

CHAPTER 7: *DROSOPHILA* SPECIES MANAGEMENT

7.1 BACKGROUND

Fourteen species of Hawaiian picture wing *Drosophila* flies are currently listed as threatened or endangered, and many more are equally rare. Six listed species are endemic to Oahu, and three – *D. montgomeryi*, *D. obatai*, and *D. substenoptera* – are currently known to occur on Army lands. OANRP work on *Drosophila* began in March 2013, focusing on monitoring known populations, surveying for new ones, and restoring habitat.

This year's surveys were significantly reduced compared to previous years due to unforeseen personnel issues, and were mostly limited to monitoring of existing sites. The El Nino weather pattern that began in the summer of 2015, with a wet summer in leeward areas followed by a dry winter, continued through late 2016 and has resulted in seriously depressed populations of both common and rare *Drosophila* species (along with many other insects). Some had brief comebacks in the spring of 2017, but the summer has been extremely dry and they dropped back to very low levels (typical of the summer months) by the end of the reporting period.

7.2 SURVEY METHODS

Many species of Hawaiian *Drosophila*, including the picture wing group to which all of the endangered species belong, are readily attracted to baits of fermented banana and mushrooms. Both baits are spread on a cellulose sponge which is hung from a tree in a cool, shaded, sheltered site, and checked for flies after about one hour. Depending on the quality of the site (number and size of host plants, and microclimate) and the density of baiting spots, surveys typically consist of setting out 16-24 sponges, in groups of 4 or 8 with groups separated by 20-100 m. Baits are checked at least every hour, as flies do not necessarily stay at baits for long periods; number and species of all picture wings on each sponge are recorded at each check. The greatest activity is typically during the cooler hours before 10 AM and after 2 PM, but flies may appear at any time. Direct quantification of *Drosophila* populations is difficult, since populations may fluctuate not only seasonally but from day to day. However, repeated surveys can yield useful data on long-term trends. Abundance numbers are reported as the maximum number of individuals observed on a survey day (compiled by adding the maximum observed at each discrete group of bait sponges at any one time, assuming that the same individual flies may move between sponges within a group but are unlikely to be seen at two different groups), since numbers fluctuate through the day.

Known, significant populations of *D. montgomeryi* at Kaluaa MU and *D. substenoptera* at Palikea MU, where flies occur relatively consistently, are monitored monthly in order to determine approximate population trends through the year. For *D. montgomeryi*, Pualii (designated as a management site for *D. montgomeryi*) and Waianae Kai (not a managed population, but the largest known population) were designated to be monitored quarterly; however, due to apparent loss of the population at Pualii due to a demographic gap in the host plant, and higher priorities elsewhere, only one monitoring visit was made to each this year (see below for other actions). Other known populations (Kaala and Lower Opaepa for *D. substenoptera*, Lihue and Manuwai for *D. obatai*) are visited periodically through the year, typically quarterly or less. New populations of endangered *Drosophila* were searched for by looking in similar habitat both in areas suggested by other staff as having host plants, at historic collecting localities, and in new sites where surveys have been minimal. Numbers of *Vespula pensylvanica* (western yellowjacket), a potentially serious invasive predator, are monitored at Palikea and Puu Hapapa with 10 traps at each site baited with heptyl butyrate and checked monthly.

Map removed to protect rare resources

Figure 1. Distribution of *Drosophila montgomeryi* observations in the 2016-17 reporting year and earlier records from 2009-15, with known *Urera* spp. sites and all survey points in the Waianae range.

7.3 RESULTS

7.3.1 *Drosophila montgomeryi*

Drosophila montgomeryi is a small yellow-brown species that breeds in rotting bark of *Urera kaalae* and *Urera glabra* (opuhe). While *Urera glabra* occurs widely across the Waianae range, it often occurs as scattered clumps of a few or only one individual, unsuited for survival of *D. montgomeryi* and probably not viable for long-term survival of this dioecious, wind-pollinated tree. *Urera kaalae* is critically endangered and only a handful of wild plants remain, although several hundred have been outplanted. *Drosophila montgomeryi* is currently known from ten sites that are regarded as five population units (PUs), effectively covering nearly its entire historic range in the Waianae mountains (Figure 1). However, it has not been found at the Pualii or Palikea PUs in over two years, and the Lihue PU has not been surveyed recently due to access issues. Field work this year has focused on monitoring known populations rather than searching for new sites, but sites in the northwest part of the range from Pahole west continue to be searched (Table 1).

