construction debris and street sweeper sediment. It is monitored during annual road surveys.
- Federal staff conducted an informational brief to Center for Environmental Management of Military Lands (CEMML) contractors, highlighting invasive species concerns, sanitation and wash rack use, and fire prevention. CEMML contractors work under the Range Division and conduct much of the vegetation maintenance on range. CEMML requested photos of priority invasive weeds for their staff; OANRP produced posters for their baseyard (completed in July 2018, outside of this report year).

**Wash Rack Status**

- The 2014 Wash Rack Utilization Policy to Control Invasive Species is still in effect. Federal staff proposed updates to the policy in 2017, but the new policy has not yet been signed.
- Last year, Federal Staff worked with the DPW Engineering Department on signs reminding personnel to use the wash racks, to be posted on all exit gates at KTA, SBE, SBS, and SBW. The signs were fabricated, but had not been installed by the end of this report year. They were installed in August 2018.


**Figure 8.** Sign reminding all personnel to use the wash rack, posted on the SBE Centerline road gate.

- This year, the Federal Natural Resource Manager officially became part of the management chain for the wash facilities. This means OANRP has greater insight into the challenges with maintenance contracts, facility scheduling, and soldier requirements. This has greatly assisted OANRP in both monitoring when the wash facilities are functional, and improving systems to encourage and require regular use. For example, all units use the RFMSS site to reserve trainings areas. The RFMSS site opens first to an announcement page; a notice detailing the hours of

operation and a contact number for the wash facilities is included on this page, making it easy for units to find more information. However, major challenges remain, such as ensuring all units are aware of SOPs regarding wash rack use and have completed required risk assessments.

- This year, the 3rd Infantry Brigade deployed to the Joint Readiness Training Center in Fort Polk, Louisiana. All equipment was shipped through Port Arthur, Texas, where it failed agricultural inspection. Soil, seedlings, twigs, and black twig borers were found by inspectors. The Brigade incurred over one million dollars in costs, including port and boat fees, as well as cleaning fees. This incident highlights the importance of cleaning all equipment and vehicles before they leave the state. Unfortunately, such rigorous USDA inspections are not conducted for shipments within the State or returning to Hawaii from the continental U.S., only when arriving in other States from Hawaii.
- The CVWF, SBE Wash Rack, and KTA Wash Rack were all at least partially operational for most of the year. The CVWF is the only facility capable of handling large, tracked vehicles, and also has the greatest capacity for washing highly soiled vehicles; the 84th Engineers were diverted from the SBE Wash Rack to the CVWF due to the enormous amount of mud on their machinery.
- The KTA Wash Rack was plagued by equipment problems throughout the year. While parts of the facility were always operational, the facility as a whole could not accommodate large units. The large-volume fire hoses were broken and many of the pressure washer hoses and spray guns leaked copiously. There was also a large leak in the equipment building. On occasion, staff were unable to use the KTA Wash Rack at all. In part, these issues were difficult to resolve as the contract for maintenance of the KTA facility ended, and a new contract has yet to be put in place. DPW is managing the maintenance of washrack facilities in the meantime.

**Figure 9.** Left: this hose reel is detached from its mount and now sits on the ground, the reel is rusted through, and water leaks from all connecting points. Right: while still on its mount, this hose reel leaks prolifically.

**Figure 10.** Leaking and broken pressure hoses.

### Wash Rack Sediment Disposal

- For the first time ever, the sediment basins at the CVWF were cleaned out this year. A secure site for the sediment was identified at the landfill off Area X. The sediment was dumped at the site in June 2018. The Army is required to maintain a vegetated cap over the landfill, so once it had dried, the sediment was spread in a thin layer over approximately 0.35 acres, and sprayed with rye grass hydromulch. Unexpectedly, staff found a fair amount of trash in the sediment. This was removed prior to hydromulching. The site was then marked with cones and rope, to prevent contractors from mowing it during regular landfill maintenance. Staff will monitor the site throughout the year for germination of priority invasive weeds.

**Figure 11.** Sediment spread out at the landfill site.

**Figure 12.** Sediment disposal site, marked by cones, after hydromulch application.

**KTA**

- Four new *C. odorata* sites were discovered at KTA this year. Three are located adjacent to the highly trafficked Kane's LZ, and one is at an abandoned building site on Mt. Kawela. It is unclear if these new sites were spread via military training or trespassing recreational motocross riders, but all were found along trails or roads, and highlight the importance of cleaning gear and vehicles before leaving KTA.
- Range Division contacted the Natural Resources office in April 2017 regarding upcoming clearing work scheduled for several roads and trails in the Bravo 1 training range. This area is adjacent to the *C. odorata* infestation. Staff surveyed the area prior to the first stage of work in May and found no *C. odorata*. Staff surveyed the area again in August 2017 before the second stage of work; one immature *C. odorata* was found and removed from one section of trail.
- Last year, OANRP reported finding a zipline tower and observing unauthorized ATV activity in the Delta 1 and 2 training ranges. The zipline tower belongs to Climbworks at Keana Farms, a business which runs zipline and ATV tours. The ITAM office investigated the zipline towers, but staff have not heard from the Department of Emergency Services about what, if any, action was taken. The entire area, both on KTA and on Keana Farms, is infested with *C. odorata*. OISC surveyed part of the Keana Farms area last year and began treatment. There is huge potential for *C. odorata* to spread from this area to other locations on the island.
- This year, there were major staffing challenges at KTA Range Control. This often had a negative impact on staff productivity, as there were numerous delays in getting keys to enter the range and use the wash rack. On a couple occasions, Range Control was unable to open the wash rack for staff, due to the keys being misplaced or mistakenly checked out to a unit for multiple days. While OANRP has since been issued a set of keys for KTA, staffing challenges at KTA need to be resolved to ensure units and other range users are able to use the washrack.

**MMR**

- OANRP and Federal staff reviewed a proposal for a training event called 'Spur Ride.' Staff emphasized the importance of cleaning gear prior to entering MMR, and investigated options for conducting outreach to the participants on the unique natural resources found in Makua Valley.

**SBE**

- Staff discovered *C. setaceus*, a high priority incipient invasive weed, along Centerline Road in August 2017. All other *C. setaceus* sites at SBE were eradicated in 2016, and no plants have been seen at the KTA infestation since 2015, making these unlikely sources for this new infestation. Since this area is heavily used for training, and *C. setaceus* is widespread at Pohakuloa Training Area (PTA) on the Big Island, the most likely vector for this introduction is soldiers or vehicles from PTA. Oahu staff continue to highlight the importance of cleaning gear between islands.
- Staff continue to monitor and maintain cones, rope, and signs around select *S. condensatum* hotpsots to prevent accidental mowing of this highly invasive grass by maintenance crews.

**SBW**

- High priority incipient invasive weeds were found at two new sites on SBW this year. In November 2017 staff found one mature *C. odorata* in the Kolekole Range area, and in January 2018 staff found a small infestation of *S. condensatum* in the BAX. This is the first time *C. odorata* was found outside of the McCarthy Flats area on SBW, and the first time *S. condensatum* was discovered outside of SBE. Both of these sites are in areas where vegetation was either mowed or cleared in the last year, and this seems like the most likely vector. Federal staff briefed Range Maintenance staff about the importance of segregating equipment used on different ranges.
- In May 2018, staff noted a stand of Eucalyptus adjacent to Area X and the McCarthy Flats access road was cut down. This area is part of the active SBW *C. odorata* infestation. When the site was surveyed, *C. odorata* plants were found in and around the cleared area. Staff sprayed the area with pre-emergent herbicide to minimize seedling recruitment, and discussed the issue with ITAM. A week later, ITAM requested OANRP survey an area adjacent to OP X-Ray prior to more vegetation clearing. One large plant was found, and staff were able to show it to both ITAM and CEMML contractors. Staff hope to maintain open lines of communication with ITAM and CEMML in the coming year, and avoid the need for retroactive surveys.
- A private contractor was again hired to spray herbicide across much of the area within the firebreak road at SBW this year, prior to the prescribed burn in May. OANRP staff worked with this contractor in the past and stored some of their gear at West Base. Staff provided the contractor with maps of sensitive habitat and ‘no-spray’ buffer areas, and ensured the contractor’s gear was accounted for.

## 3.5 WEED SURVEY UPDATES: NEW FINDS

OANRP conducted surveys along Roads and Landing Zones (LZs) used by both natural resource staff and the Army. All surveys where drivable roads may vary year to year are tracked and stored in Geographic Information Systems (GIS).

LZ surveys were conducted for the first time at Ekahanui North LZ (LZ-HON-136), and MelTen Puu LZ in Manuwai (LZ-Manuwai-209). Staff survey effort was elevated as an all-time high number of LZ surveys were conducted this year.

Staff also surveyed locations of potential introductions such as OANRP camp sites, Baseyards, Army washrack sediment disposal and storage sites, and MU access trails. Two Kaluakauila weed transect surveys were updated this year in order to survey along more of the access trails. A survey was conducted for the first time this year around the OANRP East Baseyard and will continue annually. Staff conduct a survey on land leased from Dole Food Company at Basilon DZ when Army training has taken place there during the year. This year the survey was overlooked during the report year period, but was completed in the first quarter of the new report year, and will be done so again during the regularly scheduled period (quarter 2 of the report year).

**Table 11.** 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 several were not on the schedule. | 17 road surveys |
| LZ Survey | Actively used Army LZs are surveyed once per year. OANRP LZs were surveyed if used within a quarter. | 91 surveys on 45 LZs |
| Transect Survey | Surveys are conducted annually along high use access trails to OANRP MUs, selected MU fencelines, and transects inside MUs. | 12 weed transect surveys |
| Camp/Other Survey | Surveys are conducted at OANRP campsites and other potential locations of introduction such as washrack sediment disposal sites, the baseyard, and other staging locations. Survey frequency varies based on location and use. | 14 surveys at 7 sites |

Locations of LZ and camp/other survey sites surveyed this year are depicted below as points in Figure 13. Incidental observations, or those made by staff during the course of regular work or on personal time are identified on the map as stars. Surveys along roads and transects are portrayed as lines.

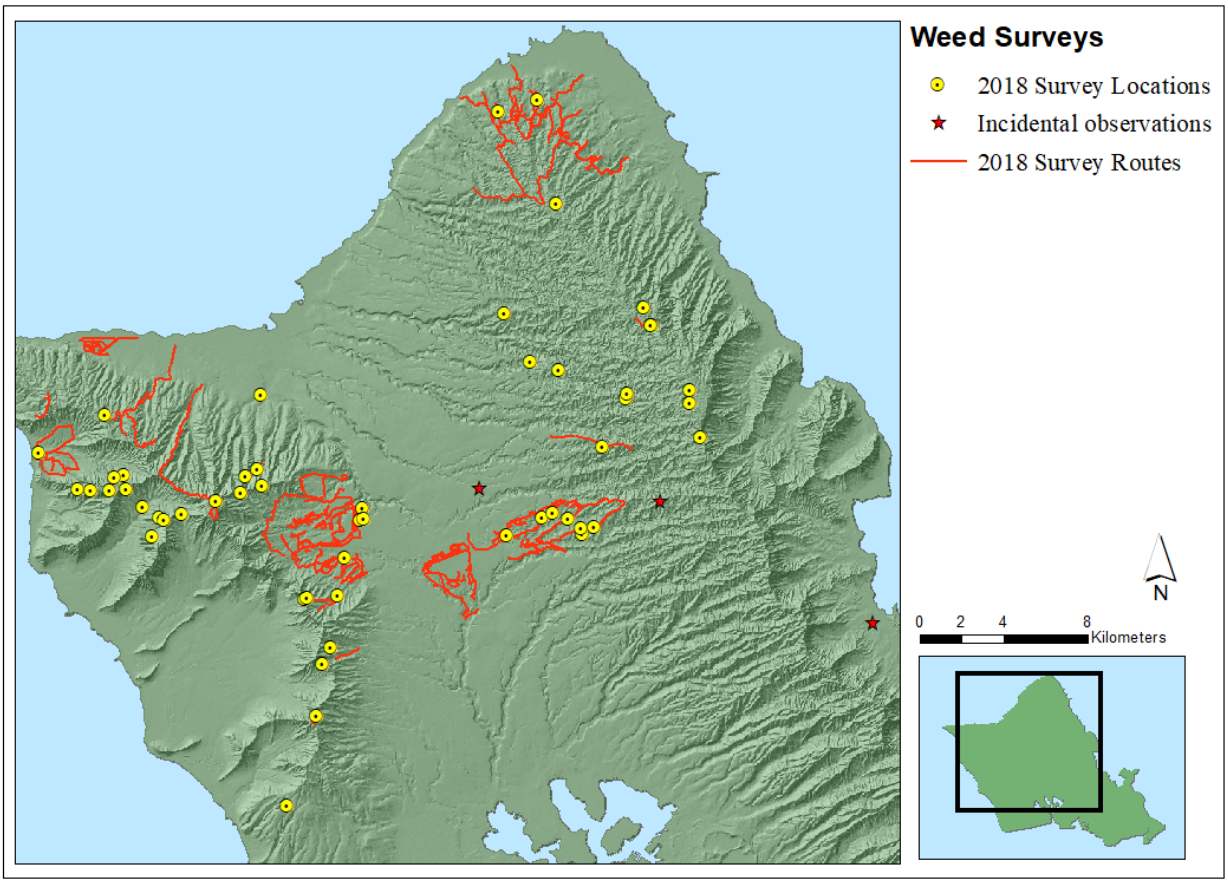


**Figure 13.** Map of conducted in 2018

Survey data are tracked in the OANRP database and each year the list of new finds on each of those surveys is reviewed. Noteworthy species are discussed in Table 12 below. Many new species this year were found, on LZs in particular. While most of these species are not considered to be ecosystem altering, they often favor disturbed habitats and have the ability to spread along fencelines and trails. In order to prevent introduction of these species into managed areas, this year, management of vegetation on LZs and drop zones will be a priority. This will include controlling select invasive weeds, as well as a push to make sites less diverse and more sterile, to reduce the potential of helicopters and gear to spread seeds.

Unusual and notable plants found during the course of other field work are referenced as "incidental" in the table. OANRP contracted the Bishop Museum to identify unknown species. This year a total of 28 alien taxa submissions were sent to Bishop Museum for identification or to document new locales for select taxa. For *Digitaria radicosa*, a grass from Kahuku Training Area, Bishop Museum updated its status as naturalizing. Another species collected opportunistically by staff, a fern, was identified only to genus, *Aglaomorpha*, however it was a new State record for that genus. The grass, *Eragrostis parviflora*, found at Dillingham Military Reservation was also a new island record for Oahu.

**Table 12.** Summary of Alien Taxa on Surveys

| Survey Type | Survey Code/ Description | Significant Alien Taxa Seen | Discussion |
|---|---|---|---|
| Road | **RS-DMR-01** | *Eragrostis parviflora* | This grass is a new island record for Oahu; previously documented only from Kauai. No control is planned. |
| Road | **RS-KAALA-01** Kaala road | *Richardia brasiliensis* | Quite a bit of this species showing up on LZs as well. Not known from Kaala summit transect surveys. It is locally widespread in certain valleys of windward Koolaus. Not widespread elsewhere. No control is planned. |
| Road | **RS-KLOA-08** Drum road | *Rhodomyrtus tomentosa* | Significant Koolau weed and is currently only known from and controlled at Schofield East Range. New ICA created at this site to prevent spread along the road and to additional training areas. |
| Road | **RS-KTA-08** Kahuku Training Area | *Filicium decipiens* | This ornamental species is known to naturalize, however much of Kahuku is alien dominated vegetation. No control will be conducted. |
| | | *Digitaria radicosa* | Bishop Museum notes that this species was suspected of naturalizing, and this record confirms its naturalized status. Not a priority for control at Kahuku Training Area. |
| Road | **RS-KTA-09** Kahuku Training Area | *Toona ciliata* | It is unclear how many monotypic stands of this species exist in the Koolaus compared with in the Waianae Mts; it may be too wet to establish in the same way. It is, however, known from all other KTA road surveys. While it is a good invader, it presents little concern on the training range and no control is planned. |
| Road | **RS-PAHOLE-01** | *Trema orientalis* | Not unusual to find this species along the road, but will be targeted during weed control sweeps if seen in nearby managed areas. |
| Road | **RS-SBE-01** | *Albizia adianthifolia* | There is uncertainty about the validity of the identification of this taxa from this road survey. This species was likely planted as an ornamental tree on Schofield Barracks and has been since removed as it has been documented as naturalizing on the training range in the BAX of SBW. This year staff will look for this potentially invasive species on this road survey. Any new individuals identified will be controlled. |
| Road | **RS-SBS-01** Training range roads across Northern SBS | *Ficus religiosa* | *Ficus religiosa* naturalizes readily across Schofield Barracks and staff will be vigilant for spread along the road and closer to Management Units. No control is planned. |
| Road | **RS-SBS-02** Training range roads across Northern SBS | *Petrorhagia velutina* | This tiny plant was first observed as a new island record in 2010 on a West Range road survey, and now occurs on an adjacent training range. Not ecosystem altering; no control is planned. |
| Road | **RS-SBW-04** Training range roads across SBW | *Cinnamomum burmannii* | This weed is invasive in the Waianaes. There is a good chance it already occurs in the forested areas of Lihue, however staff will monitor movement across the range and along roads and towards high-value areas. No control is planned. |
| | | *Schizachyrium condensatum* | This invasive grass is currently targeted at several ICAs across SBE. It is suspected to disperse readily on grass cutting equipment which is discouraged by roping off most known ICAs. It is designated as an ICA at this new site, however control will be a challenge due to access issues. This location is in the BAX area of the range that is currently off limits due to UXO issues. More discussion of this issue can be found in Section 3.1. |

**Table 12** (Continued).

| Survey Type | Survey Code/ Description | Significant Alien Taxa Seen | Discussion |
|---|---|---|---|
| LZ | **LZ-HON-106** Ekahanui Crestline | *Drymaria cordata var. pacifica* | This groundcover has been difficult to control at other known locations, such as the Hapapa snail enclosure. It has sticky seeds and is easily transported along trails by humans and animals. It should be targeted for control on LZs and staff access trails to prevent further spread. |
| LZ | **LZ-HON-151** Hapapa-Waieli Ridge | *Acanthospermum australe* | Known from elsewhere in this region, this groundcover favors open disturbed habitats and has bur-like seeds which could be transported accidentally via staff/gear. It will be targeted for control on this landing zone. |
| LZ | **LZ-HON-215** Palikea weatherport | *Ehrharta stipoides* | This species is widespread across the southern Waianes and Palikea MU. It is targeted regularly along trails and managed areas around rare resources. There is a zero tolerance for it on LZs and it will be controlled until no more is found here. It is a priority target for eradication in several other MUs in the northern Waianaes. |
| LZ | **LZ-Kaluaa-214** Kaluaa Trailhead LZ and parking area | *Pimenta dioica* | These two tree species are not new to the area, but further spread via staff should be avoided. Gear is staged in specified open dirt areas, and the landing zone is kept clear of weeds. |
| | | *Schefflera actinophylla* | |
| LZ | **LZ-KLOA-190** Poamoho connex | *Nephrolepis brownii* | As mentioned elsewhere in this table, this species continues to show up on landing zones. Less of this species is observed in Koolau MUs, however staff will note any new locations during the course of field work inside MUs. |
| | | *Sisyrinchium exile* | This tiny species continues to show up at a number of landing zones. While not habitat altering, staff will continue to pay attention to new locations of this alien species. |
| | | *Triumfetta semitriloba* | This species moves around easily on humans and animals and is very invasive in the right environment. Although the Koolaus may not be preferred habitat, it would be prudent to keep this off the LZ and parking area. Many partner organizations use this LZ. OANRP will work with DOFAW staff to delineate a weed-free area at this landing zone to prevent spread of alien species to other locations. |
| LZ | **LZ-Koloa-169** Koloa Middle Ridge | *Melaleuca quinquenervia* | This species should be controlled whenever found in Koloa MU as it is an invader elsewhere in the Koolaus. |
| | | *Rhynchospora caduca* | This species is widespread in lower elevations, however now occurs on nearly every Koolau LZ. Observations could be due to staff confidence in identification, but more likely are due to the fact that it has tiny seeds and is a successful disperser. Staff can say with confidence that it is being moved between the Koolau LZs by humans including: by staff, helicopters, and military training. The spread here seen on LZs in Koloa follows the trend seen across KLOA military LZs, and Opaeula and Opaeula Lower. Although invasive, it is only noted to occur in disturbed habitats, and no impact has yet been seen in intact forest areas. No control is planned. |
| LZ | **LZ-MMR-188** Makua Valley | *Themeda villosa* | An unusual find for this location, however there are no known occurrences in the adjacent forest, and an invasion is unlikely. Control on LZ. |
| LZ | **LZ-MOKFR-189** Nike Upper LZ | *Erigeron karvinskianus* | This invasive weed occurs in Ohikilolo MU. It is known to invade native forests and thrives particularly well on steep, cliffy habitat. Flights to that MU begin from this LZ. This species should be controlled on this LZ to prevent further spread. |

**Table 12** (Continued).

| Survey Type | Survey Code/ Description | Significant Alien Taxa Seen | Discussion |
|---|---|---|---|
| LZ | **LZ-SBE-172** Lower 36 LZ | *Pittosporum undulatum* | This ornamental plant has a somewhat high Weed Risk Assessment of 10, but has not been noted naturalizing elsewhere. Staff will monitor for spread. |
| LZ | **LZ-SBE-17** Upper 36 LZ | *Sphaeropteris cooperi* | Staff only have record of one other location of this species on East Range, however it is definitely known to be widespread across the Koolaus. Staff should control when observed. |
| Transect | **WT-Ekahanui-01** Ekahanui access trail | *Drymaria cordata var. pacifica* | Also documented from an Ekahanui LZ this year, staff will be vigilant for this weed and control where observed along trails and locations where it can be transported in gear and on staff. |
| | | *Nephrolepis brownii* | This species is a priority to control around rare resources in Ekahanui MU. |
| Transect | **WT-Kaala-01** Kaala boardwalk | *Ageratina riparia* | This species is present in disturbed habitat at the beginning of the boardwalk and is controlled during regular weeding at that location. Spread along the boardwalk should however be minimized, and all plants seen will be controlled. |
| Transect | **WT-Kaluaa-01** Kaluaa access trail | *Falcataria moluccana* | This invasive tree is widespread across Schofield Training Ranges, and its spread into Kaluaa and Waieli MU would be a significant threat. It will be controlled whenever seen inside the MU. |
| Transect | **WT-Kaluakauila-01** Kaluakauila access trail | *Acacia mearnsii* | This tree is well established along the Kuaokala road, however is targeted for control in or near the Kaluakauila MU to prevent establishment or further spread inside the enclosure. |
| | | *Pinus luchuensis* | Staff anecdotally note an increases in density of this species along the access ridge over the years. This species may pose a fire risk to the MU. Options to replace it on the eroded ridgeline will be considered. |
| Transect | **WT-Kaluakauila-02** Kaluakauila access trail to lower patch | *Acanthospermum australe* | This groundcover species could create dense mats in open disturbed areas within Kaluakauila MU. Any significant patches in the MU will be controlled. |
| | | *Pinus luchensis* | See WT-Kaluakauila-01 comments |
| | | *Toona ciliata* | This species is abundant nearby along the Kuaokala road, however is not often found within the enclosure. All occurrences within the MU will be controlled. |
| Transect | **WT-Kapuna-01** Mokuleia trail | *Rivina humilis* | This species is widespread across the Waianaes, however does not yet occur with high frequency in the MUs within Pahole NAR. It is noteworthy due to its shade-tolerance and ability to thrive in low-light conditions where other weeds do not. This species will be controlled during weed control efforts within high-value areas in the adjacent MUs. |
| Transect | **WT-Koloa-01** Koloa summit trail | *Angiopteris evecta* | This species is controlled in the Koloa MU as an important target. It is widespread in the Koolaus; recruits are common. |
| | | *Hedychium coronarium* | One small immature was seen along the weed transect. *Hedychium coronarium* is controlled in a single ICA from the old 'Kahuku Cabin' and along the trail north (along the fence). No matures have been observed since 2014. |
| Transect | **WT-Pahole-01** Pahole gulch trail | *Commelina diffusa* | This species can grow prolifically and once established is most effectively controlled with an herbicide spray, but if around rare plants, this tool can become risky. Staff will control if seen approaching rare plant areas. |
| | | *Montanoa hibiscifolia* | This species is a target in the Management Unit and single species sweeps are conducted for it. |
| | | *Sigesbeckia orientalis* | *Sigesbeckia orientalis* is a target in this area by the State. No OANRP control is planned. |

**Table 12** (Continued).

| Survey Type | Survey Code/ Description | Significant Alien Taxa Seen | Discussion |
|---|---|---|---|
| Transect | **WT-Palikea-01** | *Spathodea campanulata* | There is not currently much of this weedy tree in the Management Unit, however it occurs widely across Honouliuli. The seeds are wind dispersed, and it appears to colonize light gaps and disturbed areas. It is controlled during regular weed control efforts inside the MU. |
| Other | **OS-KLOA-01** Koloa campsite | *Angiopteris eveca* | See comments for WT-Koloa-01 |
| Other | **OS-SBE-02** East base | *Cinnamomum burmannii* | These species are highly invasive and staff do not want to transport them in the field. Most of this survey occurs around East Baseyard away from vehicles and gear, however, all of these targets will be controlled when observed. |
| | | *Citharexylum caudatum* | |
| | | *Passiflora suberosa* | |
| Other | **OS-SBW-02** West Base | *Nephrolepis brownii* | Both of these species will be controlled when seen to prevent staff, gear and vehicles from becoming vectors into managed areas. |
| | | *Passiflora suberosa* | |
| Multiple surveys | **LZ-HON-106** Ekahanui Crestline **LZ-HON-215** Palikea weatherport **WT-Ehakanui-01** Ekahanui Access Trail | *Nephrolepis brownii* | Staff emphasis on learning to distinguish this invasive fern from its native counterpart may speak to increases in observations of this species on several surveys. It is a problematic understory weed able to create dense thickets, can hybridize with the native *Nephrolopis spp.* and is therefore a priority target for control in forested areas and around valuable resources. |
| Incidental | Ahuimanu Rd, upper bridge | *Aglaomorpha* sp. | This fern was found by staff as an epiphyte on a *Schefflera actinophylla* on Ahuimanu Rd. This genus was noted by Bishop museum as a new State record. |
| Incidental | Whitmore Village | *Nassella tenuissima* | Staff observed this Mexican feathergrass on personal time. Bishop Museum has collections from 2 other locations. It has a very high Hawaii Weed Risk Assessment of 24. It was previously an OISC target, and this find was reported to them. |
| Incidental | Schofield Barracks East Range: Schofield Waikane trail | *Blechnum orientale* | It is unclear how widespread this species is across the Koolaus, but OARNP know of it from two locations: KTA and Ahuimanu. This observation was from a staff on a weekend hike. Control for this taxa at this location is currently a low priority as no training occurs where it is found, and there are no managed taxa nearby. |

**Figure 14.** *Digitaria radicosa* from KTA, naturalizing on Oahu.

**Figure 15.** *Aglaomorpha* found in Ahuimanu by staff.

## 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 43% (1,147.5 hours) of the time spent on ICA work, and 11% of the total time spent conducting all weed control. Although high, these statistics under-represent the resources required to combat *C. odorata*, as they do not include time spent conducting surveys outside of ICAs, developing and maintaining spray equipment, managing detailed data sheets, ordering dedicated gear, coordinating with Range and DPW staff, or OISC contract effort.