Kaluaa & Waieli MU

Three sites in this MU – Puu Hapapa, North Kaluaa, and Central Kaluaa gulch 1 – have been monitored monthly since June 2013 (though not every site was visited each month) over a total of 114 survey days. In past years abundance of *D. montgomeryi* has followed a distinct seasonal pattern, increasing

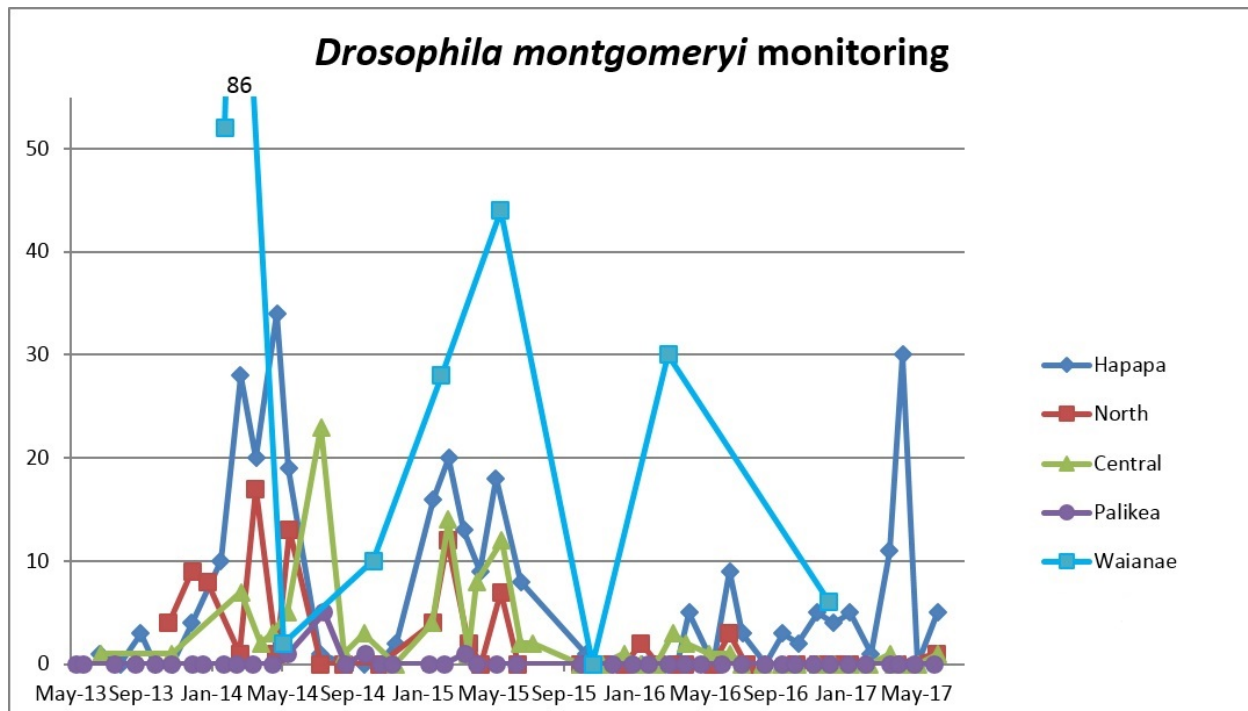


Figure 2. *Drosophila montgomeryi* numbers during monthly monitoring at three sites in Kaluaa PU (Puu Hapapa, North Kaluaa, and Central Kaluaa) and Palikea, and quarterly monitoring at Waianae and Pualii. Y axis is the maximum number observed across the entire site on the survey day (see Survey Methods, section 7.2).

dramatically over the winter months to a peak between January and May (Figure 2), more or less in synchrony with several common *Drosophila* species. This is most likely due to increased rain and treefalls from storms that cause death or branch breakage of *Urera* near monitoring sites. During 2015-16 and again in the 2016-17 sampling season, there was no such winter pulse in *D. montgomeryi*, with only relatively few scattered individuals. There was a brief late spring spike at Puu Hapapa only; at Kaluaa they were very low (Central) or absent (North). The common species *D. inedita* and *D. ambochila* did both have similar winter seasons as in previous years, although they did not reach as high abundance as usual.

Pualii

This site was visited for the first time in 2014, and quarterly monitoring began in 2015. At the time of the first visit, the last wild *Urera kaalae* tree in North Pualii Gulch had recently fallen and the decaying trunk was supporting a large number of *D. montgomeryi*. Unfortunately, the fly has not been seen since the second visit there, and the survival of this population is uncertain. Only one of the original *U. kaalae* outplants remains, but at least 10 natural offspring of these plants have grown up, and several have now reached substantial height. This appears to be the only site where outplanted trees of this species are successfully recruiting. There are no *U. glabra* aside from recent outplants, which have not grown as much as those at other sites. Nevertheless, it is an area of high-quality native habitat, both in the immediate vicinity and further downslope in the gulch, where light gaps provide better outplanting spots. It may be a potential reintroduction site after additional host plant restoration.

Site	Days	Max No.
Kaluaa - Central	13	1
Kaluaa - North	7	1
Puu Hapapa	12	30
Palikea	12	0
Moho Gulch	1	0
Pualii	1	0
Waianae	1	6
Kawaiu	1	0
Pahole	1	0

Table 1. Survey effort for *D. montgomeryi* across all potential sites in 2016-17 reporting period, in survey days. “Max No.” is the highest number of flies observed in a single day.

In July 2016, big-headed ants (*Pheidole megacephala*) were found in the lower portion of the fenced unit around the recent *Urera kaalae* outplantings. Although present in the gulch well below the fence, they had not previously been noted at this site, and would be a threat to *Drosophila* there. The ant population was determined to be relatively confined to the bottom of the gulch, and control will be attempted using granular bait in summer 2017.

Palikea

Despite continuous monitoring here since May 2013 (targeting *D. substenoptera*, which is consistently found in the area), *D. montgomeryi* was not detected until May 2014. Three of the four records of *D. montgomeryi* here have been of single individuals, indicating that the population remains low. After a year of occasional sightings, it has not been seen here since March 2015, possibly due in part to drying of the site from canopy clearing. However, there are other patches of *Urera* around the Palikea MU that may also harbor populations of *D. montgomeryi*. The area where they were found is already a target for weed management and restoration, and has high potential for management to benefit *D. montgomeryi*. *Urera glabra* had already begun to increase naturally as weed control reduced alien cover, and outplanting has significantly boosted the population. Outplanted *U. glabra* here has done exceptionally well – many of them are 6–8 feet tall after only 18 months. *Urera kaalae* has also been planted here by Oahu PEPP, and are also thriving. Weed control is ongoing as some parts of the restoration area lack canopy cover and are susceptible to heavy invasion by weeds such as *Rubus rosifolius*, *Buddleia asiatica*, and *Erechtites valerianifolia*.



Figure 3. Habitat restoration for *D. montgomeryi* at Palikea. The photos in each column were taken from the same viewpoint on opposite ends of a clearing where invasive plants had been removed (October 2014) and *Urera glabra* and other natives planted in February 2015. Note the large stump in the left photos and the hapuu in the right ones for reference.

Waianae Kai

The largest known population of *D. montgomeryi* occurs in the northeastern subgulches of Kumaipo stream, Waianae Valley. Four sites have been discovered so far, all at the base of Mt. Kaala and consisting of small patches (~0.5 ha) of diverse native forest constrained by alien-dominated vegetation above and below. All are located on or just below steep slopes that are vulnerable to landslides, which may preclude fencing as a matter of practicality. The largest has been surveyed repeatedly and had a very large population of flies, but this has been severely reduced by damage from falling boulders and subsequent weed invasion. A fifth potential site was discovered this year to the east in Hiu drainage, but it has not yet been surveyed. Much of the area further east in Hiu and Honua drainages, as well as the western half of Kumaipo, remains to be surveyed and may contain additional sites.