The status of *C. odorata* management is mixed. The KTA infestation expanded in size again this year, both on and off-range. A new ICA was found at SBW. A new site with a single individual was found at Kaluaa. Off-duty staff discovered an outlier plant along the Ehukai Trail in Pupukea, and a recreational hiker found a mature plant in Makaha. There continues to be no effective way to restrict motocross riders to the official State Motocross Park in Kahuku, and little progress in working with the State to build wash facilities for park users. In better news, no plants were seen at either SBE or Manuwai, and delimiting surveys were completed at Manuwai, with no new sites found. No plants have been found at a handful of small KTA outlier ICAs for several years. Aerial sprays continue to be effective at both KTA and SBW, with the cores of both infestations treated at least once. While control efforts at outlier infestations and designated hotspots are going well, OANRP has not succeeded in stemming the spread of *C. odorata* into adjacent and new areas.

OISC continues to manage infestations off of Army lands at Kahana, Keamanea/Haleiwa, and Aiea/Camp Smith. This year, they also worked at Kahuku/Malaekahana and Makaha; see Appendices 3-5 and 3-6. No *C. odorata* surveys have been conducted outside of known infestation areas on Oahu, so it is possible that new infestations may be found in the future. To date, all discoveries off of Army training ranges have been opportunistic. In order to better understand the scope of *C. odorata* invasion on Oahu and set realistic goals for control, island-wide surveys are needed.

In early 2017, as a result of the discovery of *C. odorata* in Manuwai, OANRP invested in gear designated solely for *C. odorata* control. Whenever working in *C. odorata* infested areas, staff use tabis, packs, gloves, and brushes dedicated to *C. odorata* control. Despite this, OANRP discovered *C. odorata* along the Kaluaa access trail this year. It is unclear whether this dispersal event occurred before or after staff began using separate gear for *C. odorata* work. Nevertheless, it is a reminder to all staff to practice rigorous decontamination after working in *C. odorata* infestation areas. Staff are directed to clean their gear either in the field at the infestation site, or at the KTA wash rack, or back at West Base. All sediment from the wash rack is collected in a basin on site; the basin has yet to be emptied, but when it is, OANRP will monitor the sediment. Annual weed surveys are conducted across West Base, and high risk weeks like *C. odorata* area a particular focus of these surveys. All *C. odorata* material collected in the field is disposed of in dedicated bins at West Base and taken to H-Power.

**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 years. Staff were unable to find the last two packets at the five year, mark, but they were later recovered at the six year mark. Final results are presented in Figure 16. Note that the fourth year seed could not be used to assess overall seedbank persistence, due to low numbers (7 seeds remaining of 2,500 buried). Unfortunately, initial

viability of the seed batch used was not tested. While germination declined dramatically, a small percentage (13.5) of seeds remained viable at six years.

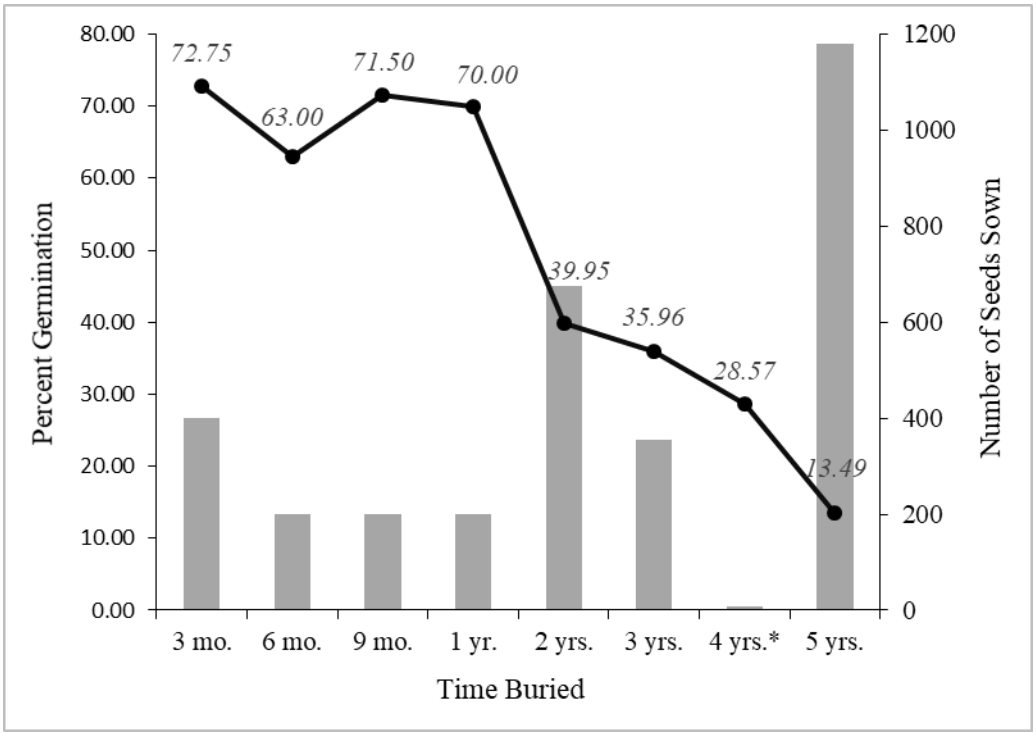


**Figure 16.** Results of the *C. odorata* buried seed sow trial at KTA. Initial viability was not tested. Percent germination is presented as a line, with actual values listed. The number of seeds sown for each test is presented as a bar. The four-year results (*) are only based off of seven seeds, and should not be given much weight.

A second buried seed trial was installed at SBW in May of 2016. Staff continue to monitor this trial, which is set up to run as long as ten years, if needed. Initial viability for the seed lot used in this trial was 63.00%. At the two year mark, germination was 41.58%, similar to the two year results for the KTA trial, 39.95%. Between the two trials, staff hope to gain greater insight into the longevity of the *C. odorata* seed bank and any differences in seed persistence between sites. Currently, it appears that *C. odorata* forms a short-term, persistent seed bank.

**Figure 17.** *Chromolaena odorata* flowers.

## KTA Update

Control efforts at KTA account for 32% 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. Figure 18 shows the distribution of ICAs across KTA.

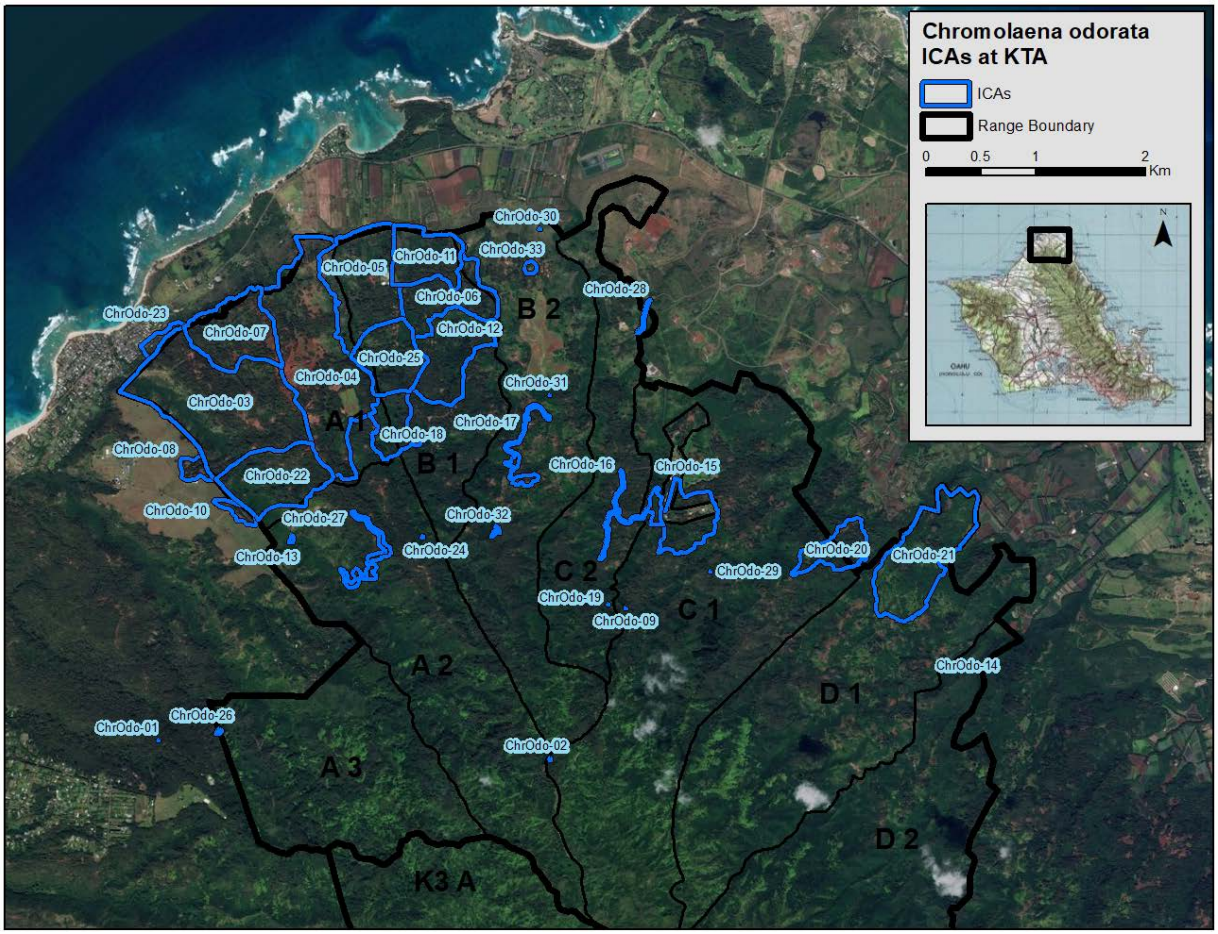


**Figure 18.** *C. odorata* Incipient Control Areas at KTA.

- New ICAs. Four new ICAs were created this year, numbers 30-33. While this spread is discouraging, only a few plants were seen at each new ICA.
    - ICA-30, North Oio: This year, staff continued to survey trails outside of known ICAs as part of early detection efforts across KTA. During trail surveys across the north end of Bravo 2 training area on November 14, 2017, staff found one immature plant close to the bluffs overlooking Turtle Bay. The ICA is located makai of Kane's LZ, and the habitat is exposed, open, and scrubby. Compared to the western part of KTA, there are few trails in this area, but it is difficult to tell if the trails present are primarily used by motocross riders, soldiers, or pigs. No plants were found at this site on subsequent surveys.
    - ICA-31, Kane's: This site was also discovered during early detection trail surveys in Bravo 2. Staff found one large mature plant on November 14, 2017 on a trail just south of Kane's LZ. The area is densely vegetated, with a tall canopy and thick understory, which is unusual as *C. odorata* generally thrives best in open habitat. Staff swept a 30 meter

buffer around the plant, but no others were found. The area around the plant was sprayed with a cocktail of glyphosate and pre-emergent herbicide. No plants were found at this ICA on subsequent surveys.

- ICA-32, Mt. Kawela: During annual road surveys on February 1, 2018, staff found a single mature plant outside an abandoned building on Mt. Kawela. Although mature fruit were present, staff did not collect them due to the risk of contaminating their clothes and footwear. A month later, staff sprayed the area immediately around the plant with a cocktail of glyphosate and pre-emergent herbicide, and surveyed the open areas to the north of the building; one immature plant was found approximately 80 meters away in a brushy area along the road. Staff monitored the sprayed area in May, and found just one immature plant. *Chromolaena odorata* was likely spread to this area via soldiers or motocross riders. In the coming year, this area will be monitored quarterly, and buffer surveys will be conducted to the south of the known sites.
- ICA-33, Kane's Flats: While hiking to ICA-30 on June 21, 2018, staff found a 1.5 meter tall mature *C. odorata* in an open area crisscrossed with trails. Staff collected and bagged as many of the seed heads as they could for later disposal at H-Power. Staff plan to treat the area with pre-emergent herbicide in the coming year. This ICA is north of Kane's LZ, and may be used by both motocross riders and soldiers. Larger surveys are needed to better map *C. odorata* presence across the area.

- ICA Changes. The boundaries of eight ICAs were expanded this year. Some were expanded to include new patches of *C. odorata* just outside their borders; these include: ICAs 12, 16, and 17. Others were expanded to better include highly trafficked roads and trails adjacent to ICAs which should be regularly monitored to prevent spread; these include ICAs 18, 20, and 27. ICA-23 is located primarily on private land; it was expanded to include the access road to the Alpha ranges and motocross park after staff found a handful of small *C. odorata* along it during the annual road survey. All of these expansions were fairly small, between 0.18 and 2.34 ha. By far the largest expansion, 37.94 ha, occurred at ICA-21. This ICA is contiguous with a *C. odorata* infestation on private land at Climbworks Keana Farms. As a precaution, the boundary of ICA-21 was expanded to the edge of the Delta 1 training area, although the most northern part of the range has not yet been surveyed. If future surveys suggest the ICA should be smaller, it will be trimmed to better reflect the actual infestation area.

**Figure 19.** Searching for *C. odorata* along Kaunala Road.

**Figure 20.** *Chromolaena odorata* leaves.

- Control Summary. All control efforts are summarized in Table 13. Area, effort and number of visits are reported for the 2018 and 2017 report years. The dates of the most recently removed mature and immature plants are included. See Tables 15 and 16 for discussion of individual ICAs. The *C. odorata* infestation now covers 646.26 ha in KTA. This is a huge area, and staff are unable to sweep every inch of it, despite contracting OISC to work in the motocross park, the highest priority area. Different strategies are employed in different ICAs as a means of stretching limited resources. The core of the infestation is divided between ICAs 03, 04, 05, 07, and 25. The other ICAs are either on the fringes of the core, represent separate infestations, or are outliers. The strategies used at each ICA are detailed in the 2016 Year End Report, and the "Type/ Strategy" column provides a quick reference to management approach at each ICA:
    - Outlier. These are geographically small sites, usually with very few individual plants found. After discovery, these ICAs are monitored quarterly. After several years with no plants found, the monitoring interval decreases to once or twice a year.
    - OISC contract + OANRP hotspot. OISC is contracted to sweep several ICAs fully twice a year. The ICAs covered by the contract are numbers 03, 04, and 07; they span the western end of the primary infestation and include the State Motocross Park. Hotspots are drawn around high densities of plants. OANRP sprays the hotspots 1-4 times per year with pre-emergent herbicide.
    - Sweep + Hotspot. Strategy at these ICAs includes rigorous sweeps across the whole ICA, in addition to more intensive monitoring and treatment with pre-emergent herbicides at Hotspots. Hotspots are tracked and monitored within ICAs. Whenever possible, staff use highly effective power sprayer equipment at Hotspots.
    - Sweep + Hotspot + Aerial Spray. As above, except aerial sprays are used to treat large, remote patches of plants which are either inaccessible to the power sprayer or located on steep cliffs.
    - Trails + Roads + Hotspots. Management at these ICAs is limited to surveys of all trails and roads 1-2 times per year, rather than landscape-wide sweeps. Staff observed that *C. odorata* spreads easily into new areas along trails and roads. Hotspots are tracked and aggressively treated. This approach is used only in ICAs with low plant density.
    - Trails + Roads + Hotspots + Sweep. As above, except portions of these ICAs are fully swept. This approach is used when *C. odorata* density is high in select areas of an ICA.
    - Private Land. OANRP does not have permission to work on infestations on private land, but OISC does. Staff assist OISC at these ICAs as feasible.

**Table 13.** KTA Control Efforts

| ICA Code | ICA Area (ha) | 2018 Report Year | | | 2017 Report Year | | | Date Last Mature Plant Found | Date Last Immature Plant Found | Type/Strategy |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Area Weeded (ha) | Effort | # Visits | Area Weeded (ha) | Effort | # Visits | | | |
| WaimeaNoMU-ChrOdo-01 | 64 m² | 64 m² | 0.5 | 1 | 64 m² | 1.0 | 2 | none | 2011-04-05 | Outlier |
| KTA-ChrOdo-02 | 328 m² | 112 m² | 1.0 | 1 | 328 m² | 0.5 | 1 | none | 2011-08-22 | Outlier |
| KTA-ChrOdo-03 | 118.44 | 3.57 | 94.5 | 6 | 7.71 | 214.0 | 16 | 2017-11-22 | 2018-05-10 | OISC Contract + OANRP hotspot |
| KTA-ChrOdo-04 | 111.63 | 5.86 | 107.0 | 11 | 10.40 | 94.0 | 10 | 2018-05-09 | 2018-05-09 | OISC Contract + OANRP hotspot |
| KTA-ChrOdo-05 | 57.96 | 29.61 | 200.1 | 16 | 40.82 | 258.5 | 21 | 2018-06-21 | 2018-06-21 | Sweep + Hotspot + Aerial spray |
| KTA-ChrOdo-06 | 32.62 | 25.30 | 104.0 | 5 | 31.68 | 103.5 | 7 | 2018-05-30 | 2018-05-30 | Sweep + Hotspot |
| KTA-ChrOdo-07 | 41.27 | 1.61 | 43.0 | 4 | 4.18 | 33.0 | 6 | 2018-04-24 | 2018-04-25 | OISC Contract + OANRP hotspot |
| AimuuNoMU-ChrOdo-08 | 4.59 | 0 | 0 | 0 | 0.59 | 1.0 | 1 | N/A | 2016-08-16 | Private Land. OISC. |
| KTA-ChrOdo-09 | 78 m² | 78 m² | 0.5 | 1 | 78 m² | 0.5 | 1 | 2013-01-09 | 2013-09-10 | Outlier |
| AimuuNoMU-ChrOdo-10 | 3.73 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | 2016-01-21 | Private Land. OISC. |
| KTA-ChrOdo-11 | 28.74 | 4.02 | 3.0 | 3 | 18.64 | 41.5 | 5 | 2016-07-28 | 2018-02-21 | Sweep + Hotspot |
| KTA-ChrOdo-12 | 39.79 | 11.51 | 55.0 | 5 | 4.23 | 19.0 | 2 | 2018-05-09 | 2018-05-09 | Trails + Roads + Hotspots + Sweep |
| KTA-ChrOdo-13 | 0.23 | 0 | 0 | 0 | 457 m² | 1.0 | 1 | 2015-12-23 | none | Outlier |
| KTA-ChrOdo-14 | 6 m² | 6 m² | 0.3 | 1 | 6 m² | 0.5 | 1 | 2014-01-07 | none | Outlier |
| KTA-ChrOdo-15 | 23.51 | 6.52 | 2.5 | 2 | 3.96 | 18.5 | 2 | 2017-12-12 | 2017-07-10 | Trails + Roads + Hotspots + Sweep |
| KTA-ChrOdo-16 | 5.75 | 1.82 | 8.5 | 4 | 1.44 | 3.5 | 3 | 2017-12-12 | 2018-02-01 | Trails + Roads + Hotspots |
| KTA-ChrOdo-17 | 4.28 | 3.42 | 15.5 | 2 | 1.98 | 4.0 | 3 | 2017-11-14 | 2017-11-14 | Trails + Roads + Hotspots |
| KTA-ChrOdo-18 | 18.59 | 2.32 | 22.5 | 2 | 2.34 | 23.5 | 2 | 2014-10-29 | 2017-11-14 | Trails + Roads + Hotspots + Sweep |
| KTA-ChrOdo-19 | 78 m² | 78 m² | 2.0 | 1 | 78 m² | 0.5 | 1 | none | 2014-09-24 | Outlier |

**Table 13** (continued).

| ICA Code | ICA Area (ha) | 2018 Report Year | | | 2017 Report Year | | | Date Last Mature Plant Found | Date Last Immature Plant Found | Type/Strategy |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Area Weeded (ha) | Effort | # Visits | Area Weeded (ha) | Effort | # Visits | | | |
| KTA-ChrOdo-20 | 17.32 | 3.99 | 36.3 | 4 | 4.87 | 42.0 | 3 | 2017-12-05 | 2018-06-27 | Trails + Roads + Hotspots + Sweep |
| KTA-ChrOdo-21 | 59.25 | 6.62 | 55.25 | 5 | 4.48 | 35.0 | 3 | 2018-06-28 | 2018-06-28 | Trails + Roads + Hotspots + Sweep |
| KTA-ChrOdo-22 | 43.8 | 0.95 | 4.0 | 1 | 0.94 | 20.5 | 3 | 2017-03-21 | 2017-10-12 | Roads + Trails + Hotspots + Sweep |
| KahukuLaie-ChrOdo-23 | 3.86 | 0.21 | 1.75 | 2 | 0.13 | 1.25 | 1 | 2016-04-27 | 2018-05-10 | OANRP Roads + OISC Private Land |
| KTA-ChrOdo-24 | 316 m² | 316 m² | 1.25 | 3 | 316 m² | 3.0 | 3 | 2016-03-02 | none | Outlier |
| KTA-ChrOdo-25 | 31.27 | 7.96 | 70.85 | 6 | 5.78 | 35.0 | 6 | 2018-06-21 | 2018-06-21 | Sweep + Hotspot + Aerial spray |
| KTA-ChrOdo-26 | 0.18 | 0.11 | 7.0 | 4 | 0.18 | 22.00 | 4 | 2016-09-08 | 2018-06-28 | Outlier |
| KTA-ChrOdo-27 | 5.91 | 2.60 | 4.5 | 2 | 1.54 | 3.5 | 3 | 2018-01-30 | 2017-07-11 | Trails + Roads + Hotspots |
| KTA-ChrOdo-28 | 0.69 | 0.35 | 1.3 | 2 | 0.35 | 1.0 | 1 | 2017-03-07 | 2017-03-07 | Outlier |
| KTA-ChrOdo-29 | 78 m² | 78 m² | 0.8 | 2 | 20 m² | 0.5 | 1 | none | 2017-03-07 | Outlier |
| KTA-ChrOdo-30 | 155 m² | 152 m² | 4.0 | 3 | 0 | 0 | 0 | none | 2017-11-14 | Outlier |
| KTA-ChrOdo-31 | 78 m² | 78 m² | 6.5 | 4 | 0 | 0 | 0 | 2017-11-14 | none | Outlier |
| KTA-ChrOdo-32 | 0.31 | 0.30 | 4.75 | 3 | 0 | 0 | 0 | 2018-02-01 | 2018-05-08 | Outlier |
| KTA-ChrOdo-33 | 0.99 | 0.23 | 1.0 | 1 | 0 | 0 | 0 | 2018-06-21 | None | Outlier |
| TOTALS | **646.26** | **118.96** | **859.20** | **107** | **146.36** | **981.75** | **113** | | | |

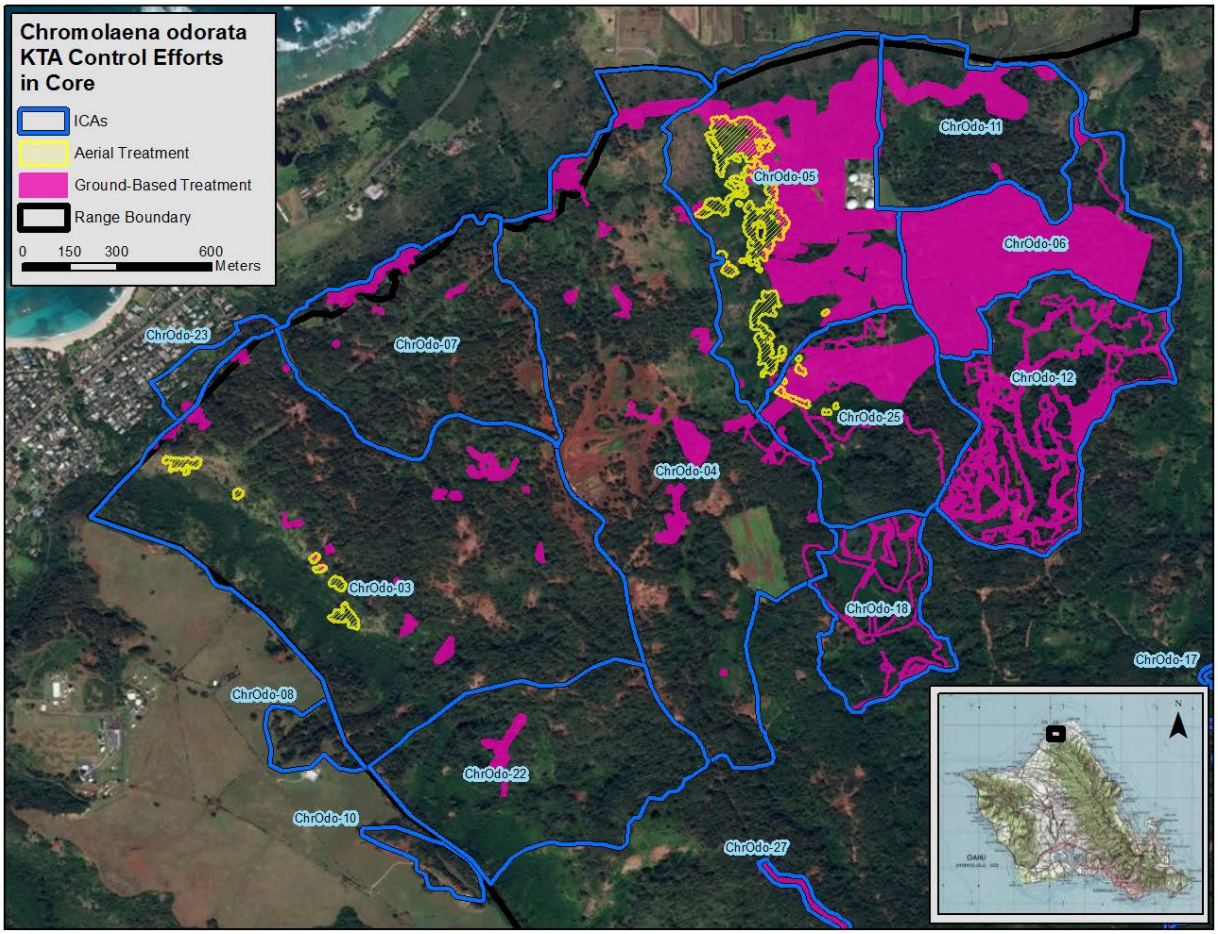


**Figure 21.** Aerial and Ground Treatment in the KTA Core Infestation

**Table 14.** KTA Aerial and Ground Treatment Area

| Report Year | Total Area Treated (ha) | Aerial Spray Area (ha) | Ground-Based Treatment Area (ha) |
|---|---|---|---|
| 2017-2018 | 118.96 | 8.13 | 112.56 |
| 2016-2017 | 146.36 | 13.36 | 140.87 |
| 2015-2016 | 98.24 | 6.36 | 91.89 |
| 2014-2015 | 71.27 | 3.98 | 67.29 |

- Aerial Sprays. This year, 8.13 ha were sprayed aerially and 112.56 ha were treated on the ground, for a total of 118.96 ha of *C. odorata* controlled (ground and aerial treatments overlapped); see Table 14. Figure 21 shows aerial and ground control efforts across the primary infestation. Aerial sprays were conducted in three different ICAs this year. While efforts focused on ICA-05 (6.64 ha), areas directly adjacent in ICA-25 (0.36 ha) were also sprayed. Last year, a new spray zone encompassing several hotspots was designated in ICA-03. This year, 1.13 ha were sprayed in ICA-03 in this zone. Total aerial spray area declined from last year, for several reasons. Firstly, fewer aerial sprays were conducted this year, in part due to logistical and weather issues. Secondly, while most of this year's sprays were done by an experienced, Big Island-based pilot, some were done by an Oahu-based pilot new to aerial spray work. The new pilot's skill continues to grow, but he is less efficient that the experienced pilot. However, having an Oahu-based pilot for aerial sprays will allow staff greater flexibility in planning spray operations in the coming year. Despite these issues, the majority of the designated aerial spray zones were completely

treated once, and some areas were sprayed twice. Aerial sprays continue to be a valuable tool for *C. odorata* management.

- Outlier ICAs. Control efforts at the outlier ICAs have been successful in reducing plant numbers. Control status is summarized in Table 15; ICAs are listed by the date plants were last observed. All outlier ICAs were monitored at least once this year, with the exception of ICA-13. Staff will monitor outliers for at least ten years after the last plant was seen, or until more information is known about seed longevity.

**Table 15.** KTA Outlier ICA Status

| ICA Code | Plant Type & Total Number | Date Last Observed | Comments |
|---|---|---|---|
| WaimeaNoMU-ChrOdo-01 | Immature only (1) | 2011 April | None found since initial discovery. |
| KTA-ChrOdo-02 | Immature only (1) | 2011 April | None found since initial discovery. |
| KTA-ChrOdo-09 | Mature (1) and immature (1) plants | 2013 September | Plants found on separate visits in 2013. |
| KTA-ChrOdo-14 | Mature only (1) | 2014 January | None found since initial discovery. |
| KTA-ChrOdo-19 | Immature only (1) | 2014 September | None found since initial discovery. |
| KTA-ChrOdo-13 | Mature only (1) | 2015 December | None found since initial discovery. However, this ICA has not been monitored consistently since it was discovered in 2015, and more regular checks are needed to determine if *C. odorata* is persistent at it. |
| KTA-ChrOdo-24 | Mature only (1) | 2016 March | None found since initial discovery. |
| KTA-ChrOdo-28 | Mature (1) and immature (7) plants | 2017 March | None found since initial discovery. |
| KTA-ChrOdo-29 | Immature only (1) | 2017 March | None found since initial discovery. |
| KTA-ChrOdo-30 | Immature only (1) | 2017 November | New this year. 3 visits made this year, no plants found after initial discovery. |
| KTA-ChrOdo-31 | Mature only (1) | 2017 November | New this year. 4 visits made this year, no plants found after initial discovery. |
| KTA-ChrOdo-32 | Mature (1) and immature (2) plants | 2018 May | 3 visits made this year, 1 plant found on each visit. |
| KTA-ChrOdo-33 | Mature only (1) | 2018 June | 1 visits made this year, additional surveys needed |
| KTA-ChrOdo-26 | Mature (1) and immature (6) plants | 2018 June | Found in 2016. Only immature plants seen this year. |

- ICA Discussion. Highlights of ICA management are summarized in Table 16. The ICAs discussed are shown in Figures 18, 21, and 22, and control statistics are detailed in Table 13.

**Table 16.** KTA ICA Highlights

| ICA | Discussion |
|---|---|
| KTA-ChrOdo-03 | ICA-03 is located in Kaunala gulch, and includes all the areas west of the main Alpha road. The more moderately sloped portion of the ICA on the east side of the gulch is located in the motocross park. The western portion of the ICA is dominated by steep terrain, including numerous cliffs, and is densely vegetated with tall alien grasses. This ICA is swept by OISC and OANRP staff conduct follow-up by treating hotspots. Area treated and effort dropped from last year to this year, primarily due to a reduction in aerial surveys of the northern bluffs. Other contributing factors include slightly decreased aerial sprays, a few hotspots becoming inactive, and a shift in strategy for a handful of hotspots on the west slope of Kaunala; as these western hotspots are most easily accessed from private land, it is logistically simpler for OISC to treat them instead of OANRP. This year, OANRP continued to focus treatment on the aerial spray zone, hotspots, and conducted one aerial survey. Six hotspots along a grassy cliff were treated with aerial sprays, and the rest were sprayed or swept on the ground. The largest hotspot (HS-037) required multiple treatments this year. Staff are experimenting with adding imazapyr to the spray mix to achieve longer suppression and increase efficiency. |

**Table 16** (continued).

| ICA | Discussion |
|---|---|
| KTA-ChrOdo-04 | This ICA is located just west of Pahipahialua gulch and the *C. odorata* core, and includes much of the motocross park. The terrain is fairly flat, and much of the area is kept open by motocross users. OISC sweeps the entire ICA and OANRP treats all hotspots. Area swept decreased from last year, due to a reduction in the area aerially surveyed. While one aerial survey was performed this year, it covered a smaller area. This year, OANRP scoped and power sprayed 12 hotspots, five of which were treated twice. In addition, two other hotspots were surveyed, but did not require spraying. A number of hotspots lining the border between ICA-04 and ICA-05 are best treated via aerial sprays; some of these were not treated this year, but are a priority for future aerial operations. |
| KTA-ChrOdo-05 | This ICA includes the core of the *C. odorata* infestation in Pahipahialua gulch. The terrain is difficult; the western slopes are steep and grassy, while the eastern slopes are split by cliffs. The far eastern side of the ICA is comparatively moderately sloped. Both area swept and effort decreased this year. In part, this is due to a reduction in the number of aerial sprays, but most of the decline in area is due to a reduction in aerially surveyed area. Last year's aerial survey covered much more terrain than the survey performed this year. This year, staff swept most of the moderate eastern slopes and sprayed accessible hotspots with the power sprayer. In addition, aerial sprays targeted the lower eastern slopes, part of the gulch bottom, and hotspots on the western slope. Staff will continue aggressive control in the coming year. |
| KTA-ChrOdo-06 | This ICA is directly east of the Opana Radar Tracking facility, and contains four hotspots. This year, most of the ICA was swept, with the exception of the far eastern edge and part of the northern finger. All hotspots were swept, but only the two largest were power sprayed with pre-emergent herbicide. Control efforts continue to be successful; numbers of plants found continue to decline across the ICA, from an estimated 11,600 in in report year 2015 to an estimated 640 this report year. Staff note that this decline is particularly evident within hotspots, but during sweeps, mature plants were found just outside the hotspots; this is a good reminder for staff to avoid limiting themselves to hotspot boundaries. In the coming year, staff will sweep the portions of the ICA missed this year, sweep any area where plants have been found within the last two years, and monitor hotspots at least twice. |
| KTA-ChrOdo-07 | Spanning the Waialee flats between two roads, ICA-07 is in the heart of the motocross park. Most of the terrain is relatively flat, but the northern edge of the ICA includes the top of the bluffs. OISC staff sweep the ICA while OANRP staff treat hotspots. Area swept decreased from last year, due to a reduction in the area aerially surveyed. While an aerial survey was performed this year, it covered a smaller area. This year, staff monitored all six active hotspots at least once. Plant numbers continue to decline at the hotspots on the flats, but large numbers persist on the northern bluffs. |
| KTA-ChrOdo-11 | ICA-11 includes the area northeast of the Opana Radar Tracking facility. The terrain of the southern portion of the ICA is moderate, with flat areas bisected by shallow gullies. The northern half of the ICA is steep, covered with alien grass and shrubs. The entire ICA was surveyed in 2015 and 2016. Since few *C. odorata* have ever been found here, this year staff opted to spend their limited time in the more densely infested ICA-06 instead. The single hotpsot was monitored and only two immatures were found. One aerial survey was conducted over the northern slopes. Next year, OANRP will prioritize this ICA. The southern half will be swept, and the northern half will be surveyed from vantage points. |
| KTA-ChrOdo-12 | This ICA is an interesting case study of *C. odorata* spread and adaptive management, see Figure 22. In 2012, the whole area was surveyed as part of infestation delimiting efforts, with no plants found. Quickly thereafter, a few plants were found along roads, necessitating the creation of the ICA. In response, staff started surveying trails around known plant locations in report year 2014, although the primary focus continued to be along roads. In 2015, all trails in the southern half of the ICA and all roads were surveyed, and one large patch of plants was power sprayed (HS-12d). In 2016, all trails in the ICA were surveyed for the first time, another large patch (HS-12c) was power sprayed, and staff noted that plant numbers across the ICA were increasing. This report year, more extensive management was conducted than ever before; area and effort almost tripled from last year. Staff surveyed all trails in the ICA twice. Five hotspots were finally designated and named, making it easier to track control efforts at each. Four of the hotspots were sprayed with a cocktail of glyphosate and pre-emergent, and the fifth (HS-12c) was thoroughly swept. Due to the large size of the *C. odorata* infestation at KTA, OANRP avoided conducting extensive management at this ICA in early years. Unfortunately, these minimal efforts were not sufficient at halting the spread of *C. odorata* and management had to ramp up in response. At this |

**Table 16** (continued).

| ICA | Discussion |
|---|---|
| | point, landscape sweeps may be needed to effectively bring plant numbers down at this ICA, but OANRP currently does not have the personnel to do this. In the coming year, staff plan to again sweep all trails and roads twice, and monitor/control all hotspots two to four times. If resources allow, landscape sweeps will be conducted, starting with the northern half of the ICA. |
| KTA-ChrOdo-15 | Located around a portion of the CACTF training facility, this ICA includes heavily used and maintained areas around roads and buildings. Staff surveyed all trails and known *C. odorata* locations once this year and found very low numbers of plants, just 4 mature and 2 immature. One of these mature plants was found within a small Cultural Resources fence. Staff will monitor the entire ICA twice in next year. |
| KTA-ChrOdo-16 | Previously, this ICA was limited to a large clearing and gravel storage area. Last year it was expanded along the Oio road to the north, and this year it was expanded along the same road to the south. This year, staff found more plants than in previous years: 7 matures and 7 immatures. Most of the plants were seen at the new southern Oio road spot, but staff also observed plants for the first time on a gravel pile and next to a small Cultural Resources fence. Both the gravel pile and south Oio road sites were treated with pre-emergent herbicide. The continued spread of *C. odorata* at this ICA is concerning. Staff will monitor the entire ICA twice in the coming year. |
| KTA-ChrOdo-17 | This ICA runs along a portion of the road leading towards Mt. Kawela and includes a few side trails. This year, staff monitored the entire road area twice and the trail area once. Only four plants were found, three of which were located close to the site where a very large mature plant was treated in 2017. This spot has previously been sprayed with pre-emergent, and relatively few plants have been observed since. The last plant was found on a side road, and appeared to have been cut or run over many times. No plants were found in the trail portion of the ICA. This site will continue to be monitored twice a year. |
| KTA-ChrOdo-18 | Located west of the motocross park and north of the ICA-25, *C. odorata* distribution is relatively sparse in this ICA. There is one hotspot, located on the south edge of the ICA above Echo Gate. This year, staff surveyed trails across the ICA and monitored the hotspot. While no mature plants have been seen since 2014, staff note increased numbers of plants on the northern border. Also, immature plants continue to pop up at the hotspot, perhaps because it never was treated with pre-emergent herbicide. In the coming year, staff will survey trails twice, monitor the hotspot two to four times a year and treat it with pre-emergent, and do landscape sweeps across the northern border if resources allow. |
| KTA-ChrOdo-20 | This ICA is located along the border of KTA, in the northwestern corner of the Charlie 1 training range. This year, all trails were surveyed once, and some trails were surveyed twice. Few plants were found, except around one previously identified hotspot and one brand new hotspot. Hundreds of plants were found at the new hotspot, which was treated with pre-emergent herbicide. Larger surveys around this new hotspot are needed, and OANRP will seek permission from the State to do this, as the ICA extends on to State land. This will be a high priority in the coming year, as management strategies may need to be adjusted if large, densely infested areas are found. In the meantime, staff will continue to monitor known *C. odorata* locations and trails. |
| KTA-ChrOdo-21 | ICA-21 is located in the Delta 1 training range on the far western side of KTA. Last year, the ICA was expanded to include newly discovered *C. odorata* patches to the north. This year, staff continued to explore even further north, and discovered yet more *C. odorata*, including patches with hundreds of plants. One complication is that the northern portion of the ICA is not easily accessible by vehicle from KTA. Fortunately, Climbworks Keana Farms granted permission for staff to drive through their land on to KTA, which allowed staff to treat one hotspot with the power sprayer. Further surveys are needed to completely delimit the ICA, identify new hotspots, and revise the management strategy; these surveys are a high priority in the coming year. |
| KTA-ChrOdo-22 | This large ICA is directly south of ICA 03, which is surveyed by OISC. It spans Kaunala gulch and is on the edge of the motocross park. All trails in the ICA were swept in report years 2016 and 2017, and one hotspot was identified and sprayed. This year, the hotspot was monitored, and only 8 immatures were found. In the coming year, all trails will be surveyed twice, and the hotspot will be monitored 2-4 times. |
| KTA-ChrOdo-25 | Last year, ICA-05 was split, and the southern half became ICA-25. This ICA spans Pahipahialua gulch, and includes the southern edges of the *C. odorata* core infestation. Effort this year almost doubled over last year, while area treated increased by a third. Despite this, due to limited time, staff were unable to sweep the entire ICA. Sweeps focused just on the northern portion of the ICA (closest to the core) and some trails. Some hotspots in the northwestern corner of the ICA were sprayed either aerially or with the |

**Table 16** (continued).

| ICA | Discussion |
|---|---|
| | power sprayer. It appears that *C. odorata* is actively spreading throughout this ICA. This ICA will be a priority for control next year. |
| KTA-ChrOdo-27 | This ICA runs along the Kaunala road, from the gulch bottom up the east side of the gulch to the ridge crest. Only seven plants have ever been found in this ICA, including one mature and one immature removed this year. This is a large area to survey, but is best done on foot, due to the poor condition of the road, and the presence of *Pluchea carolinensis* lining the road. |

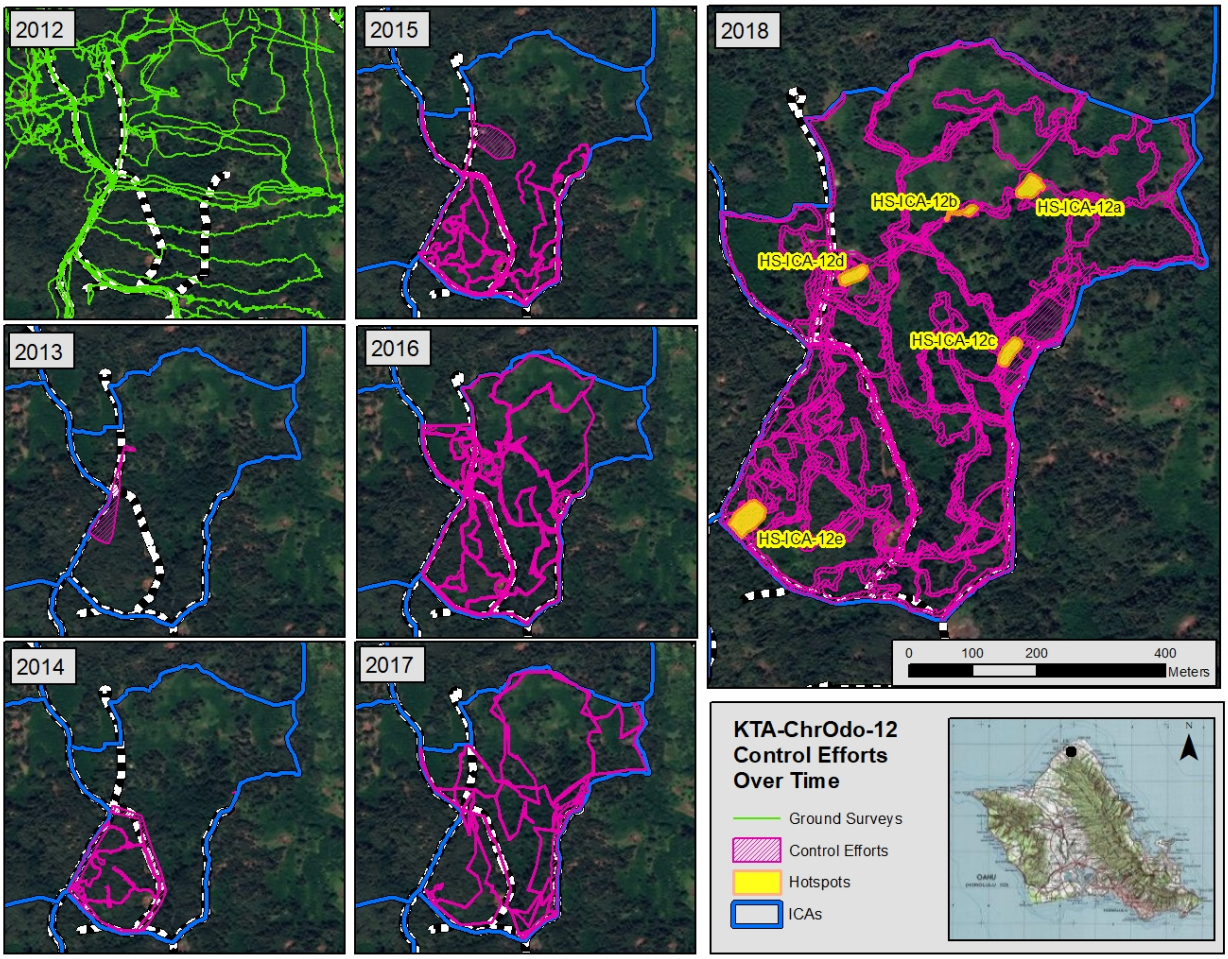


**Figure 22.** Control efforts at KTA-ChrOdo-12 over time.

- Makai Bluffs and Private Land. The bluffs lining the north edge of KTA are steep, thickly vegetated, and difficult to survey. While portions of them lie within KTA, one section is owned by the State, and the majority is privately owned. OANRP does not have permission to work on private land, and generally defers to OISC when *C. odorata* control is needed in these zones. Even if OANRP could access all the bluffs, the steep terrain and dense vegetation preclude effective *C. odorata* surveys. This year, OANRP conducted one aerial survey over the bluffs, on the west side of KTA between the Alpha and Opana access roads, through ICAs-04, 05, 07, and 11. While *C. odorata* can be difficult to spot from the air, staff have grown more comfortable doing so after many hours directing aerial sprays. A handful of plants were found, included a small patch in ICA-05, and a few plants along the northern edges of ICAs-04 and 07, In coming years, aerial surveys of the bluffs will be conducted annually, and will be expanded to extend to

the Charlie access road to the east. They will serve as an early detection system for the northern edge of the *C. odorata* infestation.

**SBW Update**

*Chromolaena odorata* was first discovered at SBW on May 25, 2013 during annual road surveys. SBW contains the second largest *C. odorata* infestation found on Army training lands after KTA. Unlike in KTA, the infestation is mostly confined to a portion of one gulch, Mohiakea, with a small handful of outlier sites. Training activities in SBW are much different than in KTA. As opposed to navigating across large areas, units tend to set up at select locations. While soldiers occasionally venture into the edges of the *C. odorata* infestation, the primary military presence in the infestation is via contractors and civilians conducting range maintenance and vegetation management. OANRP works to maintain positive relationships with these groups, as discussed in Section 3.4 above. Control efforts at SBW are limited by range availability and the need for an UXO escort in all areas off of roads. OANRP has been able to take advantage of regularly scheduled range maintenance 'cold' days, but access to Schofield was limited this year during the UXO stand down. One new *C. odorata* ICA was found on SBW this year, see Figure 23. Staff continue to conduct weed road surveys across SBW and SBS annually.