Habitat restoration

This was the second year of active habitat management for *Drosophila montgomeryi*. Last year, approximately 50 *U. glabra* grown from cuttings were planted at each of North Kaluaa, Pualii, and Palikea, and 35 at Central Kaluaa, between November 2014 and April 2015. In December 2015, an additional 35 *U. glabra* were planted at Central Kaluaa, and 25 *U. glabra* and 50 *U. kaalae* at North Kaluaa (see Restoration section for details). Approximately 50 *U. kaalae* each were also planted at Palikea, Central Kaluaa, and Pualii by the OPEPP program. All sites are exhibiting high survivorship (87–100%) and good growth, especially Kaluaa and Palikea (Figure 3). Observations of some individuals



Figure 4. Underside of a *Urera kaalae* leaf at Puu Hapapa, showing a dense covering of yellow urediniospores characteristic of heavy mamaki rust (*Pucciniastrum boehmeriae*) infection.

suggests that pruning of tip shoots of *U. glabra* may promote extremely vigorous growth of side branches and ultimately larger, more robust trees that will be better habitat for flies in a few years. Recent clearing of dense weed patches at Pualii and a major treefall at North Kaluaa in the past year and a half have created new outplanting opportunities, and more plants will be placed at those sites in the coming year.

In May 2016, the alien fungal pathogen mamaki rust (*Pucciniastrum boehmeriae*) was first noticed on *Urera kaalae* (Figure 4), and positively identified by HDOA. Although it manifests differently than in mamaki (*Pipturus albidus*), without any scorching or wilting of the leaves, the leaves are much more heavily covered in fungal spores and may fall off easily. The full effect of the rust is unknown. After a significant dieoff of *U. kaalae* in 2015 at Puu Hapapa from unknown causes, the situation has stabilized there and there has not been any mortality at other sites despite some having very heavy infections.

7.3.2 *Drosophila substenoptera*

Surveys for this species have focused on finding new populations. Based on collection records, it requires moderately tall, non-boggy wet forest with its host plants, *Cheirodendron* spp. (olapa) and *Polyscias* (= *Tetraplasandra*) *oahuensis* (ohe mauka), a habitat which is relatively uncommon since these trees tend to occur most abundantly in boggy, short-stature forest near summit crestlines. Compared to other islands, *Cheirodendron* is rather uncommon on Oahu relative to available habitat, and a large proportion occurs on steep slopes or in the bottom of drainages that are weedy and difficult to access. Currently, there are three known PUs for *D. substenoptera* – Palikea, Kaala-Kalena, and Opaepala (Figure 5). PU trends are

Site	Days	Max No.
Palikea	12	6
Kaala	4	0
Lihue	2	0
Lower Opaepala	5	0

Map removed to protect rare resources

Figure 5. Distribution of *Drosophila substenoptera* observations in the 2016-17 reporting year and earlier records from 2013-16.