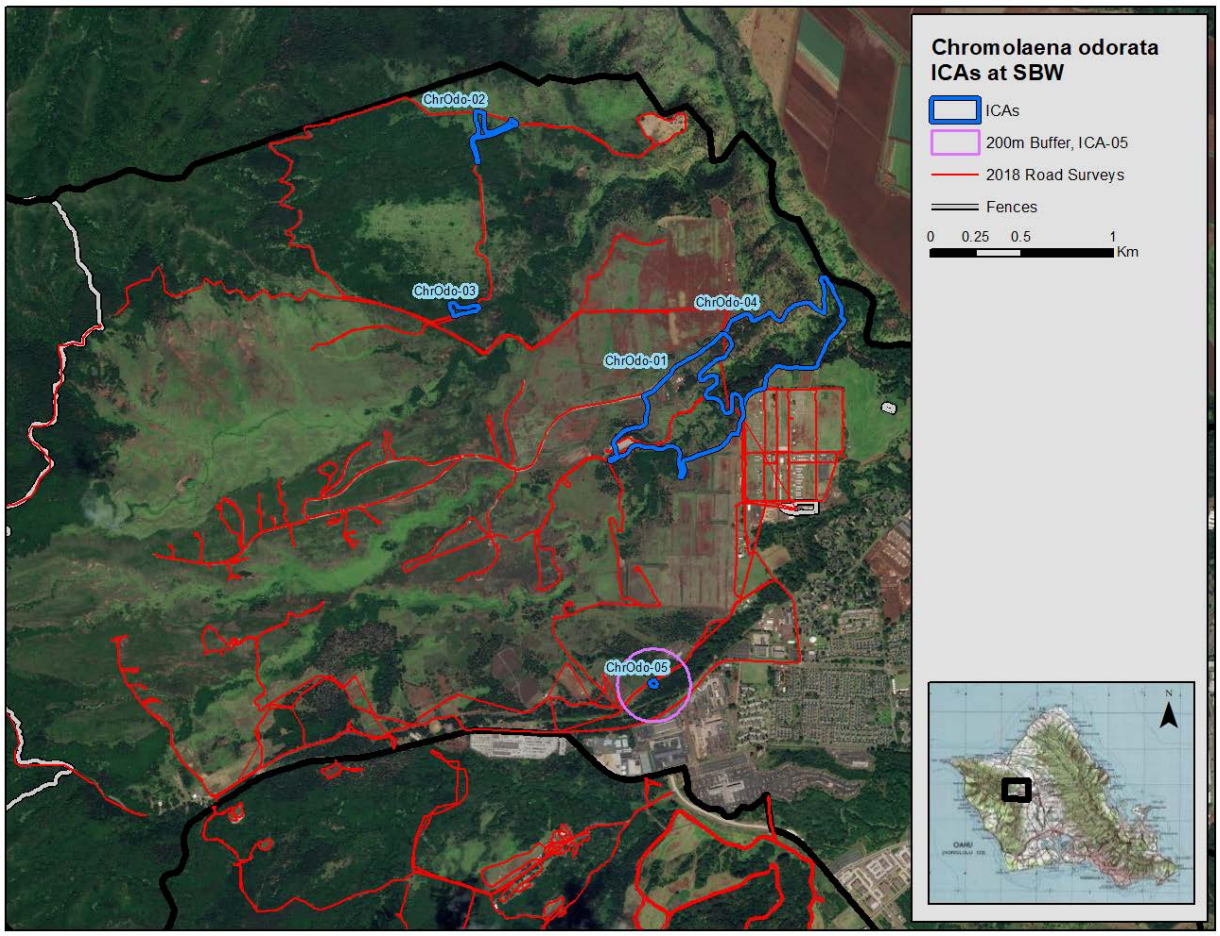


**Figure 23.** *C. odorata* ICA locations at SBW

Table 17 below summarizes control efforts at SBW this year; control efforts from last report year are included for reference. The Type/Strategy listed for each ICA is defined in the KTA Control Summary discussion above. Due to differences in overall infestation size, terrain, military training, and UXO

presence, fewer management strategies are employed at SBW than at KTA. Three ICAs are designated as outliers, while the largest two require a combination of sweeps/surveys and intensive hotspot control This year, staff conducted quarterly visits, focused on known hotspots, and treated select areas with aerial sprays. Total effort and areas treated increased from last year, primarily due to increases at ICA-04. Each ICA is discussed in more detail below. Control efforts were successful in reducing plant numbers at the outlier ICAs and at hotspots in the core ICAs. Due to the limited Range time available, staff did not conduct landscape surveys across the two core ICAs. After the Range shutdown, some ICAs were overgrown with grass, which limited staff ability to both spot *C. odorata* and walk through the areas safely (due to UXO risk, staff must be able to see the ground whenever working off road). In future, maintaining open vegetation at the ICAs will be a priority.

**Table 17.** SBW Control Efforts

| ICA Code and Type/Strategy | 2018 Report Year | | | | 2017 Report Year | | |
|---|---|---|---|---|---|---|---|
| | ICA Area (ha) | Area Weeded (ha) | Effort (hours) | # Visits | Area Weeded (ha) | Effort (hours) | # Visits |
| SBWNoMU-ChrOdo-01 Sweep + Hotspot + Aerial Spray | 22.28 | 4.69 | 46.5 | 9 | 5.60 | 56.7 | 11 |
| SBWNoMU-ChrOdo-02 Outlier | 1.10 | 0.84 | 5.5 | 4 | 0.88 | 7.0 | 3 |
| SBWNoMU-ChrOdo-03 Outlier | 0.57 | 0.51 | 5.0 | 5 | 0.46 | 9.5 | 3 |
| SBWNoMU-ChrOdo-04 Sweep + Hotspot + Aerial Spray | 23.79 | 10.62 | 92.0 | 13 | 7.79 | 56.8 | 9 |
| SBWNoMU-ChrOdo-05 Outlier | 0.11 | 919 m² | 9.60 | 3 | 0 | 0 | 0 |
| TOTAL | **47.86** | **16.76** | **158.6** | **34** | 14.72 | 130.0 | 26 |

- SBWNoMU-ChrOdo-01. This ICA covers the western half of the primary *C. odorata* infestation. Bordered by roads to the north and east, the center of this ICA is dominated by dense stands of *Urochloa maxima*. The grass is so thick in some areas that *C. odortata* doesn't appear to easily colonize it, unless a disturbance creates bare ground. These grass patches are unsafe to survey due to UXO concerns. Next year, staff will survey them from vantage points using binoculars, and possibly conduct an aerial survey. Surveys haven't been done since 2016, in part due to access restrictions, and in part because staff opted to focus on hotspot work this year. Geographic hotspots are designated around concentrations of plants to facilitate efficient and thorough coverage; seven are drawn in this large ICA, see Figure 24. This year, staff swept all hotspots at least twice, while many were treated multiple times, and several were treated during aerial sprays. Last year, access to one large hotspot was restricted due the presence of a low-lying electrical cable. This year, Range Division partially addressed this safety hazard, by removing vegetation from a corridor along the cable. This allowed staff to more safely survey and treat plants in the hotspot. Special emphasis was made to treat hotspots aggressively with an herbicide cocktail of glyphosate and a pre-emergent. Of the nine visits made to this ICA, two were aerial sprays, five utilized the power sprayer, one used hand sprayers, and one used only manual control. Although hundreds of plants were found, total numbers declined from last year, a promising trend. In the coming year, staff plan to maintain high pressure on known hotspots, continue aerial sprays, and remotely survey grass-dominated areas.
- Core Buffer Surveys. While buffer surveys were completed around ICA-02 and ICA-03, the full 200 meter buffer around the core of the infestation in ICA-01 and ICA-04 was not completely surveyed. Much of the 200 meter buffer includes active ranges which are regularly mowed and maintained as open fields. Staff monitor these areas during annual road surveys. Some portions of

the buffer include grassy bowls and forest patches, and the eastern portion of the buffer includes steep vegetated slopes leading into Kaukonahua gulch. Staff surveyed Kaukonahua gulch aerially in 2014 and 2016, with no plants found. These aerial surveys will be repeated in the coming year. Completing buffer surveys will be a survey priority in the next two years, and will likely include a combination of ground sweeps, binocular surveys and aerial surveys.

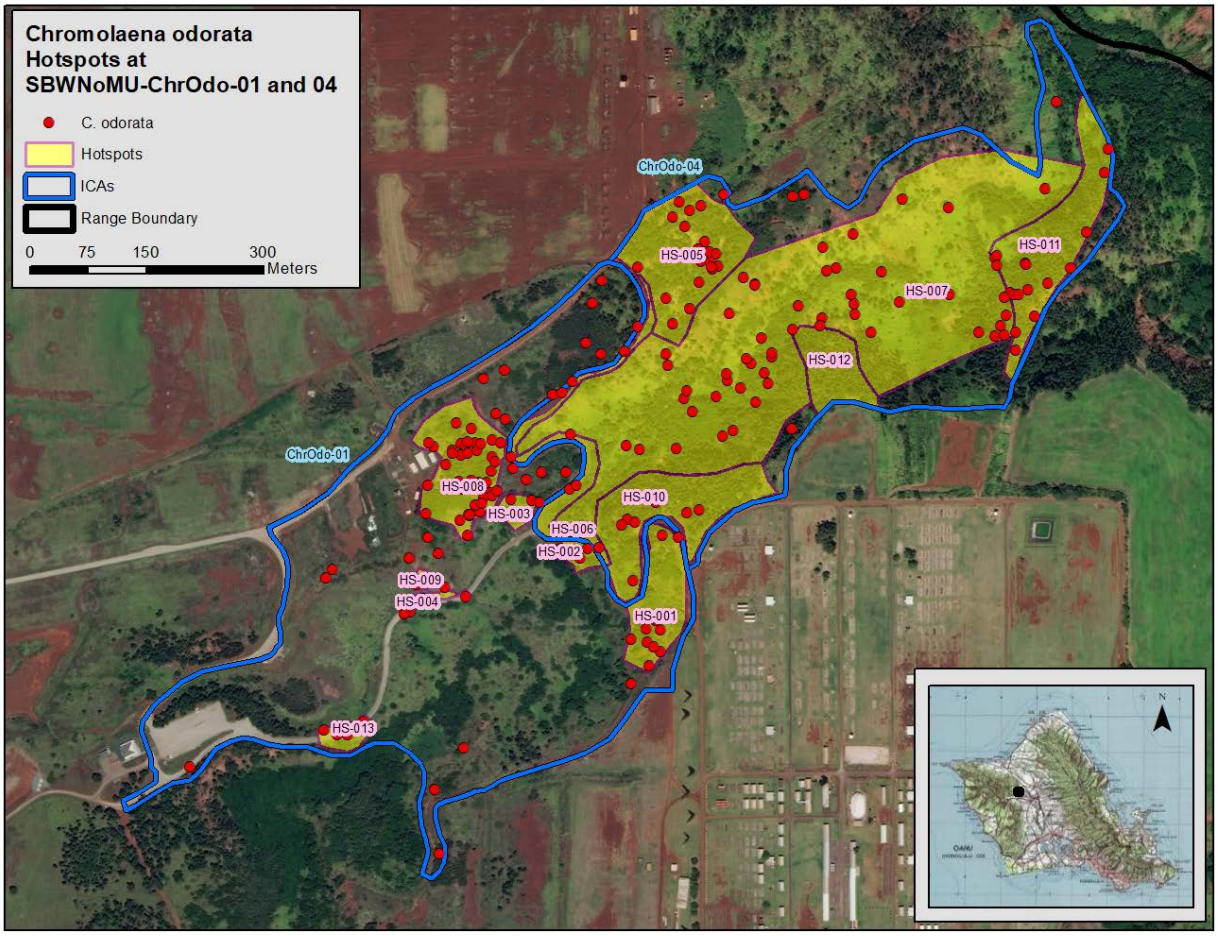


**Figure 24.** Hotspots in SBW Core ICAs

- SBWNoMU-ChrOdo-02. The most northerly of the ICAs at SBW, this site was first discovered in February of 2014. This site is surrounded by fast-growing, thick *U. maxima*. Staff sprayed the grass on three visits, including one aerial treatment in June. All sprays included a pre-emergent herbicide, which is vital in both suppressing grass cover and minimizing *C. odorata* germination. Thorough checks can only be conducted if the area is open. No *C. odorata* was found at the ICA this year, a milestone. Also, this makes three years with no plants found in the roadside portion of this ICA. The last mature plant was removed from the ICA in April 2016, and the last immature plant was removed in January 2017. In the coming year, staff will work to maintain consistent pressure on this ICA.
- SBWNoMU-ChrOdo-03. Located next to a training target, this ICA was first discovered in July of 2014. The west half of the ICA is dominated by trees and has an open understory, while the east half runs along a bluff above a road and is dominated by *U. maxima*. Previously, control efforts were hampered by the thick grass and presence of one suspected piece of UXO. This year, the UXO was inspected by EOD and determined to be scrap metal only. Staff also sprayed the grassy portion of the ICA twice with pre-emergent herbicide, including once aerially. This

allowed staff to conduct more thorough checks across the ICA. While few mature plants have ever been seen at this ICA, last year a patch of 250 immatures were found tucked in the grass, in a spot which was missed on previous visits. This year, total numbers of plants dropped, with only 1 small mature, 33 immatures, and 20 seedlings found. In the coming year, staff will continue to focus on maintaining low grass cover, and conducting thorough surveys of the entire ICA.

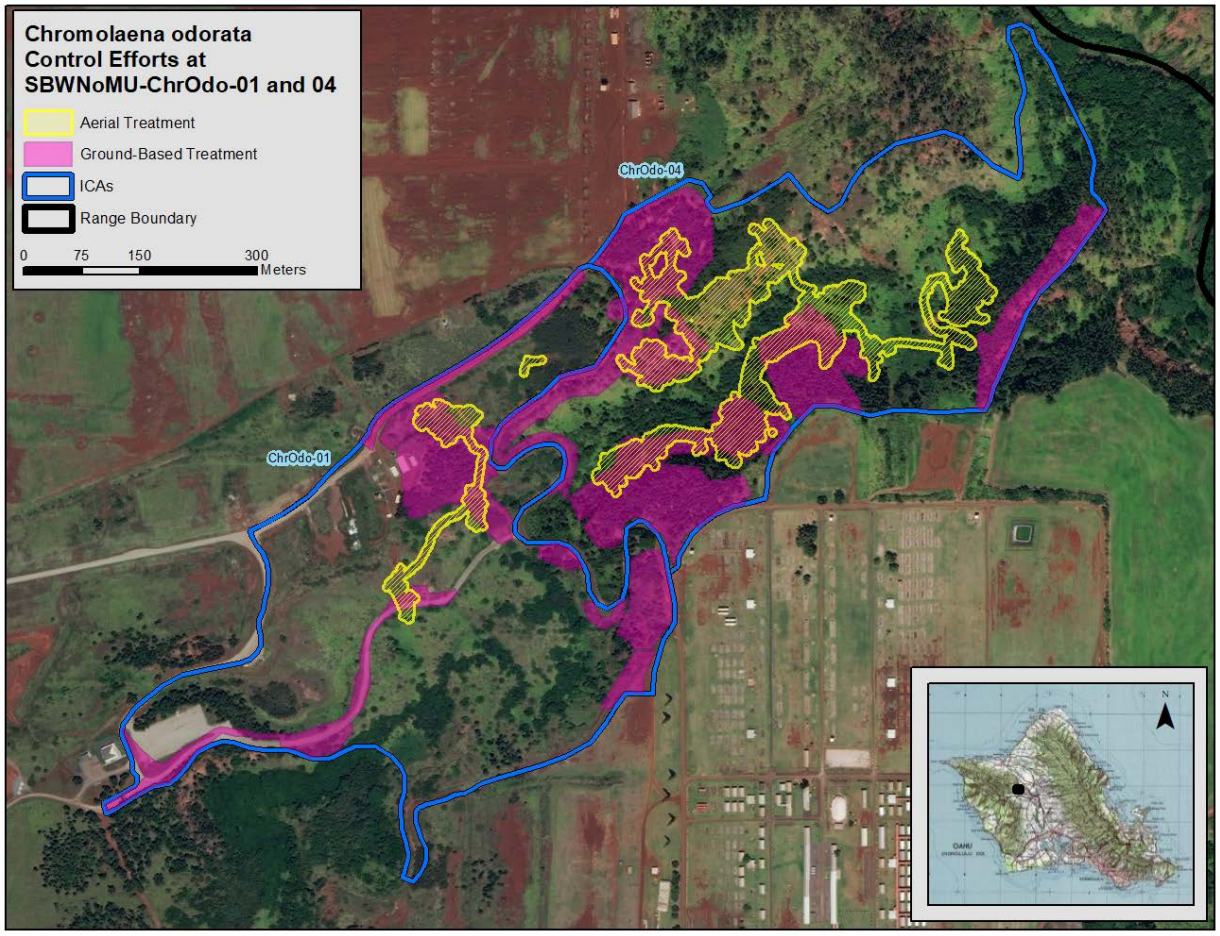


**Figure 25.** Aerial and Ground Treatment in SBW Core Infestation

- SBWNoMU-ChrOdo-04. This ICA encompasses the eastern portion of the primary *C. odorata* infestation, including the core. The terrain is challenging. Portions of the gulch are dominated by dense grass, the slopes are very steep, and there is a high UXO hazard which limits ground access. As in ICA-01, hotspots were drawn around concentrations of plants; there are six hotspots in this ICA. Most of the hotspots are treatable from the ground, but the largest, HS-007 is best treated via aerial sprays. This year, staff maintained aerial spray effort and expanded ground-based control of hotspots, particularly on the southeastern side of the gulch. All hotspots were treated at least twice the year, and most of them received multiple treatments. Of the 13 visits made to the ICA, four were aerial sprays, five utilized the power sprayer, and the remaining four used hand sprayers or manual control. As in ICA-01, all sprays included a pre-emergent. This year, 5.05 ha were aerially sprayed and 7.71 ha were treated on the ground, see Figure 25. In contrast, last year 4.97 ha were aerially sprayed and 5.56 ha treated on the ground. The entire aerial spray zone can now be treated in a day, a testament to the efficacy of past sprays. The total number of plants treated declined somewhat this year, however, as it is difficult to accurately estimate the number of plants controlled in dense patches, this may not yet be a useful measure of

success. In the coming year, staff plan to maintain high pressure on known hotspots, expand ground-based surveys on the northeastern side of the gulch, continue aerial sprays, and remotely survey grass-dominated areas.

- SBWNoMU-ChrOdo-05. This new ICA was discovered on November 28, 2017 during sweeps for another target weed, *E. poepiggiana*. One mature, flowering plant was found along the main road running through the Kolekole Ranges (KR). Staff previously had noted that a wide band of vegetation was cleared along the road, presumably as part of range maintenance efforts. It is strongly suspected that *C. odorata* was introduced to KR as a result of this clearing work. The infestation area was sprayed with pre-emergence herbicide, and checked quarterly, with no additional plants found. A 200m buffer was drawn around the site. Most of the southern half of the buffer has already been swept, but most of the northern half of the buffer falls within the live fire range and is dominated by thick grass, making it unsafe to survey. Staff will consider other options, such as aerial or drone surveys, to inspect this portion of the buffer.

**SBE Update**

First discovered in October 2014, only 15 plants have ever been found at SBE, all in one ICA: 14 immatures in October of 2014 and 1 mature in February 2015. A 200 meter buffer survey around the infestation site was completed in 2014-2015 to delimit the infestation. Although the single mature plant did set seed, staff treated the area with pre-emergent herbicide, and no plants have been found since. This makes almost three and a half years with no plants found, which strongly suggests that no seed bank was formed. Initially, the site was scheduled for quarterly checks, but due to the lack of recruitment, it is now scheduled for twice a year checks. Due the site's close proximity to other work areas in SBE, staff occasionally conduct extra monitoring as well. Control efforts are summarized in Table 18.

**Table 18.** SBE Control Efforts

| ICA Code | 2018 Report Year | | | | 2017 Report Year | | |
|---|---|---|---|---|---|---|---|
| | ICA Area (ha) | Area Weeded (ha) | Effort (hours) | # Visits | Area Weeded (ha) | Effort (hours) | # Visits |
| SBE-ChrOdo-01 | 0.18 | 0.18 | 3.00 | 3 | 0.18 | 3.25 | 3 |

In the past, staff observed evidence of vegetation spraying around the ICA, possibly because it is adjacent to powerline poles maintained by HECO. These sprays keep the area open and easy to survey. The ICA will be monitored for at least ten years from the date of the last mature plant. As seed longevity trials progress, staff will revise plans based on the best available data. Given the intensity of training at SBE and the high number of plants at KTA and SBW, there is a chance that *C. odorata* will be reintroduced to SBE. Fortunately, staff already survey or sweep much of SBE. Road surveys are conducted once a year and include all drivable trails. Large areas are regularly swept in the course of ICA control work on *S. condensatum* and *R. tomentosa*. Staff hope these efforts will detect any new *C. odorata* infestations in a timely manner.

**Manuwai Update**

*Chromolaena odorata* was first found at Manuwai on February 23, 2017. The plant was large enough to have flowered the previous flowering season (starting December 2016), but was vegetative and did not have any obvious signs of spent inflorescences. Two immatures were later found in March 2017. The ICA was treated once with pre-emergent herbicide, and no plants have been seen since. Control efforts for the year are summarized in Table 19. The ICA will be monitored quarterly in the coming year.

**Table 19.** Manuwai Control Efforts

| ICA Code | 2018 Report Year | | | | 2017 Report Year | | |
|---|---|---|---|---|---|---|---|
| | ICA Area ($m^2$) | Area Weeded ($m^2$) | Effort (hours) | # Visits | Area Weeded ($m^2$) | Effort (hours) | # Visits |
| Manuwai-ChrOdo-01 | 78 | 78 | 125.70 | 10 | 78 | 13.75 | 4 |

Last year, staff determined the dispersal of *C. odorata* to Manuwai likely occurred either in January 2016 or December 2015, during camp trips geared towards treating alien canopy weeds across six different WCAs; these are the 'Potentially Contaminated' purple polygons in Figure 26. This year, staff surveyed all Potentially Contaminated areas, 14.09 ha. No additional *C. odorata* was found. The high effort spent this year is entirely due to these buffer sweeps. Since much of the area within the 200m buffer is marginal habitat for *C. odorata*, full sweeps were not conducted across it. Instead, staff looked for *C. odorata* whenever conducting weed control or other management work in the MU; these areas are noted in green in Figure 26. While these surveys were a major effort, staff had only moderate confidence in detecting isolated *C. odorata* due to the thick vegetation and steep terrain. Therefore, OANRP plans to survey the Potentially Contaminated areas again in five years (2022-2023 report year). In the meantime, staff will continue to look for *C. odorata* in the course of other management work and practice good sanitation.

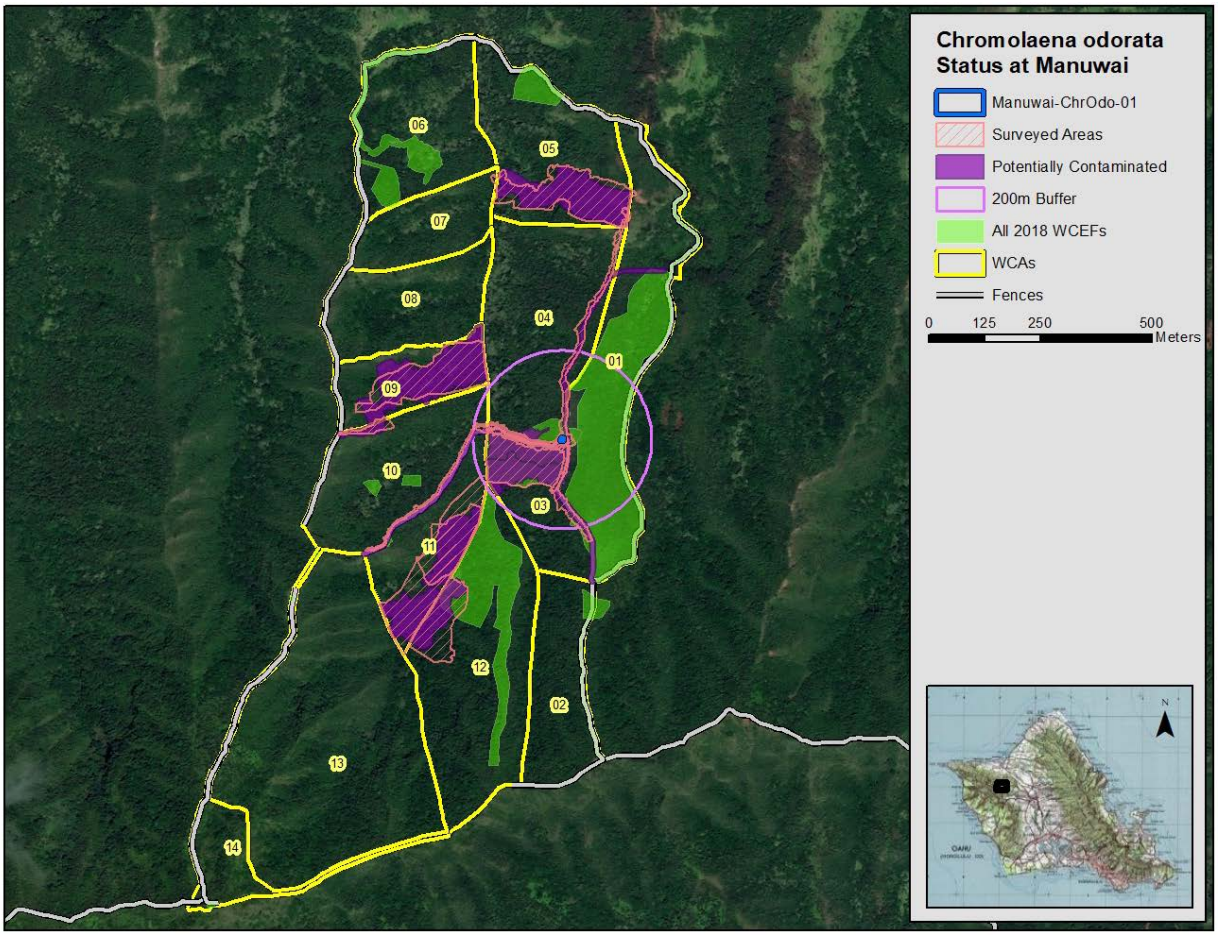


**Figure 26.** *C. odorata* Status at Manuwai

**Makaha Valley Update**

In December 2017, a recreational hiker posted a photo of *C. odorata* in Makaha Valley on social media, see Figure 28. OANRP staff conducted a site visit on December 11, 2017 and found two plants. One of the plants was flowering and mature, with a 2" diameter base, while the other was immature. Both were controlled. The plants were found on an unofficial trail on the west side of the valley, see Figure 27. The find was reported to OISC, who conducted extensive surveys in both 200m and 800m buffers around the plant; no other plants were found. The *C. odorata* site is about 900 meters away from the Makaha I MU, and is not visited by OANRP or partner agencies. Makaha is managed by BWS and is not open to public hiking, however, there are numerous trails throughout the valley, and it appears to be a popular local hiking and hunting spot. In the absence of a more likely source, it is assumed that *C. odorata* was introduced to the area via recreational use. OANRP supports OISC and BWS efforts to manage *C. odorata* in Makaha, and will look for it whenever conducting field work in the valley.

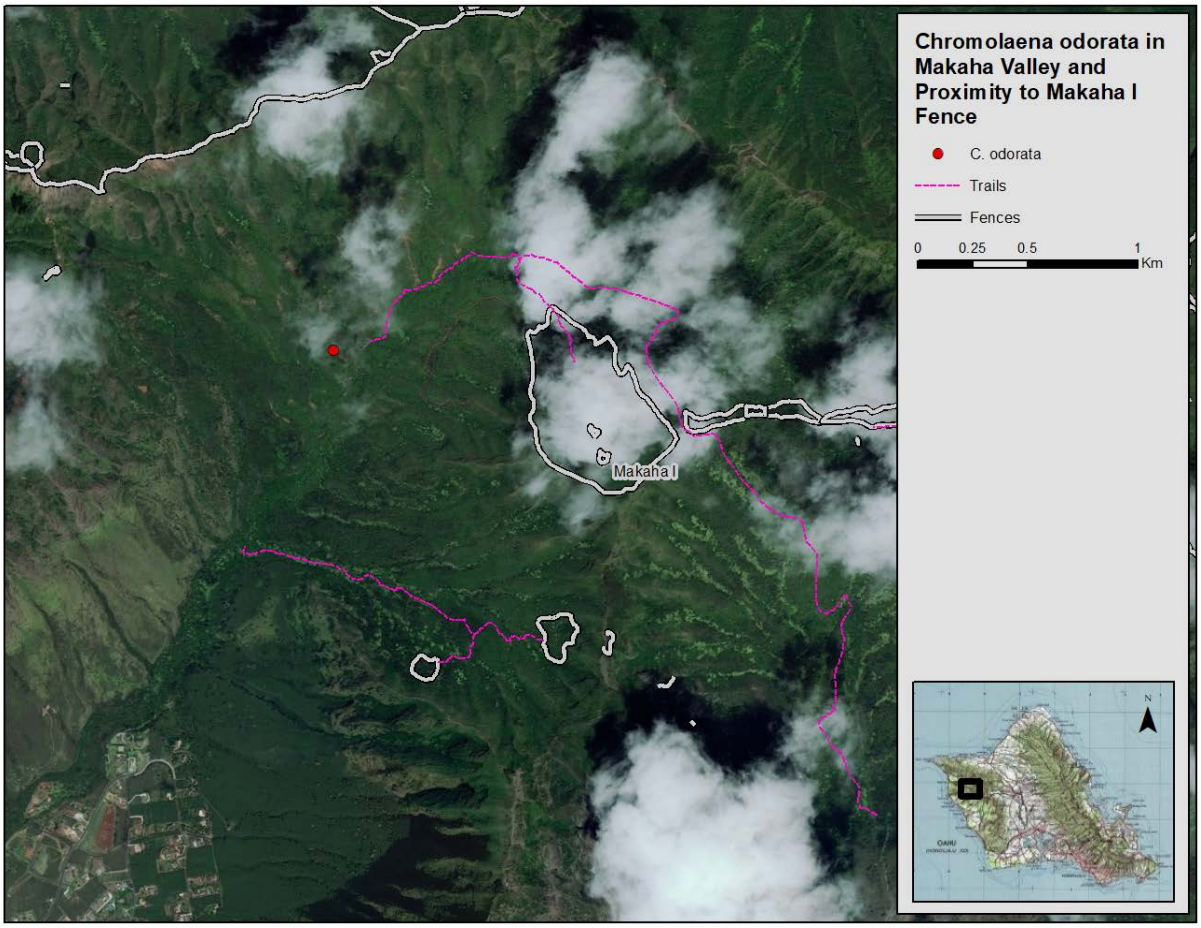


**Figure 27.** *C. odorata* site found in Makaha Valley, and proximity to Makaha I MU.

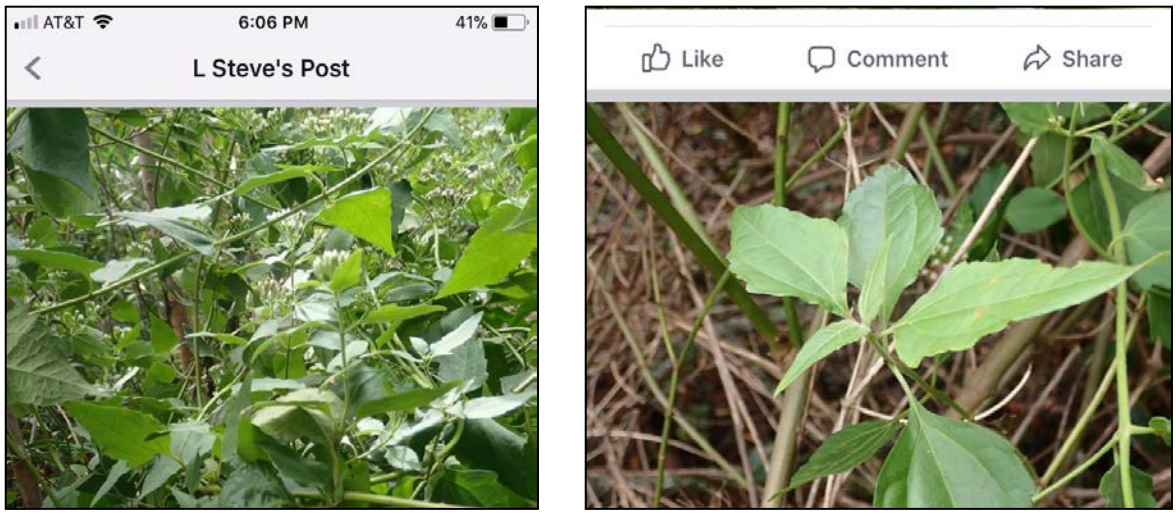


**Figure 28.** Social media post showing *C. odorata* found by a hiker in Makaha Valley.

**Pupukea-Paumalu State Park Reserve Update**

During a weekend recreational hike, OANRP staff discovered one mature, meter tall, *C. odorata* along the Ehukai trail above Sunset Elementary School in the Pupukea-Paumalu State Park Reserve; see Figure 29. This popular trail sees heavy recreational use and connects to a network of trails in the Reserve. The new *C. odorata* site is about 2 km from heavily infested areas at KTA to the east, and a little over 2 km from two small ICAs on the edge of the KTA Alpha 3 training area to the southeast. The Reserve trails connect to the State's Kaunala Trail in Alpha 3, and from there to all the roads in KTA. Both the Reserve trails and Kaunala Trail are used by hikers, mountain bikers, and motocross riders; these are the suspected vectors for this find. OANRP reported the find to OISC, and plans to assist OISC's efforts here by obtaining a permit from the State Parks Department and surveying the trails in the Reserve. The North Shore Community Land Trust works with the State Parks Department to manage the area, and according to their website, holds monthly community work days at the Reserve (https://northshoreland.org/the-latest/land-stewarship/pupukea-paumalu-2/). This may be a venue to increase public awareness of *C. odorata* and encourage hikers and other recreational users to clean their boots and gear before entering natural areas. Once trail surveys are complete, OANRP will meet with OISC to discuss management and public outreach options.

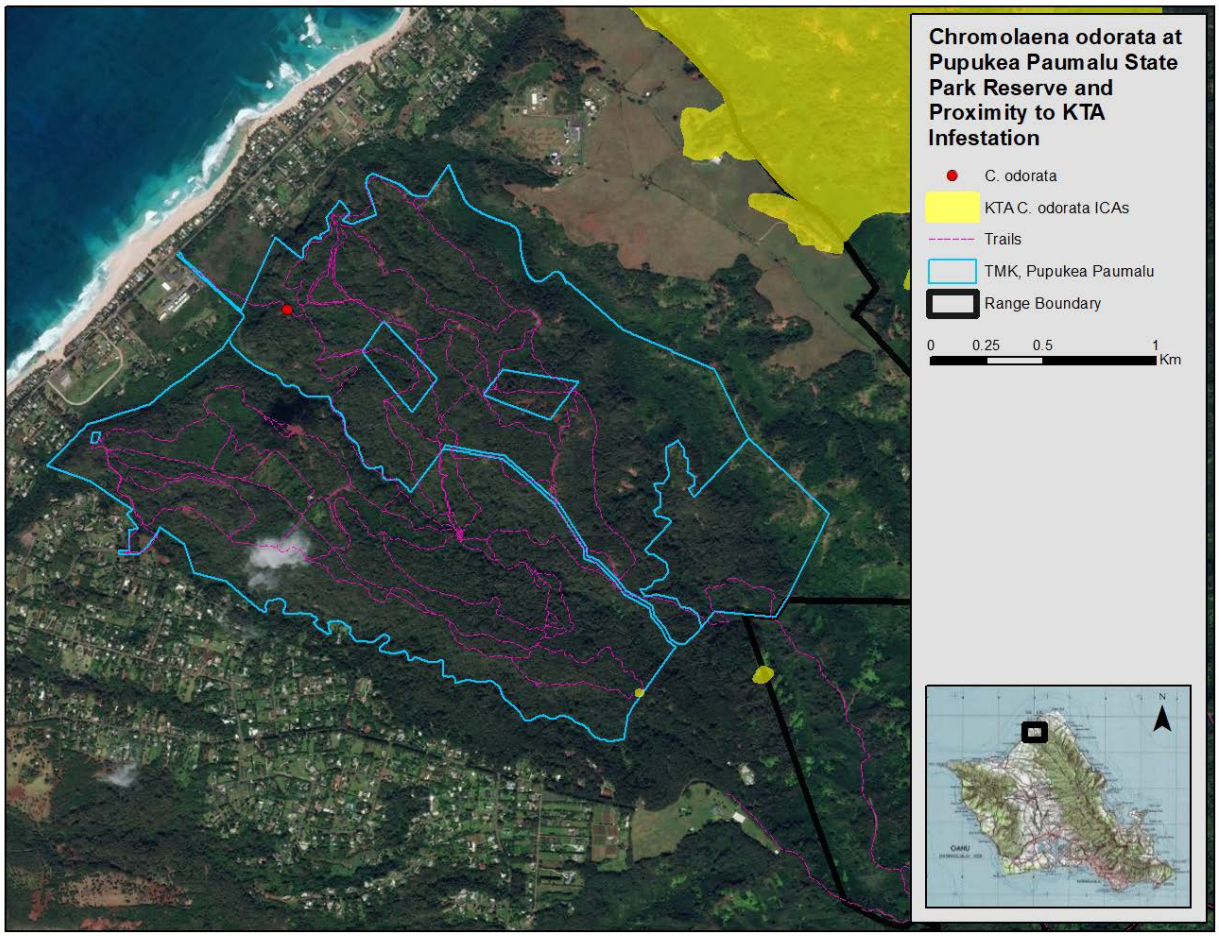


**Figure 29.** *C. odorata* infestation site at Kaluaa No MU, and proximity to the SBW infestation.

**Kaluaa No MU Update**

Staff discovered *C. odorata* along a major access trail for the Kaluaa & Waieli MU on May 10, 2018. Two plants were found; one was immature, but the other was large, mature, full of seed, and possibly several years old. The trail is used by staff, and occasionally partner agencies, to access the north end of the MU, including Puu Hapapa; the trail is not easily accessible to the public and is not used by the military. The plants were approximately 10 meters off the trail. The most likely vector for this new infestation site is OANRP. Between early 2018 and 2014, there are numerous occasions where staff worked in KTA controlling *C. odorata*, and within one or two working days visited Kaluaa & Waieli. The new site is unlikely to have dispersed from SBW, as it is approximately 3 km from the closest known *C. odorata* in SBW, and 4 km from the SBW infestation core; see Figure 30. Last report year, OANRP began using gear dedicated to *C. odorata* during all control efforts. Given the size of the mature plant, it is possible dispersal to Kaluaa occurred prior to the use of this dedicated gear, but this find serves as a reminder of the importance of always practicing good sanitation.

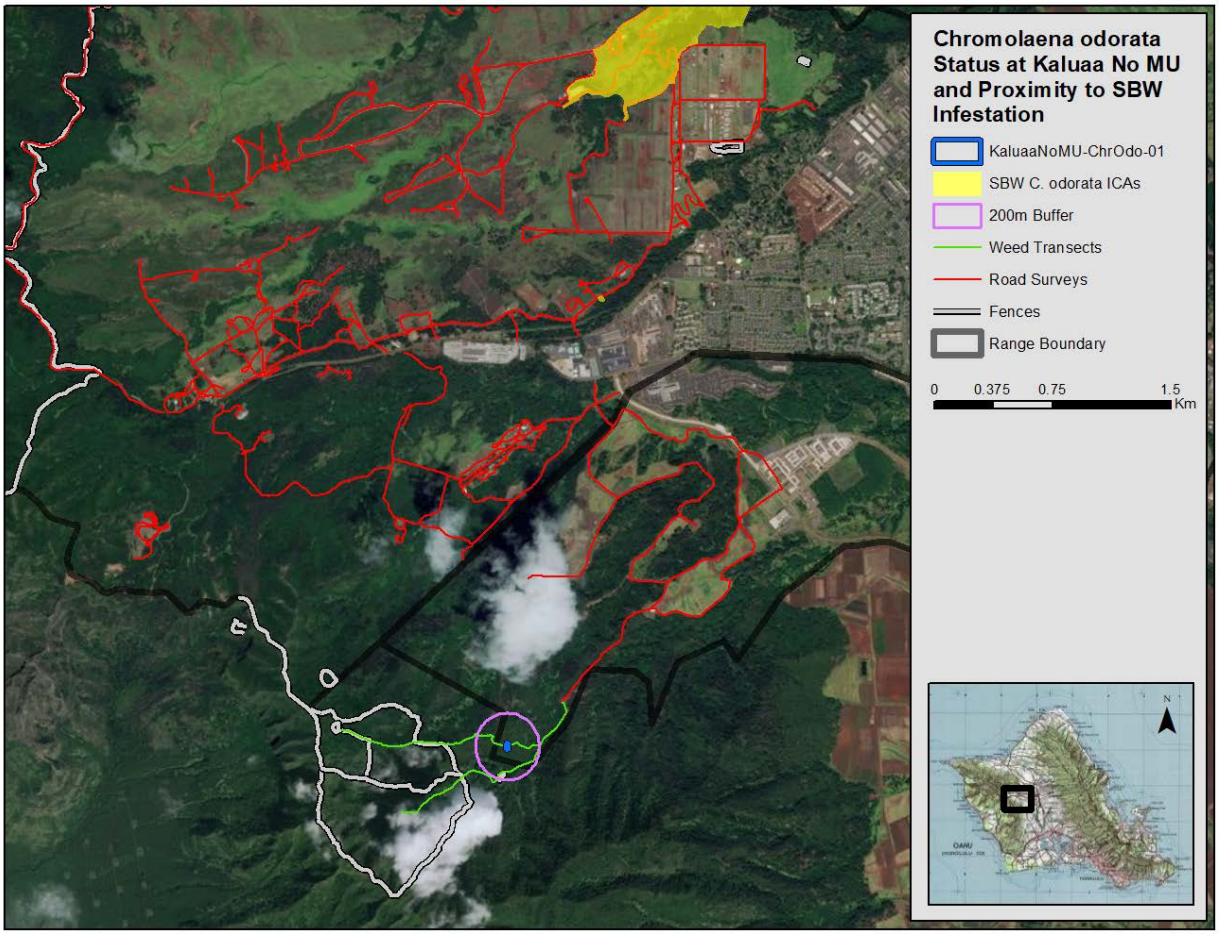


**Figure 30.** *C. odorata* infestation site at Kaluaa No MU, and proximity to the SBW infestation.

The Kaluaa site is located within the SBS installation boundary, but is less than 100 meters from the Honouliuli Forest Reserve. Control efforts are summarized in Table 20. In the coming year, staff will delimit the infestation by surveying a 200 meter buffer around the known plants and monitoring the whole access trail. Staff already monitor Weed Transects along the entire access trail. The transects are generally read in the first quarter of the year; this year, an additional reading is scheduled for fall of 2018. The road leading to the Kaluaa trail head is monitored during regular annual road surveys, as are all roads

within SBS. Fortunately, the area around the known plants is heavily forested, and not the open, scrubby habitat *C. odorata* appears to thrive in best. The ICA was treated once with a pre-emergent herbicide to reduce on-site recruitment, and will be monitored quarterly in the coming year.

**Table 20.** Kaluaa No MU Control Efforts

| ICA Code | 2018 Report Year | | | | 2017 Report Year | | |
|---|---|---|---|---|---|---|---|
| | ICA Area ($m^2$) | Area Weeded ($m^2$) | Effort (hours) | # Visits | Area Weeded ($m^2$) | Effort (hours) | # Visits |
| KaluaaNoMU-ChrOdo-01 | 812 | 812 | 1.0 | 1 | n/a | n/a | n/a |

**Biocontrol Update**

Despite the considerable resources and time invested into *C. odorata* management by OANRP and OISC, efforts appear to be insufficient at stopping the spread of this pest to new locations. Resources are inadequate to conduct planned treatment at all known infestations, much less survey potentially infested lands. More aggressive tools are needed. Biocontrol agents have successfully been used to manage *C. odorata* in other parts of the world. This year, OANRP continued to talk with partner agencies about how to pursue development of a biocontrol for release here in Hawaii. The most promising biocontrol is *Cecidochares connexa*, a gall-forming fly. The International Organization for Biological Control of Noxious Animals and Plants (IOBC) Working Group on Chromolaena endorses this agent: "*C. connexa* is the best biocontrol agent for chromolaena available at present, in terms of host range, efficacy and east of establishment." Galls develop on the stems of plants affected by *C. connexa*, and act as resource sinks; heavily galled plants are reported to have little flower/seed set. In addition, *C. connexa* is easy to rear and establish in the field, and disperses widely; see Appendix 3-11.

One complicating factor for this agent is that there are two different biotypes of *C. odorata*: the Asian/West African (AWA) and South African (SA). These names do not refer to the origin of the biotype, but to the area infested by it. The IOBC defines describes the morphological differences between the biotypes on their website; see Appendix 3-12. The AWA biotype is thought to be more widespread; as its nickname suggests, it is the type found at infestations across Asia and the Pacific. The IOBC states, "due to (*C. connexa's*) narrow host range, it cannot develop on the SA biotype of chromolaena."

While plants found on Oahu morphologically appear most similar to the AWA biotype, this needs to be confirmed before pursuing *C. connexa* further. OANRP is currently working with Dr. Cliff Morden (University of Hawaii) and OISC to answer this question. OANRP and OISC collected samples of *C. odorata* from different infestations around the island, including Aiea/Camp Smith, Kahana, Makaha, SBW, and both the eastern and western sides of KTA. Dr. Morden's lab will conduct genetic analysis of the samples and compare them to published results as well as a fresh sample from Guam; a permit to import vegetative *C. odorata* material was obtained from HDOA. OANRP provided funding for a student hire for Dr. Morden's lab to conduct this work. Once complete, Dr. Morden plans to publish the results of the genetic analysis. Included in the paper will be a discussion of the distribution of *C. odorata* on Oahu, the history of management efforts, and the current status of the infestation. Partners at DOFAW recommended that such a paper would be useful in justifying the threat of *C. odorata* to Hawaii and support later efforts to pursue a biocontrol for it.

Assuming the *C. odorata* in Hawaii does genetically match the AWA biotype, OANRP will continue to pursue *C. connexa* biocontrol testing.

## 3.7 RESTORATION ACTIONS UPDATE

### 3.7.1. Management Unit Summaries

This year, restoration actions continued in high priority Weed Control Areas. Restoration activities aim to complement weed control efforts in areas with high weed recruitment, to restore connectivity and structure to native forest patches, and to replace vegetation following removal of dense patches of alien species. In general, the most common restoration approach entails conducting seed sows with fast-growing native species, and/or outplanting plants that are also expected to establish either understory or canopy cover quickly. Some more nuanced approaches are taken for species where host specificity and/or habitat specificity is critical such as for *Drosophila* and *Achatinella* spp.

Restoration actions are tracked within WCAs, as two types: 1) outplantings; and 2) seed sows, divisions, transplants (SDT). Outplantings require a higher level of planning and effort, and SDT actions can be done opportunistically and as needed. Area for each restoration type is calculated by merging all the efforts into a single geographic footprint within a given WCA for the year (overlapping areas are not additive). Reporting of numbers of outplants and restoration area began in 2016, and total number of outplants, and area totals for outplants and SDT efforts to date are displayed in Figure 31 and 32 below. Total number of outplants in each MU since 2016 is displayed in Figure 33.

More detailed restoration information is presented, organized by MU, with a map showing locations of restoration activities and the specific WCAs in which those occurred, followed by a table summarizing restoration actions for each MU, for the last report year. Total number of plants and outplant and SDT area for 2018 is also presented in Table 32 at the end of all the summaries.

This year, over three times more common native outplants were planted than last year. Outplants continued to account for the largest restoration action effort. Additionally, nearly 1500 *Bidens torta* were grown at OANRP nurseries and planted at Kahua to establish a Seed Production Plot for that taxa. See Seed Production Plots Update later in this section for details on those efforts. Hand broadcast seed sows were conducted at restoration sites that were cleared of large swaths of alien vegetation to establish quick cover. Sows were mostly conducted with *B. torta* and *Pipturus albidus* but a few other species were opportunistically broadcast as well; no formal follow-up on those has been conducted. However, this year staff aim to collect enough seed from these species as well as others to be able to conduct seed sow trials. While these trials are not formally designed yet, staff would like to pin down best practices for broadcast sows for a variety of species, as well as to determine how both processed and stored seed perform and compare to each other.

Restoration efforts commenced at the Palikea North snail enclosure this year. Four outplanting events occurred from December through June. Numbers of snail enclosure outplants are reported separately from WCA outplants in the Palikea summary in Table 31.

Individual outplant survival is not monitored. Outplants are re-visited post-planting as needed for supplemental water and to take general observations about overall outplant health. Vegetation monitoring occurs at a subset of restoration sites. Those thought to warrant the effort associated with monitoring include but are not limited to: sites where significant amounts of alien canopy has been removed (all of the Ecosystem Restoration team sites), sites like those in Makaha on

Board of Water supply land where data can be presented to the land owner about native vegetation response after weed control with herbicide, or sites like snail enclosures where monitoring can help assess appropriate habitat for snails. Monitoring techniques vary at each restoration site including: vegetation plot monitoring, point-intercept vegetation monitoring, photopoints, and Gigapan Imagery analysis. The MU belt plot monitoring that looks at overall success of management across the MU as a whole now includes analysis of restoration effort impacts. The Kahanahaiki and Palikea MU vegetation monitoring reports, Appendices 3-8 and 3-10 both address restoration impacts for each of those MU.