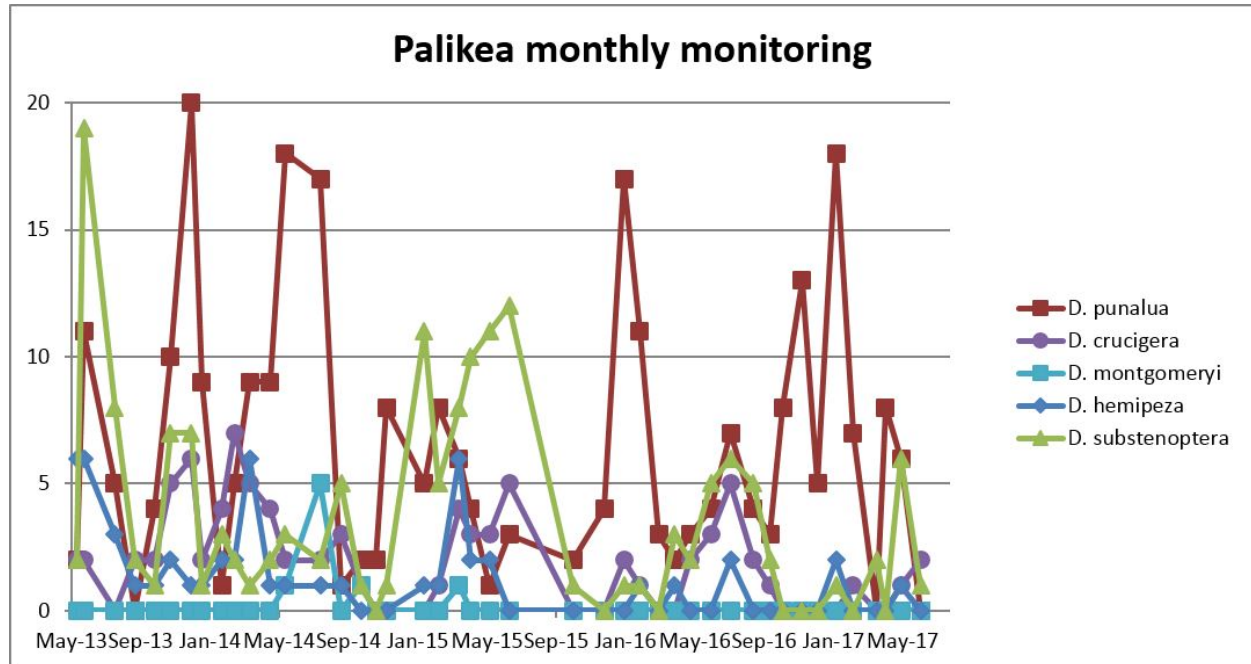


Figure 6. Monthly monitoring results for all picture-wing *Drosophila* species at Palikea, from May 2013 to June 2017.

only graphed for Palikea as the other two PUs have insufficient numbers of survey days. At other PUs *D. substenoptera* is highly sporadic, typically occurring as single individuals observed only once during a day. This rarity has undoubtedly hampered our ability to detect it at new sites.

Waianae Range

Monthly monitoring in the northern portion of Palikea MU has been ongoing since May 2013 (54 survey days total, 12 in the current reporting period; Table 2). Aside from a large flush in late May 2013, numbers of *D. substenoptera* and another endangered species, *D. hemipeza*, have been consistently low to modest, but they have almost always been present. In contrast to *D. montgomeryi*, abundance of *D. substenoptera* tends to increase in the summer rather than winter, somewhat correlated with *D. hemipeza* and the common *D. crucigera* but not *D. punalua* (Figure 6), indicating differences in host availability. At the Kaala-Kalena PU, five sites were surveyed (Kalena summit ridge, Kaala transect, and Kaala west, southeast, and northeast faces). No flies were found, but the Kaala sites are promising and will be revisited.

Koolau Range

In December 2013, a single *D. substenoptera* was observed at Opaepa Lower MU, the first record of the species in the Koolau range since 1972. In early 2015, it was sighted again in the same area. Historically, *D. substenoptera* was more widespread and abundant on this side than in the Waianae range. However, collection effort has been limited due to the difficulty in accessing areas of intact habitat for this species. OANRP survey trips in the Koolaus are now relatively few due to higher priorities elsewhere, and concentrated in only a few sites. In 2016-17, Lower Opaepa was visited twice for a total of five days; none were found. Finding additional Koolau populations is a high priority for this species; Helemano, Poamoho, and Kaukonahua have yet to be surveyed. Lower Opaepa and Koloa will continue to be

Site	Days	Max No.
Palikea	12	6
Kaala	4	0
Lihue	2	0
Lower Opaepa	5	0

Table 2. Survey effort for *D. substenoptera* and number of flies found across all potential sites in 2016-17 reporting period, in survey days. “Max No.” is the highest number of flies observed in a single

checked given the extremely high quality of habitat there and low observation rate at sites where *D. substenoptera* is known to be present.