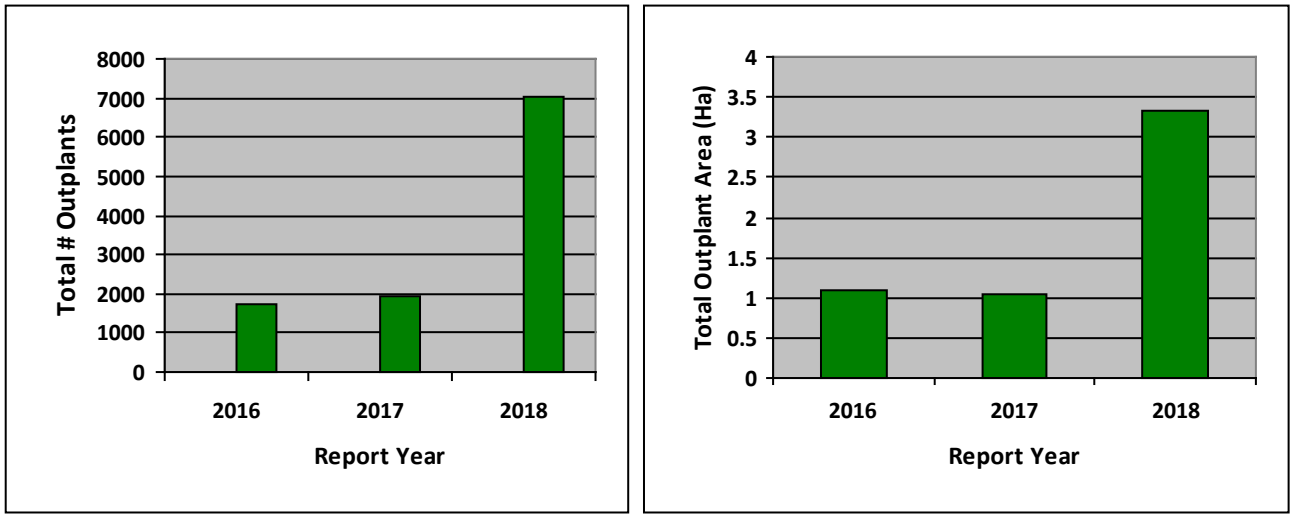


**Figure 31.** Number of outplants (left) and total area of outplants (right) each year since 2016

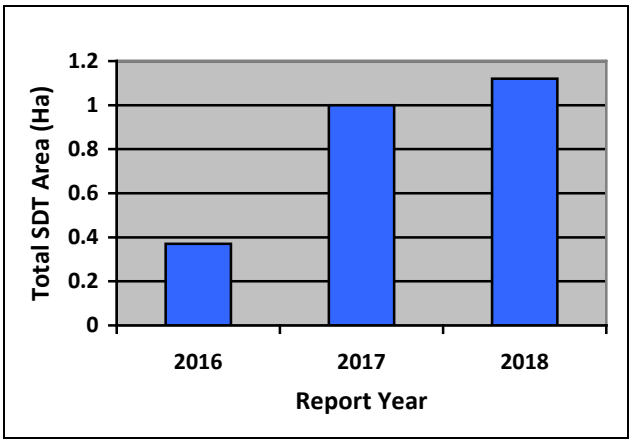


**Figure 32.** Total SDT area each year since 2016.

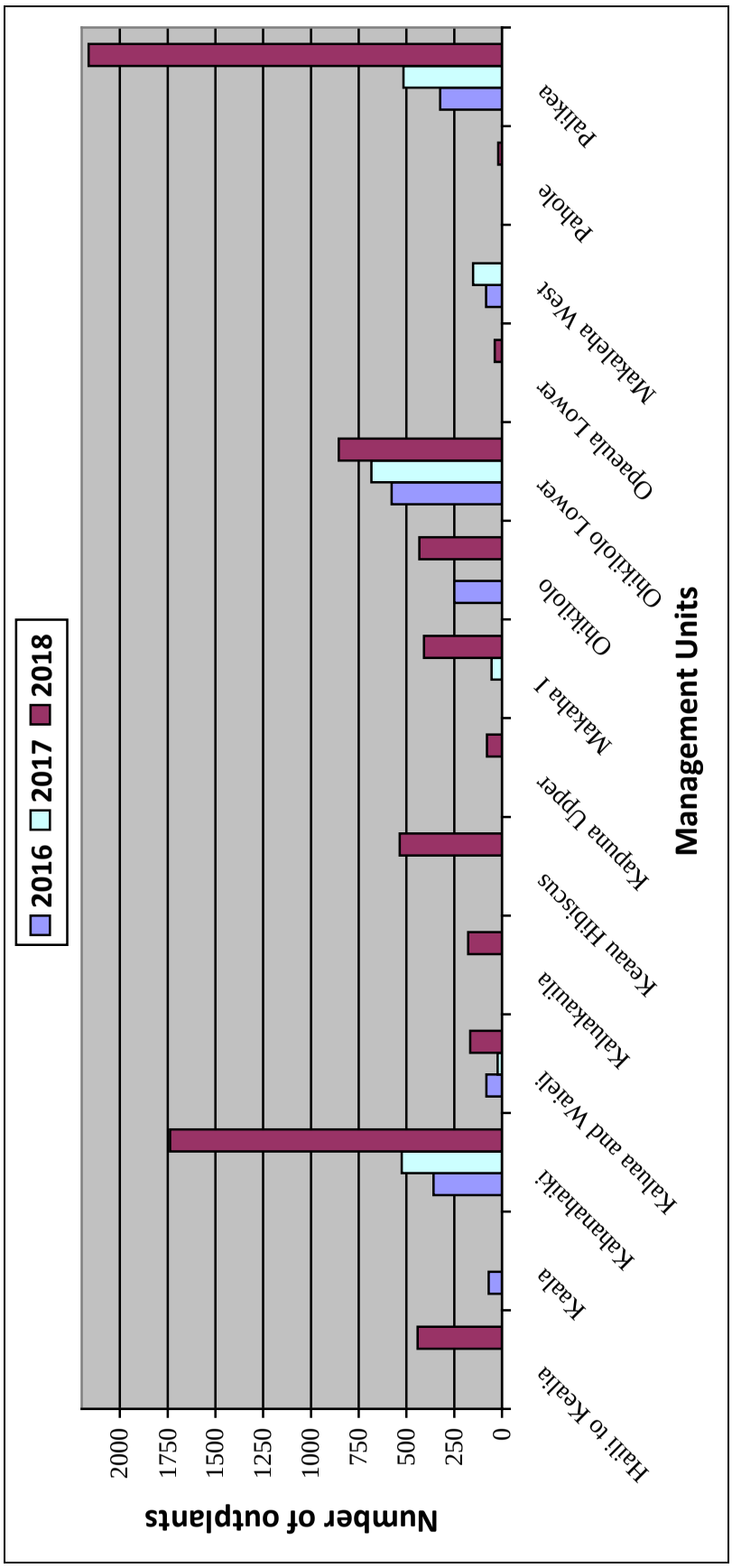


**Figure 33.** Number of outplants in each MU since 2016

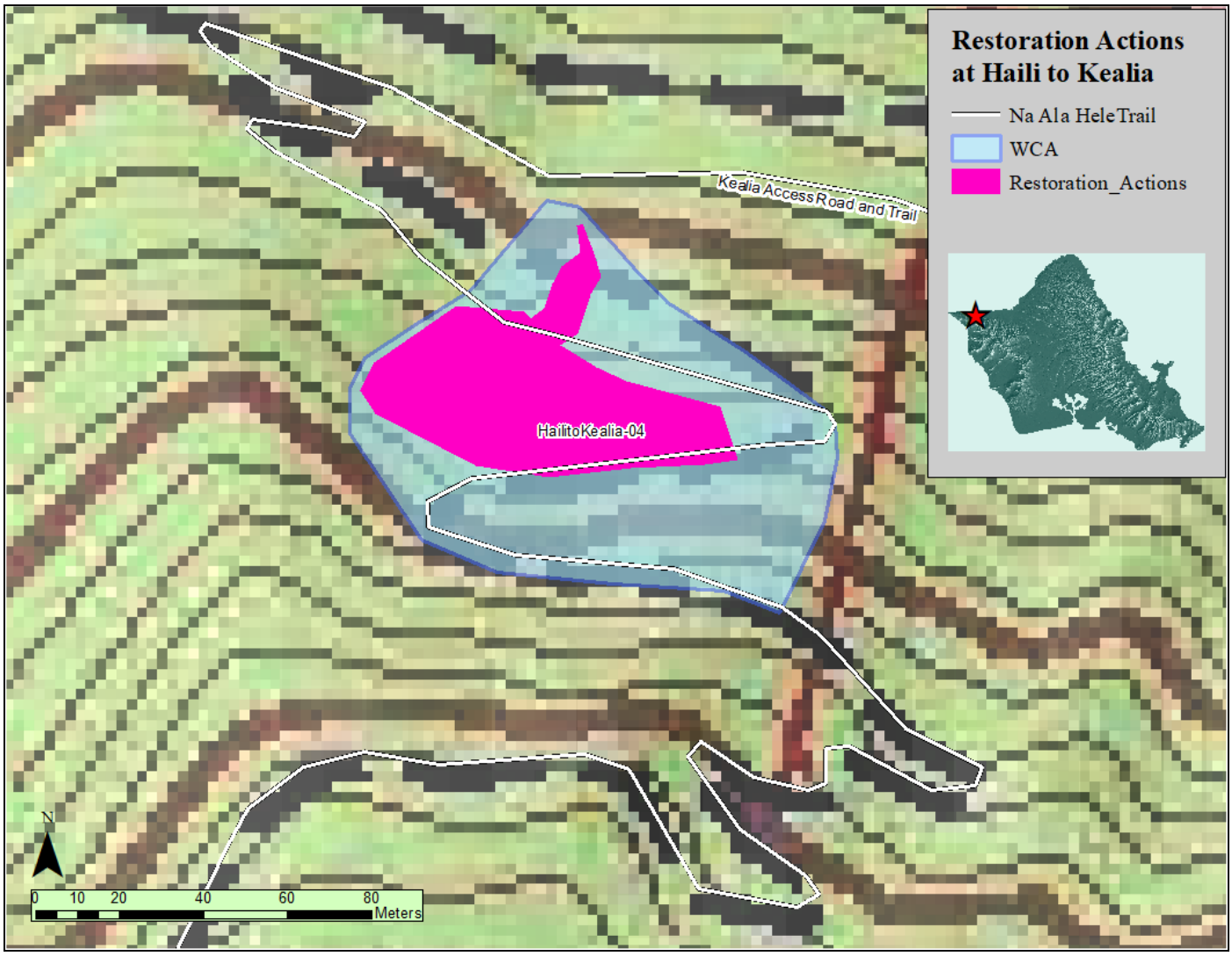


**Figure 34.** Map of Restoration site in respective WCA in Haili to Kealia.

**Table 21.** Summary of Restoration Actions in Haili to Kealia

| MU | Restoration Action | # of plants | Area ($m^2$) | Taxa | Comments |
|---|---|---|---|---|---|
| Haili to Kealia | Outplanting | 441 | 2412 | *Plumbago zeylanica*, *Erythrina sandwicensis*, *Chenopodium oahuensis* | Outplants were focused around the *Hibiscus brackenridgei* subsp. *mokuleianus* reintroduction in an effort to increase native cover and reduce alien grass levels. Future outplantings with *Dodonaea viscosa* are planned. |

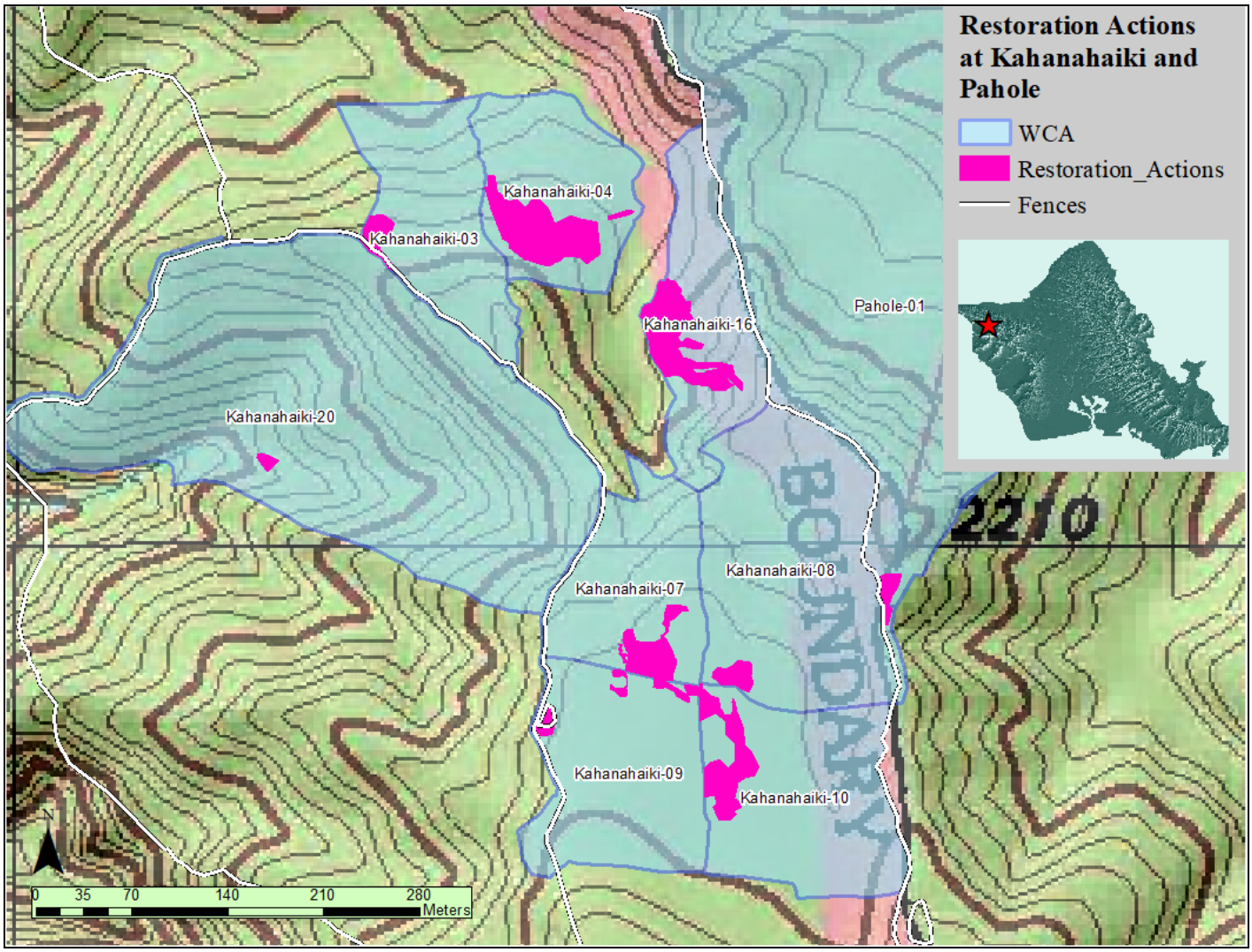


**Figure 35.** Map of Restoration sites in respective WCAs in Kahanahaiki and Pahole.

**Table 22.** Summary of Restoration Actions in Kahanahaiki and Pahole

| MU | Restoration Action | # of plants | Area ($m^2$) | Taxa | Comments |
|---|---|---|---|---|---|
| Kahanahaiki | Outplanting | 1737 | 8817 | *Acacia koa, Alyxia stellata, Bidens torta, Canavalia galeata, Carex wahuensis, Dodonaea viscosa, Hibiscus arnottianus* subsp. *arnottianus, Kadua affinis, Myrsine lessertiana, Pisonia* spp. | This year outplanting efforts continued at the 'Shire' site in Kahanahaiki-04, and at the largely expanded 'Schweppes' site in Kahanahaiki-16. A significant amount of *A. koa* and other common native species were planted across the 'Chipper' site in Kahanahaiki 07-10 with volunteer support. Smaller plantings were also conducted in Kahanahaiki-20 and 03 around *Flueggea neowawraea* and *Schiedea obovata* reintroductions respectively. |

**Table 22** (Continued).

| MU | Restoration Action | # of plants | Area ($m^2$) | Taxa | Comments |
|---|---|---|---|---|---|
| | SDT | N/A | 4574 | *A. stellata, B. torta, Carex wahuensis, Dianella sandwicensis, Pipturus albidus* | Seed sows were conducted on several occasions in the Ecosystem Restoration team's sites in Kahanahaiki-04 and 16. Here *A. stellata* was sown opportunistically; no follow-up has been conducted to identify what if any germinates resulted from these sows. |
| Pahole | Outplanting | 20 | 365 | *A. koa, M. lessertiana, K. affinis* | These species were planted on a small puu around a *Cenchrus agrimonioides* var. *agrimonioides* reintroduction after aggressive removal of a persistent patch of *Melinis minutiflora* grass. |

**Figure 36.** Photos of 'Schweppes Extension' site. Left: photo taken May, 2017 post initial clearing. Right: photo taken February, 2018 highlighting recruitment from seed sows.

**Figure 37.** Photos of original 'Schweppes' site where thickets of *C. hirta* and stands of *P. cattleianum* are now replaced with *Pisonia* outplants, and *P. albidus* seed sow recruits. Left: photo taken July, 2014. Right: photo taken April, 2018.

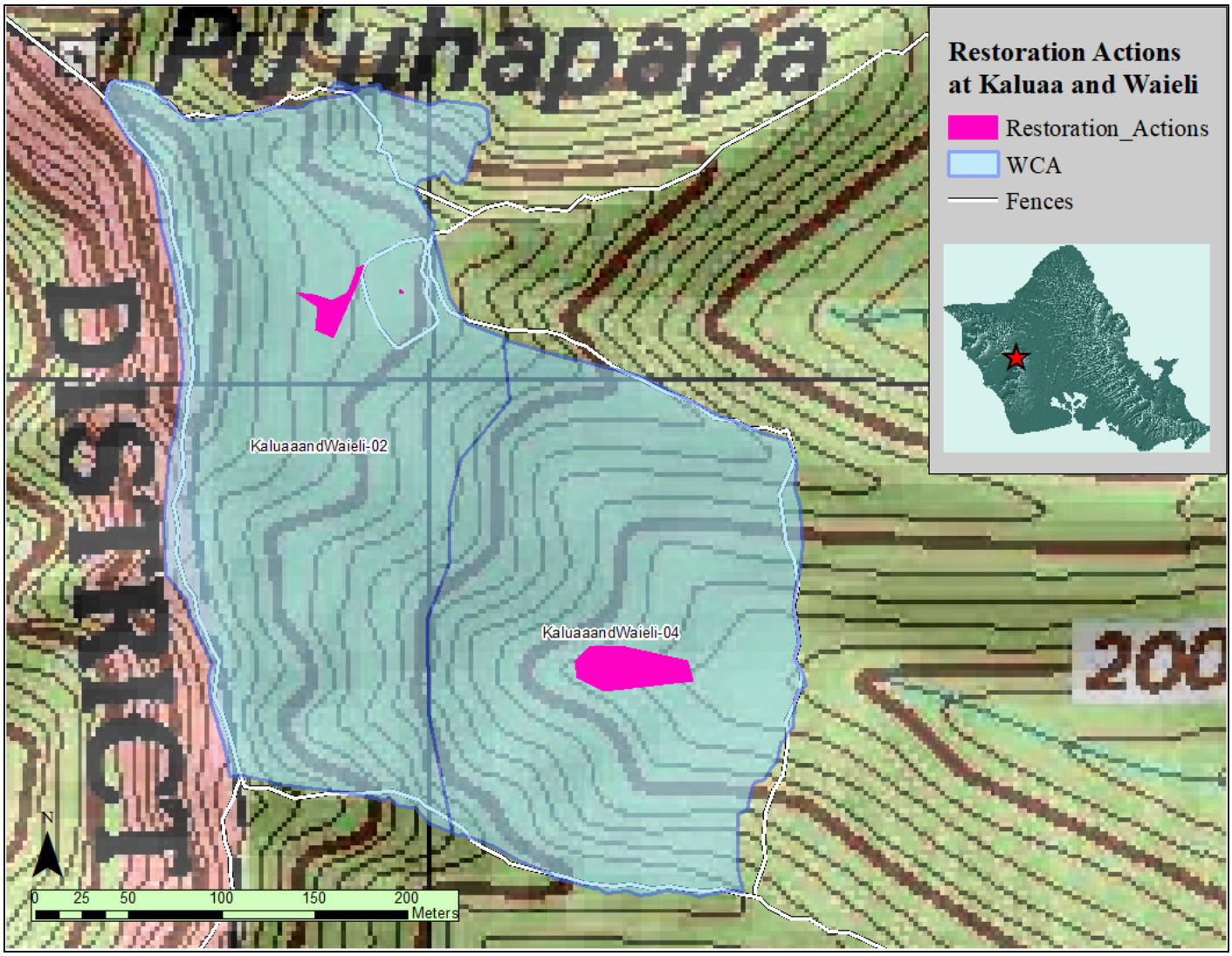


**Figure 38.** Map of Restoration sites in respective WCAs in Kaluaa and Waieli

**Table 23.** Summary of Restoration Actions in Kaluaa and Waieli

| MU | Restoration Action | # of plants | Area ($m^2$) | Taxa | Comments |
|---|---|---|---|---|---|
| Kaluaa and Waieli | Outplanting | 166 | 1551 | *Labordia kaalae, Urera glabra, Urera kaalae,* | Two reintroduction events were conducted in Kaluaa and Waieli MU, both in support of *Drosophila montgomeryi* management with outplantings of host species *Urera* spp. |

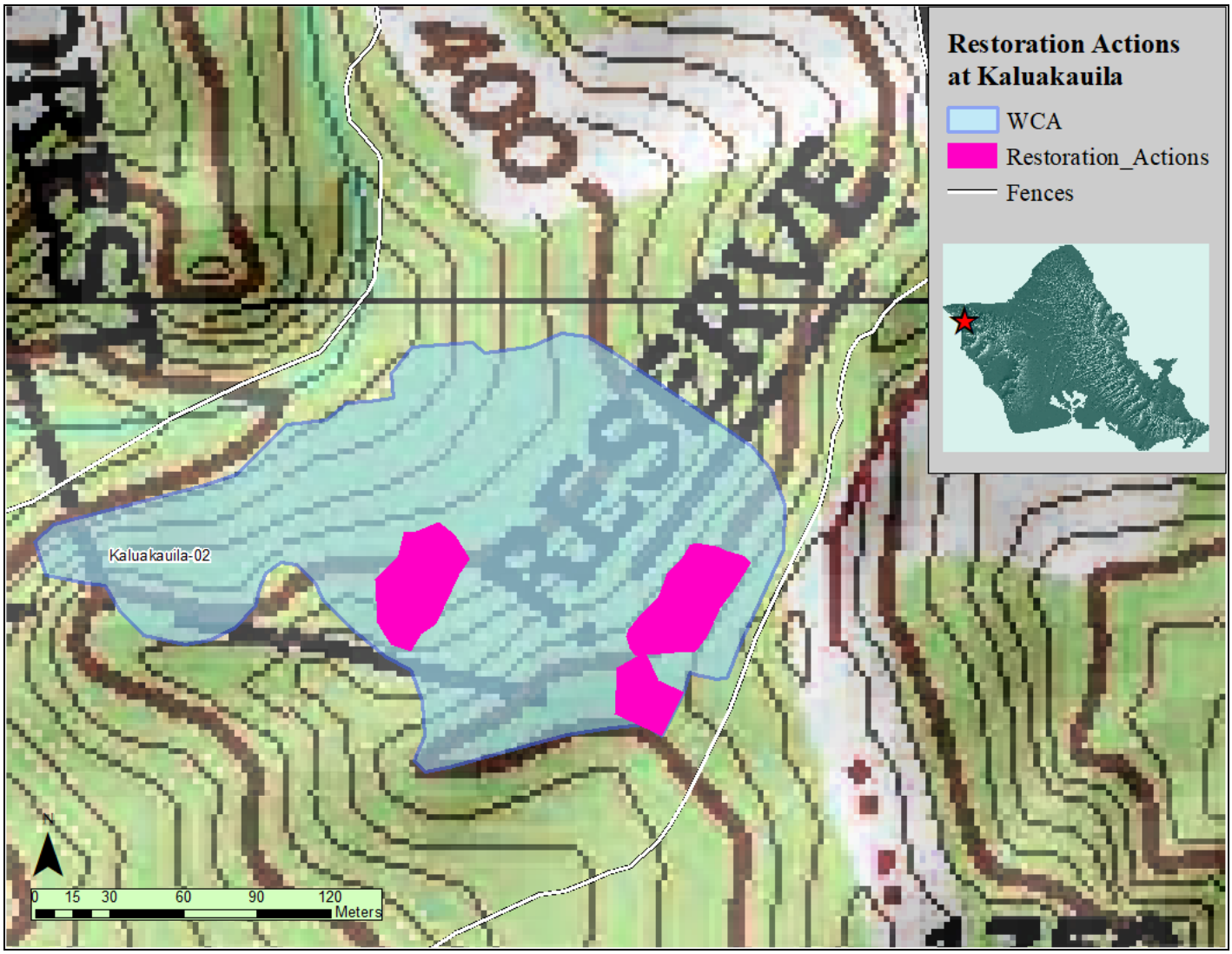


**Figure 39.** Map of Restoration sites in respective WCAs in Kaluakauila

**Table 24.** Summary of Restoration Actions in Kaluakauila

| MU | Restoration Action | # of plants | Area ($m^2$) | Taxa | Comments |
|---|---|---|---|---|---|
| Kaluakauila | Outplanting | 177 | 3066 | *Dodonaea viscosa, E. sandwicensis, Myoporum sandwicense* | A single reintroduction effort was made at the 'Upper Patch' of Kaluakauila MU where *Neraudia angulata* and *Nototrichium humile* are managed. In the forested areas, outplants were planted in locations where native canopy was sparse. Some *D. viscosa* was planted in full sun on bare soil in order to prevent erosion and establish more cover adjacent to the forested area near the ridge crest. More understory outplants are planned for the future. |

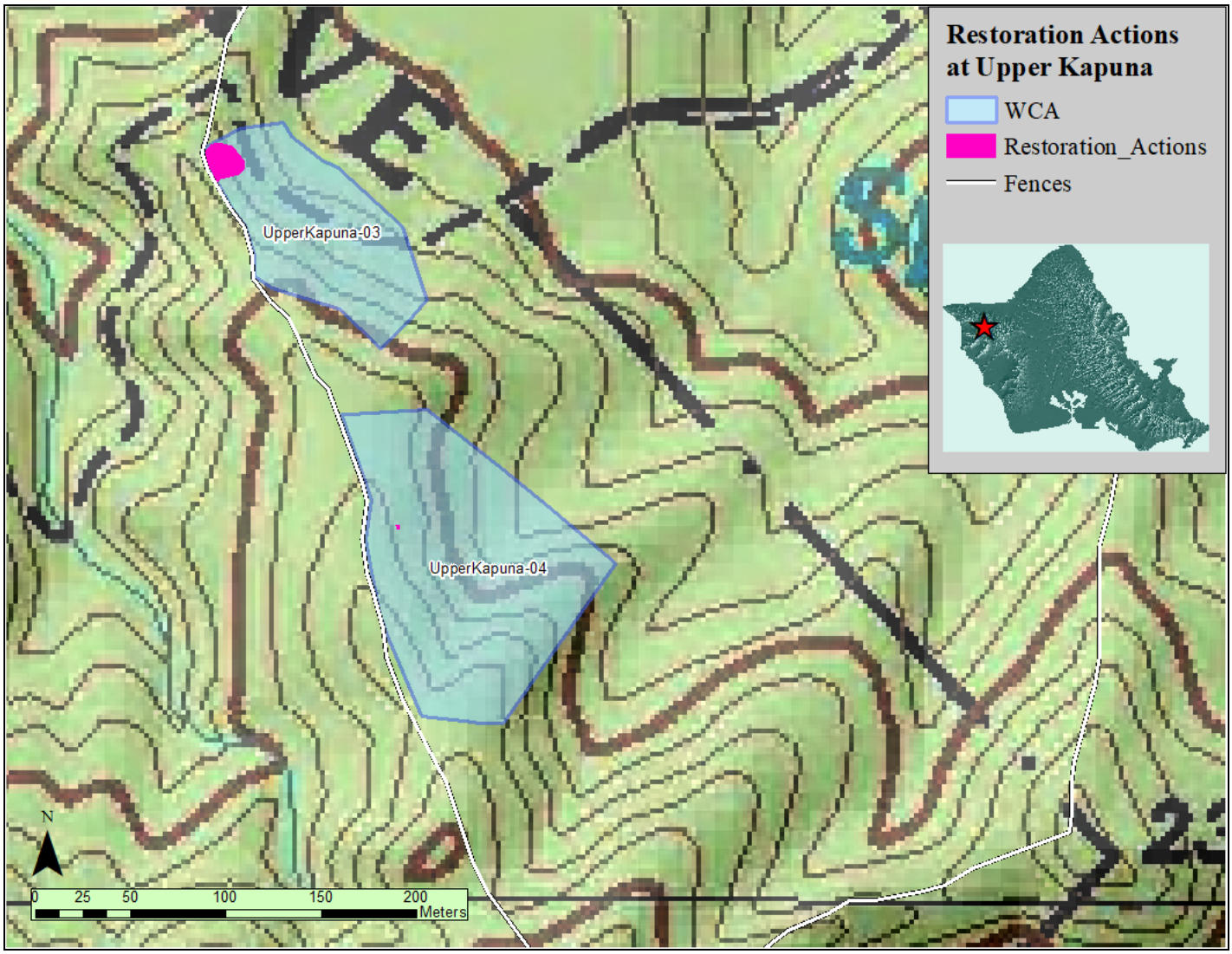


**Figure 40.** Map of Restoration sites in respective WCAs in Kapuna Upper

**Table 25.** Summary of Restoration Actions in Kapuna Upper

| MU | Restoration Action | # of plants | Area ($m^2$) | Taxa | Comments |
|---|---|---|---|---|---|
| Kapuna Upper | Outplanting | 78 | 401 | *A. koa* | Reintroductions of *A. koa* were planted along upper slopes of 'K/K' ridge to increase native cover around populations of *Schiedea nuttalii* and *Cyanea longiflora.* |

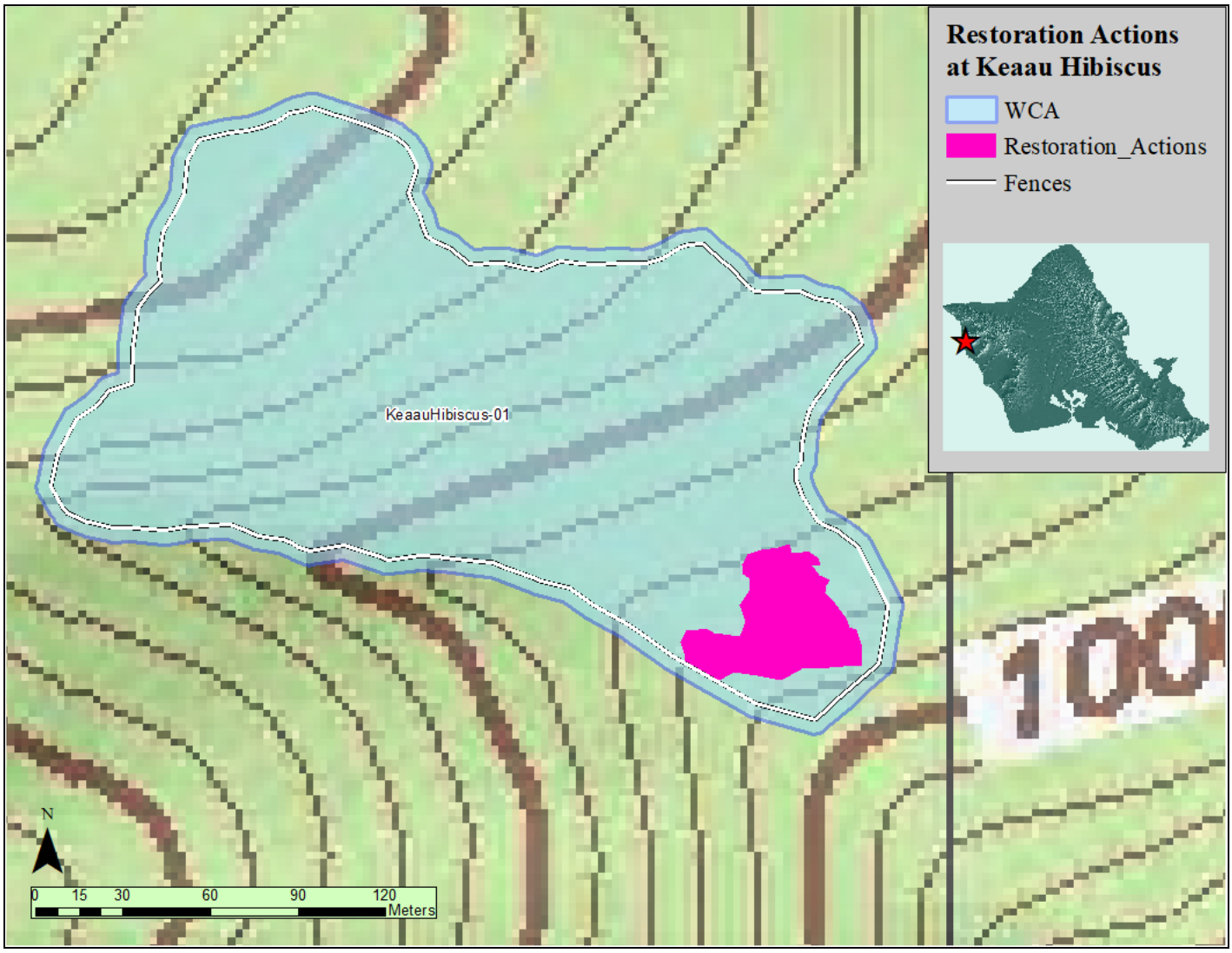


**Figure 41.** Map of Restoration site in respective WCA in Keaau Hibiscus

**Table 26.** Summary of Restoration Actions in Keaau Hibiscus

| MU | Restoration Action | # of plants | Area ($m^2$) | Taxa | Comments |
|---|---|---|---|---|---|
| Keaau Hibiscus | Outplanting | 536 | 1667 | *D. viscosa, E. sandwicensis, M. sanwicense* | Restoration activities in Keaau *Hibiscus* began around the *Hibiscus brackenridgei* reintroductions where alien grasses and woody species are controlled. Staff aimed to minimize grasses and *Leucaena leucocephala* around the *Hibiscus* with the addition of common native plants. Continued reintroduction efforts are planned for this coming year, however at the time of writing this report, a fire swept through the fenced area and burned most of the surrounding habitat. While some of the reintroductions were spared, future restoration work needs to be discussed. |

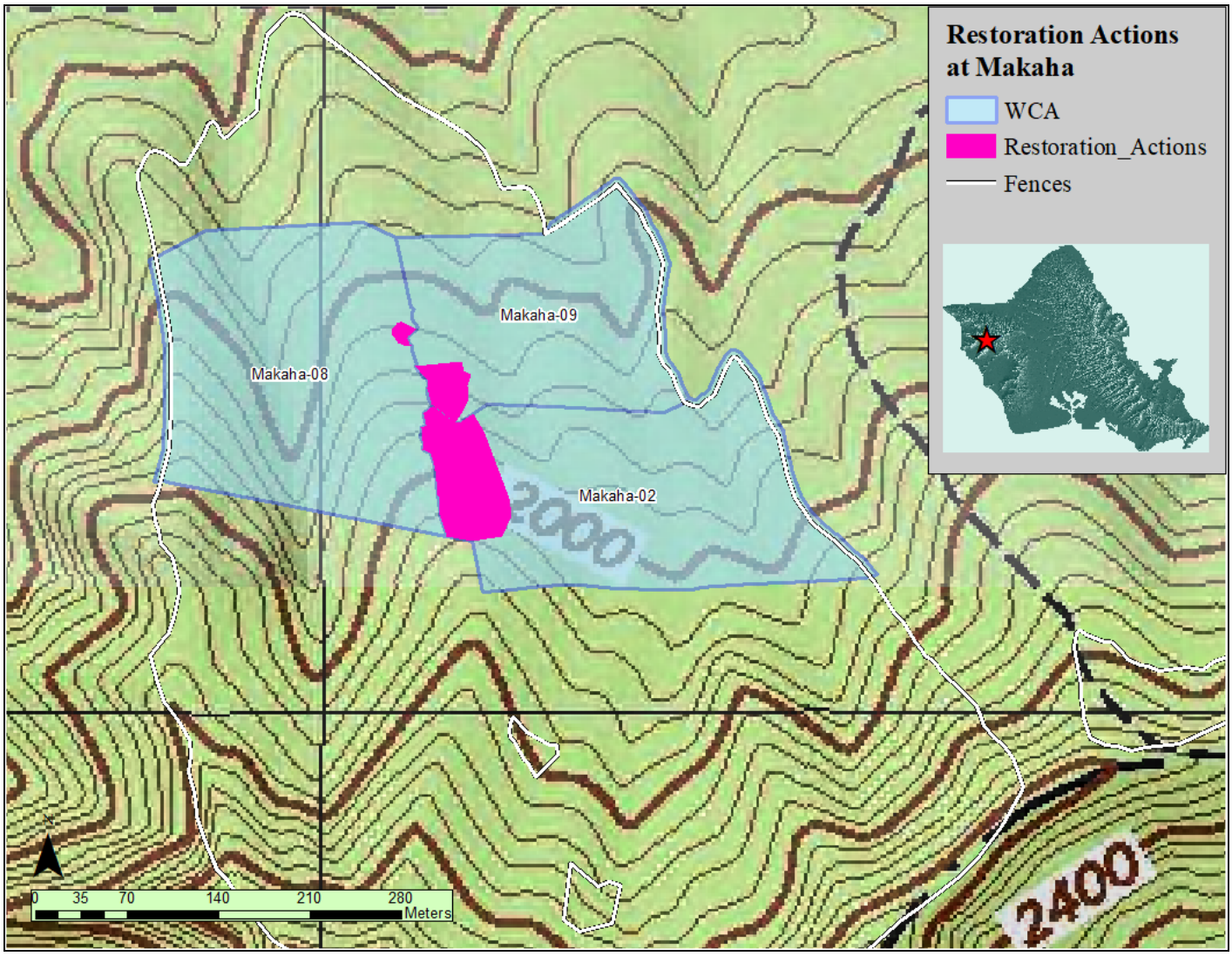


**Figure 42.** Map of Restoration sites in respective WCAs in Makaha

**Table 27.** Summary of Restoration Actions in Makaha

| MU | Restoration Action | # of plants | Area ($m^2$) | Taxa | Comments |
|---|---|---|---|---|---|
| Makaha | Outplanting | 408 | 4917 | *C. wahuensis, D. viscosa, H. arnottianus, K. affinis, Microlepia strigosa* | This year staff focused on seed sows and reintroductions at restoration sites on 'camp ridge.' Staff observed relatively little weed incursion in the Makaha-09 restoration site, major *A. koa* recruitment at both Makaha-09 and Makaha-02, and positive response of existing native canopy species uncovered by restoration efforts (i.e., flushing seen in Figures 43 and 44.) at both sites, suggesting that this ridge is resilient. Thus far, less weed follow-up and fewer restoration actions have been needed here than at some other MUs. Staff plan to expand efforts along this ridge in coming year. |
| | SDT | N/A | 4683 | *B. torta* | Seed sows were conducted on one occasion at Makaha-02, the newest cleared area where clearing resulted in much more open ground than the site in Makaha-09. |

**Figure 43.** Photos taken at the Makaha-02 site on August, 2016. Right: photo taken May, 2018.

**Figure 44.** Photos taken at the Makaha-02 site on Camp Ridge. Existing individuals of native fern *Microlepia strigosa*, have also flushed out over the last two years. Left: photo taken in Aug, 2016. Right: photo taken May, 2018.

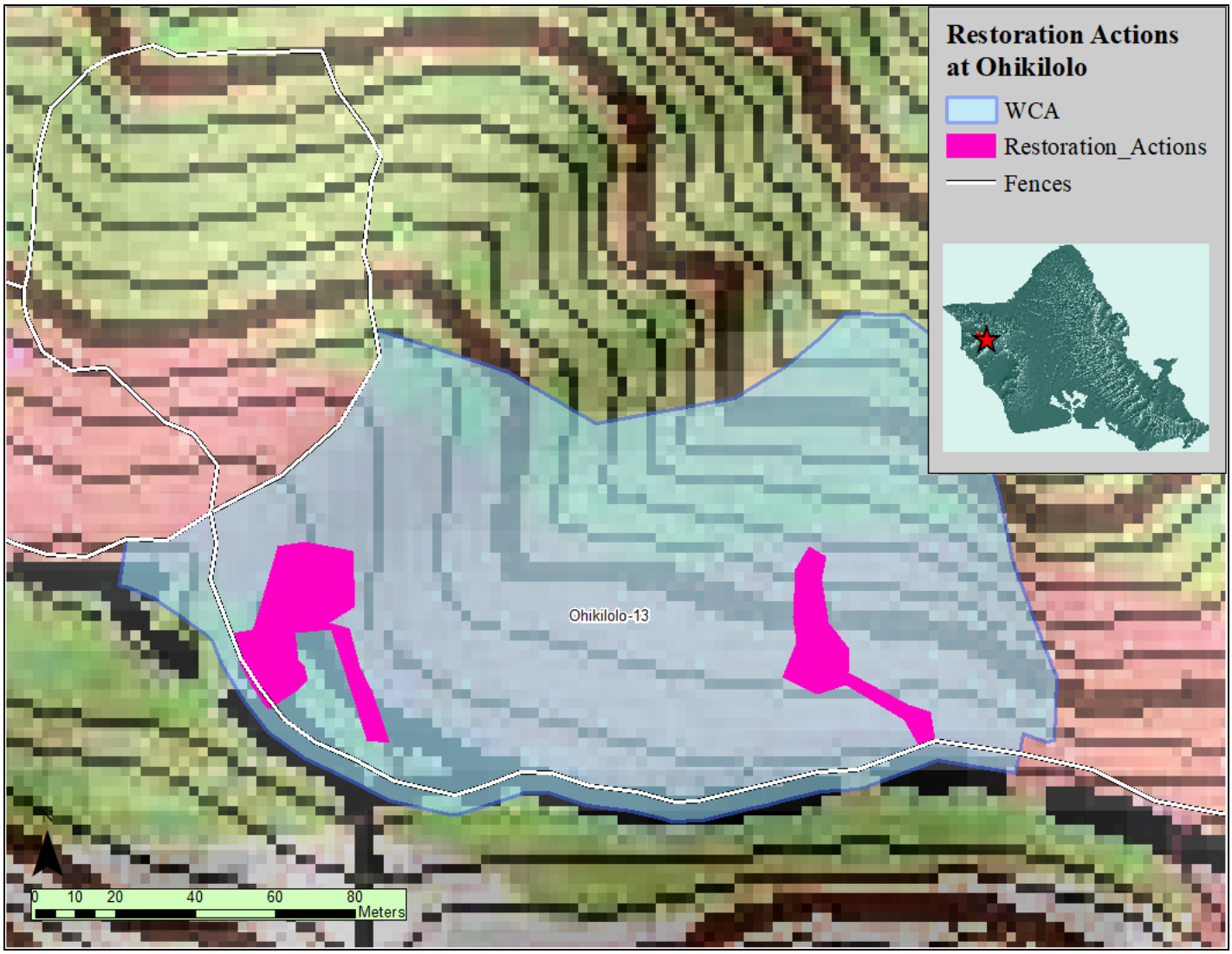


**Figure 45.** Map of Restoration site in respective WCA in Ohikilolo

**Table 28.** Summary of Restoration Actions in Ohikilolo

| MU | Restoration Action | # of plants | Area ($m^2$) | Taxa | Comments |
|---|---|---|---|---|---|
| Ohikilolo | Outplanting | 432 | 1385 | *A. koa, D. viscosa, Metrosideros polymorpha, Myoporum sandwicense, Sophora chrysophylla* | This year plantings were added at the restoration site around the cabin on the west end of the WCA to fill in locations where aggressive weeding took place over the last couple of years. Staff aim to connect the patchy native forest in this area to existing native cover in the WCA. On the east side of the WCA, *A. koa* were planted along ridges and in persistently grassy patches. Plans this year aim to aggressively remove the remaining *Schinus terebinthifolius* and continue replacement with *A. koa. D. viscosa* will also be planted to assist with exclusion of grasses on the slopes and to rehabilitate steep eroded areas. |

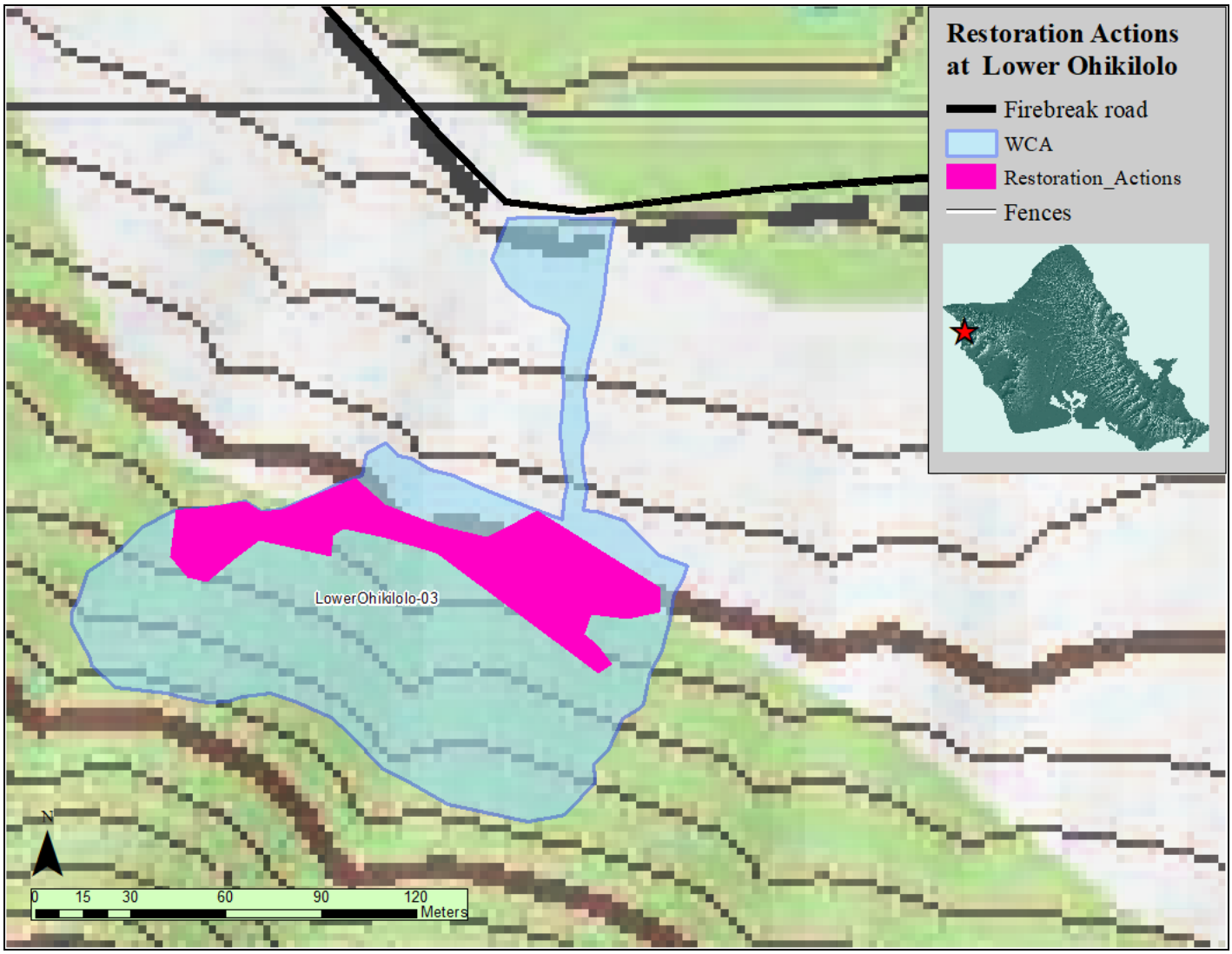


**Figure 46.** Map of Restoration site in respective WCA in Ohikilolo Lower.

**Table 29.** Summary of Restoration Actions in Ohikilolo Lower

| MU | Restoration Action | # of plants | Area ($m^2$) | Taxa | Comments |
|---|---|---|---|---|---|
| Ohikilolo Lower | Outplanting | 855 | 2872 | *D. viscosa, E. sandwicensis, M. sandwicense* | Efforts in the past had been concentrated in the 'Upper Akoko Patch', however, this year all outplants were planted around the *Hibiscus brackenridgei* reintroductions. Reductions of grass cover and the need for grass sprays are anticipated following reintroducing native species. While *E. sandwicensis* may take a long time to establish a canopy, staff are enthusiastic about the *M. sandwicensis* which grew and filled out quickly after the reintroduction here this year. This coming year more outplants are expected with an emphasis on *M. sandwicense* and with some new species as well. Hand broadcasts of common shrubby species may also take place. |

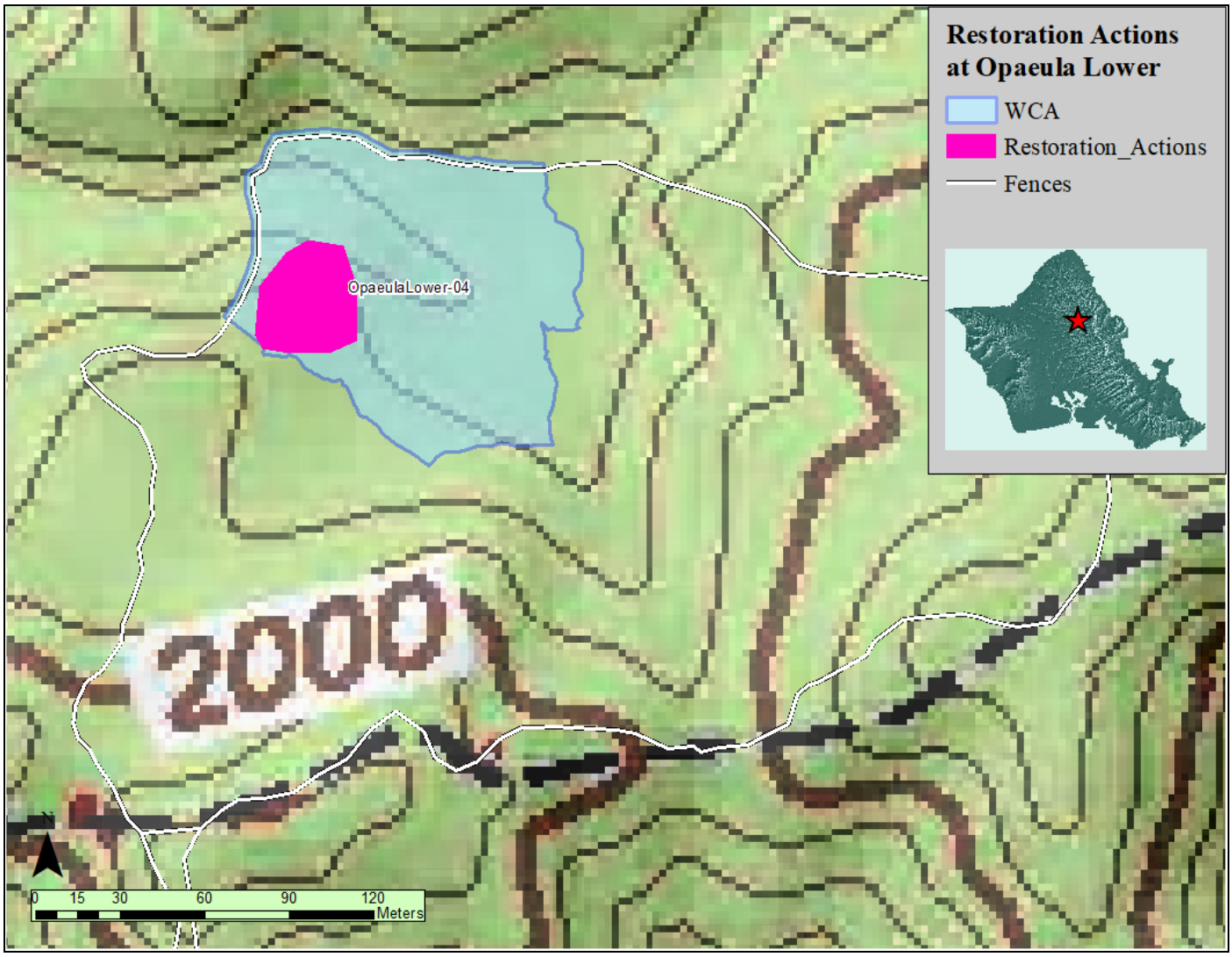


**Figure 47.** Map of Restoration sites in respective WCA in Opaeula Lower.

**Table 30.** Summary of Restoration Actions in Opaeula Lower.

| MU | Restoration Action | # of plants | Area ($m^2$) | Taxa | Comments |
|---|---|---|---|---|---|
| Opaeula Lower | Outplanting | 38 | 1210 | *Clermontia kakeana* | A small amount of *C. kakeana* that were the result of germination trials were planted around the area managed for *Gardenia mannii*. Future restoration is planned for this MU. See Appendix 3-3 for the ERMUP with restoration plans. |

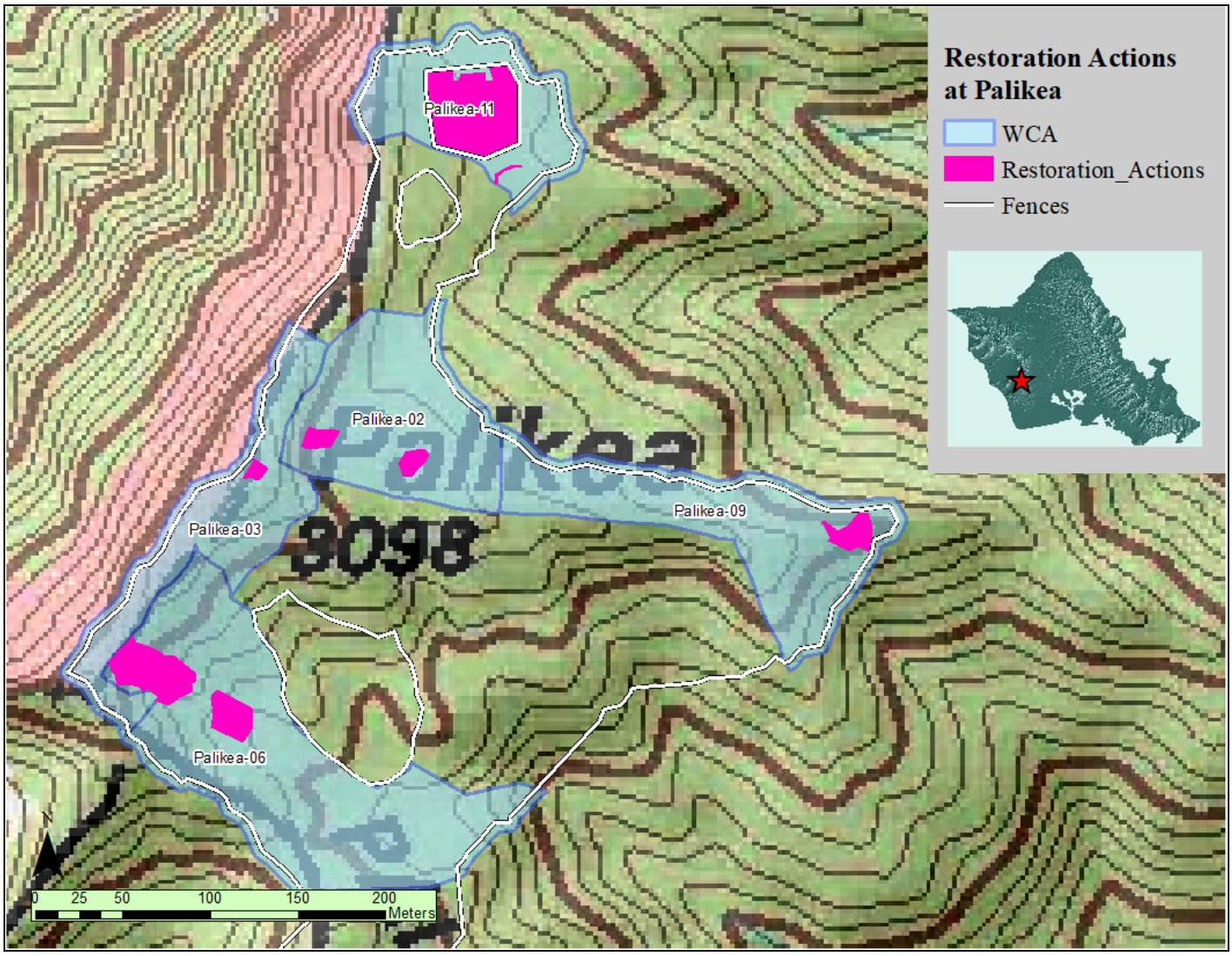


**Figure 48.** Map of Restoration sites in respective WCAs in Palikea.

**Table 31.** Summary of Restoration Actions in Palikea.

| MU | Restoration Action | # of plants | Area ($m^2$) | Taxa | Comments |
|---|---|---|---|---|---|
| Palikea | Outplanting-MU restoration | 696 | 4780 | *A. koa, B. torta, Cheirodendron trigynum, Coprosma longifolia, Eragrostis grandiflora, Freycenetia arborea, Ilex anomala, K. affinis, Pipturus albidus, Pisonia brunoniana, Psychotria mariniana, Santalum freycinetianum Scaevola gaudichaudiana, U. glabra, Wikstroemia oahuensis* | MU restoration outplantings were conducted at four sites. Outplantings began at 'Fern Gully' in WCA-06 for the first time following aggressive removal of alien canopy and understory this past year (Figure 49 below). Alien canopy was cleared from the gulch bottom up to native canopy boundaries on the surrounding slopes. The site is steep and challenging to work in, but when restored could be suitable for a suite of uncommon and endangered species. When complete, it is also anticipated to serve as an additional management site for *Drosophila montgomeryi.* A number of *U. glabra* were planted here as a host for *D. montgomeryi* this year.<br>Restoration continued at the 'Guava clear-cut' site in Palikea-09 where *B. torta* and *C. wahuensis* were planted in conjunction with grass removal. *D. viscosa* were planned for outplanting, but were not ready by the scheduled outplanting date. They will be planted this coming year. Additional outplants were added to sites on the crestline and around the H-line trail in Palikea-03 and 02 respectively. At the H-line site, weed prep and outplantings were conducted by HYCC staff. Building off previous efforts in the WCA for Drosophila habitat restoration, efforts will continue in this WCA to remove canopy weeds and replace with outplants on the north side of the H-line. |
| | SDT- MU restoration | N/A | 1300 | *A. stellata*, C. wahuensis*, Cocculus orbiculatus*, D. sandwicensis*, K. affinis, Leptecophylla tameiameiae, P. albidus, U. glabra, Wikstroemia oahuensis* var. *oahuensis** | These efforts were conducted at 'Fern Gully.' Small amounts of the starred plants from the list to the left were transplanted and the rest were sown using fresh fruit collected in the MU. Three efforts of *C. chamissoi* transplants were conducted as well. |

**Table 31** (continued).

| MU | Restoration Action | # of plants | Area ($m^2$) | Taxa | Comments |
|---|---|---|---|---|---|
| Palikea | Outplanting-Snail Enclosure | 1467 | 2347 | *A. koa* (24), *A. stellata* (3), *B. torta* (146), *Carex wahuensis* (20), *Cheirodendron trigynum* (168), *Coprosma longifolia* (290), *Freycenetia arborea* (3), *Ilex anomala* (12), *K. affinis* (412), *Perrotettia sandwicensis* (2), *Pipturus albidus* (12), *Pisonia brunoniana* (160), *Psychotria mariniana* (38), *Santalum freycinetianum* (4) *Scaevola gaudichaudiana* (9), *U. glabra* (131), *Wikstroemia oahuensis* (33) | Four reintroduction efforts established outplants across nearly the entire Palikea North snail enclosure, accounting for the most outplants of any site this year. In general, plants were spaced at 1 m or less, avoiding established trails. Numbers of plants per species are listed next to the taxa in the column to the left. Tree species were not planted within at least 5 meters of the wall. A handful of outplants such as *A. koa* and *C. wahuensis* were planted outside the enclosure, far from the walls. 10 *A. koa* were planted inside as well. Plant survival was high, and the wet winter likely contributed to this. The last set of plants were planted, atypically, outside the wet season, in the middle of June. However since this site is a high priority, and staff visit the snail enclosure regularly to maintain the barriers, supplemental watering was done as needed without undue extra effort.<br><br>This coming year outplants will represent those taxa planted in lower numbers, and will include more snail host species such as *Antidesma platyphyllum, P. sandwicensis, Metrosideros polymorpha,* and *Myrsine lessertiana*. Additional *F. arborea* is currently in propagation in the greenhouse, but as a slow grower will likely be outplanted the following year. |
| | SDT- Snail Enclosure | N/A | 645 | *Bidens torta, Cibotium chamissoi, Pipturus albidus, Scaevola gaudichaudiana* | Several seed sows were conducted this year, and will continue in order to establish cover and connectivity between outplants. A total of 65 *C. chamissoi* stumps were relocated from outside of the MU fence and planted inside the snail enclosure. Significant time was taken to ensure that no *Euglandina rosea* were present on the fern transplants. |

**Figure 49.** Photo of upper slopes of 'Fern Gully' site on outplanting day

**Figure 50.** Palikea North snail enclosure June, 2018

**Table 32.** 2018 Restoration Actions by MU Summary

| **MU** | **Total # Outplants** | **Total Outplant Area** ($m^2$) | **SDT Total Area($m^2$)** |
|---|---|---|---|
| Haili to Kealia | 441 | 2412 | |
| Kahanahaiki | 1737 | 8817 | 4574 |
| Kaluaa and Waieli | 166 | 1551 | |
| Kaluakauila | 177 | 3066 | |
| Keaau Hibiscus | 536 | 1667 | |
| Kapuna Upper | 78 | 401 | |
| Makaha I | 408 | 4917 | 4683 |
| Ohikilolo | 432 | 1385 | |
| Ohikilolo Lower | 855 | 2872 | |
| Opaeula Lower | 38 | 1210 | |
| Pahole | 20 | 365 | |
| Palikea | 2163 | 4780 | 1945 |
| **Total:** | 7051 | 33443 | 11202 |

### 3.7.2 Common Native Species Collection

Utilizing genetically appropriate and ecologically adapted native plant materials is essential to successful restoration efforts. However, identifying genetically appropriate plant materials for restoration actions is rather complicated and requires the understanding of genetics of adaptation through reciprocal transplant experiments or common garden studies, used to develop empirical seed zones. A seed zone is an area within which native plants can be transferred with minimal risk of maladaptation to their new location. In many instances restoration practitioners do not have access to seed zones developed through genetic research and must try and match seed source and planting location as closely as possible. In the absence of genetic research to inform seed zones or seed transfer guidelines, provisional seed zones are a useful decision making tool for the movement and use of native plant materials. These provisional zones are delineated by integrating climate and ecological factors known to affect plant adaptation and can be used guide plant material transfer until species specific genetic research is available to delineate empirical seed zones.

OANRP has adopted the Oahu Seed Zone Map developed by Alex Loomis (Duke University) and Matt Keir (DOFAW). These provisional seed zones were initially demarcated to inform seed collections and use of *Metrosideros* spp. plant materials in response to ROD, however, they can also be applied to other common native plant species. The Oahu seed zones were delineated by overlaying Oahu moisture zones, biogeographic regions, HRPRG population reference codes, and by incorporating local expert knowledge (pers. comm., M. Keir). The map includes 14 distinct zones (Figure 51). AONRP is currently utilizing these provisional zones as a tool to guide common native seed collection goals and to inform the appropriate transfer of plant materials to restoration sites until more species specific genetic information or empirical seed zones become available.

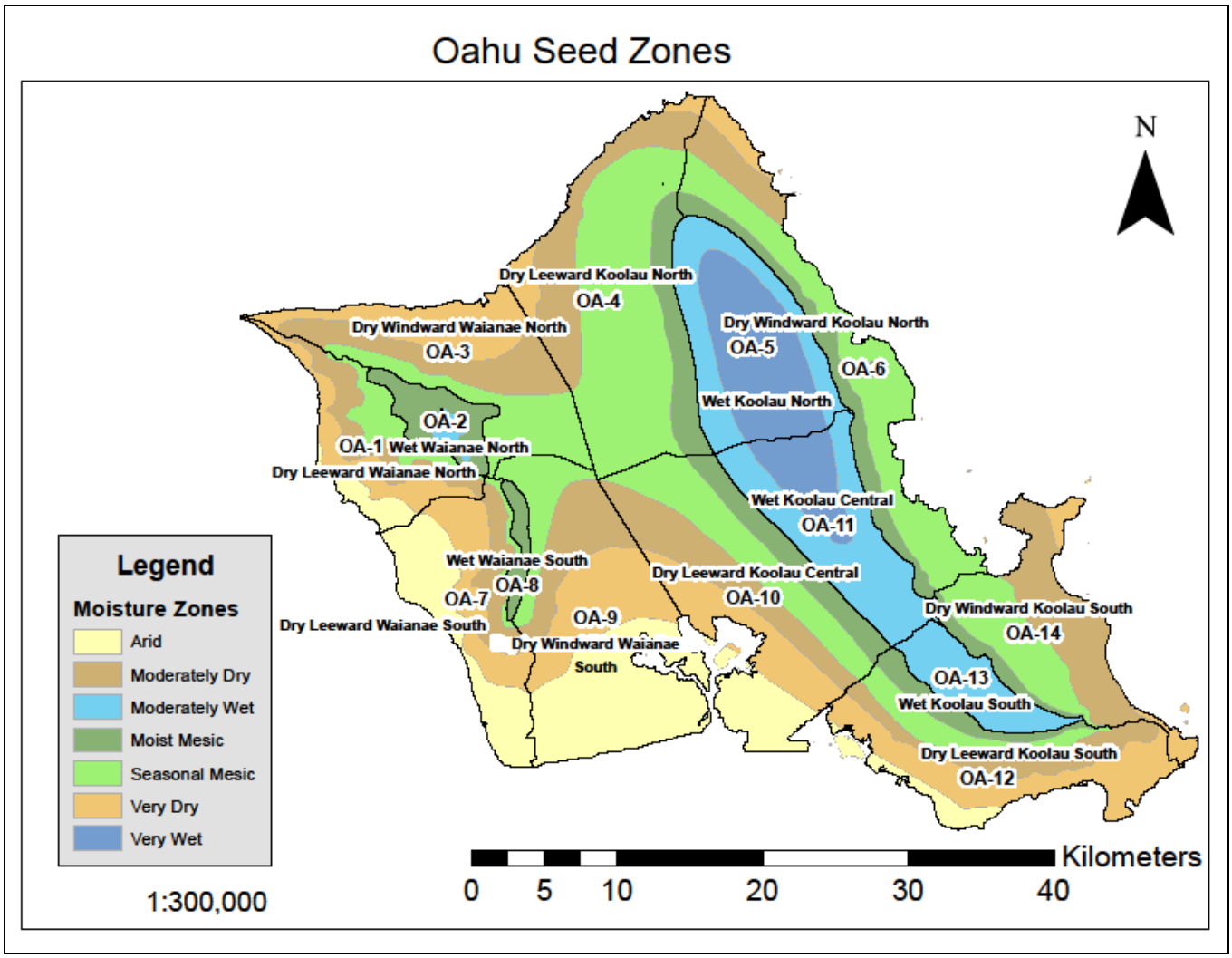


**Figure 51.** Map of Oahu Seed Zones

This year efforts continued to target and collect seed from an increased diversity of common native species and populations in support of ongoing restoration actions in high priority weed control areas. Collection targets were informed by the list of 57 restoration species developed in 2017 (Table 33). This list includes species commonly used in OANRP restoration outplantings and seed sows, as well as species not used in past actions, but which exhibit traits beneficial to OANRP restoration goals. Common native seed collections are processed and curated in the OANRP Seed Lab until they are withdrawn for the propagation of restoration plant materials or to develop seed storage and/or propagation protocols for those species where this information is lacking. The “Propagation Protocol Developed” column lists “S” or “V” if successful protocols for seed and vegetative propagation are being used and “No” if propagation protocols are unknown.

**Table 33.** Summary of taxa for OANRP restoration projects

| Taxa | Family | Seed Storage Possible | Propagation Protocol Developed | Total # of Seeds in Storage | Total Seed Accessions Currently in Storage | # of Seed Accessions Collected in 2018 | Seed Zones Represented |
|---|---|---|---|---|---|---|---|
| *Acacia koa* | Fabaceae | Yes | S | 26930 | 22 | 13 | OA- 1,2,5,8 |
| *Alyxia stellata* | Apocynaceae | Yes | S | 577 | 9 | 3 | OA-1,2,8 |
| *Antidesma platyphyllum* | Phyllanthaceae | Yes | S,V | 1193 | 2 | 2 | OA-1,2 |
| *Asplenium kaulfussii* [a] | Aspleniaceae | Unknown[b] | No[c] | NA | 0 | 0 | ---------- |
| *Bidens torta* | Asteraceae | Yes | S | 354925 | 16 | 8 | OA-1,2,8 |
| *Carex meyenii* [a] | Cyperaceae | Yes | No | 16654 | 3 | 0 | OA-2 |
| *Carex wahuensis* | Cyperaceae | Yes | S | 15645 | 9 | 4 | OA-2,8 |
| *Cheirodendron trigynum* | Araliaceae | Yes | S | 11397 | 5 | 0 | OA-5,8 |
| *Chenopodium oahuense* | Chenopodiaceae | Yes | S | 44209 | 5 | 2 | OA-3 |
| *Cibotium* spp.[a] | Dicksoniaceae | Unknown[b] | No[c] | NA | 1 | 1 | OA-2 |
| *Coprosma foliosa*[a] | Rubiaceae | Yes | S | 175 | 1 | 3 | OA-2 |
| *Coprosma longifolia* | Rubiaceae | Yes | S | 17747 | 5 | 3 | OA-2,8 |
| *Cyperus hillebrandii* var. *hillbrandii* [a] | Cyperaceae | Unknown | No | 0 | 0 | 0 | ---------- |
| *Cyperus polystachyos* [a] | Cyperaceae | Unknown[b] | No[c] | 1706 | 1 | 1 | OA-2 |
| *Deparia prolifera*[a] | Athyriaceae | Unknown | No | NA | 0 | 0 | ---------- |
| *Dianella sandwicensis* | Xanthorrhoeaceae | Yes | S,V | 18896 | 5 | 5 | OA-2,8 |
| *Diplazium sandwichianum* [a] | Athyriaceae | Unknown | No | NA | 0 | 0 | ---------- |
| *Dodonaea viscosa* | Sapindaceae | Yes | S | 200402 | 22 | 5 | OA-1,2,3,8 |
| *Doodia kunthiana*[a] | Blechnaceae | Unknown[b] | No[c] | NA | 2 | 2 | OA-2 |
| *Eragrostis grandis* | Poaceae | Yes | S | 14779 | 3 | 1 | OA-2,8 |
| *Eragrostis variabilis* | Poaceae | Yes | S | 7088 | 1 | 0 | OA-3 |
| *Erythrina sandwicensis* | Fabaceae | Yes | S | 1519 | 18 | 2 | OA-1 |
| *Freycinetia arborea* [a] | Pandanaceae | Yes | S | 32294 | 5 | 1 | OA-8 |
| *Gahnia beecheyi* [a] | Cyperaceae | Yes | No[c] | 4091 | 5 | 2 | OA-1,2,8 |
| *Hibiscus arnottianus* subsp. *arnottianus* | Malvanceae | Unknown | V | 0 | 0 | 0 | ---------- |
| *Ilex anomala* | Aquifoliaceae | Yes | S | 7997 | 6 | 1 | OA-2,5,8 |
| *Kadua acuminata* | Rubiaceae | Yes | S | 0 | 0 | 0 | ---------- |
| *Kadua affinis* | Rubiaceae | Yes | S | 42217 | 14 | 2 | OA-2,8 |
| *Labordia kaalae* | Loganiaceae | Yes | S | 1515 | 2 | 0 | OA-8 |
| *Luzula hawaiiensis* | Juncaceae | Yes | S | 158 | 1 | 0 | OA-2 |
| *Machaerina angustifolia* [a] | Cyperaceae | Yes | No | 0 | 0 | 0 | ---------- |

**Table 33** (Continued).

| Taxa | Family | Seed Storage Possible | Propagation Protocol Developed | Total # of Seeds in Storage | Total Seed Accessions Currently in Storage | # of Seed Accessions Collected in 2018 | Seed Zones Represented |
|---|---|---|---|---|---|---|---|
| *Melicope oahuensis* [a] | Rutaceae | Unknown | No | 0 | 0 | 0 | ---------- |
| *Metrosideros polymorpha* | Myrtaceae | Yes | S | 2542295 | 59 | 20 | OA-1,2,5,8 |
| *Microlepia speluncae* [a] | Dennstaedtiaceae | Unknown | No | NA | 0 | 0 | ---------- |
| *Microlepia strigosa* var. *strigosa* | Dennstaedtiaceae | Unknown[a] | V | NA | 1 | 0 | OA-2 |
| *Myoporum sandwicense* | Scrophulariaceae | Yes | S | 2050 | 1 | 3 | OA-3 |
| *Myrsine lessertiana* | Primulaceae | Yes | S | 183 | 3 | 1 | OA-2 |
| *Nephrolepis exaltata* subsp. *hawaiiensis* [a] | Nephrolepidaceae | Unknown | No | NA | 0 | 0 | ---------- |
| *Nestegis sandwicensis* | Oleaceae | Yes | S,V | 0 | 0 | 0 | ---------- |
| *Perrottetia sandwicensis* | Dipentodontaceae | Yes | V | 0 | 0 | 0 | ---------- |
| *Pipturus albidus* | Urticaceae | Yes | S | 148432 | 3 | 2 | OA-2,8 |
| *Pisonia brunoniana* | Nyctaginaceae | No | S,V | 0 | 0 | 2 | OA-8 |
| *Pisonia sandwicensis* [a] | Nyctaginaceae | No | No | 0 | 0 | 0 | ---------- |
| *Pisonia umbellifera* | Nyctaginaceae | No | Yes | 0 | 0 | 0 | ---------- |
| *Planchonella sandwicensis* | Sapotaceae | No | S | 0 | 0 | 1 | OA-2 |
| *Plumbago zeylanica* | Plumbaginaceae | Unknown | V | 0 | 0 | 0 | ---------- |
| *Polyscias sandwicensis* [a] | Araliaceae | Yes | S | 0 | 0 | 0 | ---------- |
| *Psychotria hathewayii* | Rubiaceae | Yes | S | 428 | 4 | 1 | OA-8 |
| *Psychotria mariana* | Rubiaceae | Yes | S | 83 | 2 | 3 | OA-8 |
| *Psydrax odorata* [a] | Rubiaceae | Yes | S | 0 | 0 | 2 | OA-2 |
| *Pteris excelsa* [a] | Pteridaceae | Unknown | No | NA | 0 | 0 | ---------- |
| *Rumex albescens* | Polygonaceae | Yes | S | 4260 | 3 | 0 | OA-8 |
| *Santalum* spp.[a] | Santalaceae | Yes | S | 106 | 3 | 4 | OA-2 |
| *Scaevola gaudichaudii* [a] | Goodeniaceae | Unknown | No | 0 | 0 | 1 | OA-8 |
| *Scaevola gaudichaudiana* | Goodeniaceae | Yes | V | 0 | 0 | 0 | ---------- |
| *Scaevola taccada* | Goodeniaceae | Yes | S,V | 0 | 0 | 0 | ---------- |
| *Sida fallax* [a] | Malvaceae | Yes | S | 2914 | 2 | 1 | OA-3 |

[a] Native species targets for future restoration efforts

[b] Research underway to develop seed storage protocols

[c] Research underway to develop propagation protocols

### 3.7.3 Seed Production Plots Update

Outplantings of *B. torta* for the seed production plot at Kahua occurred early this year. In September 2017, 1,498 individuals representing 30 founders from the upper elevations of the southern Waianaes, seed zone OA-8 (Wet Waianae South) were planted from dibble pots. There were some minor setbacks in plot establishment and growing conditions over the year including: compacted soil, hot and dry conditions, and pest infestations. However, most plants fared well and seed collection efforts have taken place on five occasions from 4/26/18 to 7/11/18 from the plants that set fruit, totaling 51 grams of seed, approximately 25,000 seeds. Staff estimate that only 15% of the plants set flower and fruit. It is common for perennial crops to exhibit low seed yields in the first year of establishment and we anticipate that next year most plants will set fruit and harvest quantities will be much larger.

This July, in reporting year 2019, 550 *Carex wahuensis* were also planted at Kahua. Staff are hopeful to acquire seed from these plants during the fruiting season in April.

Plans are underway to establish two seed production sites within Kahanahaiki and Palikea for *Bidens torta* and *Scaevola gaudichaudiana* respectively. Degraded field sites will be cleared, prepared, and planted with those species this coming year.

**Figure 52.** Photos of *B. torta* production plot at Kahua. Left: photo taken September, 2017. Right: photo taken November, 2017 on day of supplemental planting.