7.3.3 *Drosophila obatai*

Drosophila obatai was rediscovered in Manuwai Gulch MU in 2011, 40 years after the previous record in 1971. It breeds in rotting stems of *Chrysodracon* (= *Pleomele*) spp. (halapepe), which suffers from very low reproduction rates but remains widespread in the northern Waianae range thanks to its longevity. It is currently known from seven sites in four potential PUs (Makaleha, Manuwai, Palikea Gulch, and Pulee), although three of these are within 1,200 m of each other and could potentially form one contiguous population. While the populations were almost certainly contiguous until recently, native forest in general and *Chrysodracon* in particular is now much more fragmented, and moving between patches of host trees is more difficult for the flies.

Surveys for *D. obatai* in 2016-17 were few due to limited survey time available and focus on monitoring *D. montgomeryi* (Table 3). Three sites at Manuwai, two in Pulee (SBW), and two in Makaleha were

Site	Days	Max No.
Manuwai	4	1
Lihue – Pulee	4	0
East Makaleha	1	0
Central Makaleha	1	0

Table 3. Survey effort for *D. obatai* across all potential sites in 2016-17 reporting period, in survey days.

Map removed to protect rare resources

Figure 7. Distribution of *Drosophila obatai* observations from 2013-17, with known *Chrysodracon* spp. sites and all survey points in the Waianae range.

visited; only a single *D. obatai* was seen, at Manuwai. While this is disturbingly few, it is nevertheless the first record of the species since June 2015, with relatively low survey effort. In the coming year staff will attempt to increase surveys for *D. obatai*, as it is the most threatened of the three managed species.

7.3.4 Other Rare *Drosophila*

During the course of surveys, four additional rare but non-listed *Drosophila* were found in management units where *D. montgomeryi* and *D. substenoptera* occur (Table 4). A fifth, *D. craddockae*, was found at Makua. Most of the rare species that had been found as of 2014 (*D. flexipes*, *D. kinoole*, *D. paucicilia*, *D. reynoldsiae*, *D. sobrina*, *D. spaniothrix*, and *D. n. sp. nr. truncipenna*) were not seen this year, due to the generally poor conditions (dry winter and wet summer) and reduced survey effort.

Table 4. Non-target rare *Drosophila* observed during surveys, July 2016–June 2017

Species	Sites	Total Observed	Max. No.
<i>D. craddockae</i>	Lower Opaepala	2	1
<i>D. divaricata</i>	Kaluaa, Hapapa	43	8
<i>D. hemipeza</i>	Palikea, Hapapa	5	2
<i>D. nigribasis</i>	Kaala	11	4
<i>D. oahuensis</i>	Kaala, Koloa	6	4
<i>D. pilimana</i>	Manuwai	1	1

Drosophila craddockae is closely related to *D. pullipes* of Hawaii and *D. grimshawi* of Maui Nui. Like the former, it is a specialist on *Wikstroemia* spp., an unusual host for *Drosophila*. While its host is abundant, *D. craddockae* is rarely observed, and has been found only sporadically at widely separated localities in recent years. Only two were seen, at Lower Opaepala, where it has been most abundant in the past.

Drosophila divaricata is closely related to the more common *D. inedita*, but can be easily distinguished by its much larger size and slightly different wing pattern. The host plant is unknown. It is generally rare, but has been observed regularly in Kaluaa Gulch. This year it was unusually abundant at both North and Central Kaluaa during the months of the winter and spring peak.

Drosophila hemipeza is the only listed endangered species on Oahu that is known to be extant but does not occur on Army lands or OIP/MIP action areas, although it historically occurred at Kahuku Training Area and West Makaleha Gulch adjacent to Makua. It has been consistently found at Palikea MU for several years but always in low numbers; occasional individuals have shown up at Puu Hapapa as well. It has only been seen three times (total of five individuals) in the past year's monthly monitoring, and none at Hapapa.

Drosophila nigribasis breeds in *Cheirodendron*; it is related to *D. substenoptera* but appears to favor wetter habitats. In our surveys, it is restricted to Koloa and the vicinity of Kaala summit.

Drosophila oahuensis is also a *Cheirodendron* breeder, and appears to span the habitat range of *D. nigribasis* and *D. substenoptera*, including both the near-summit area of Kaala and wet-mesic sites such as North Haleauau Gulch in Lihue. The majority of both *D. nigribasis* and *D. oahuensis* came from one site on the west side of Kaala. A total of only six were found this year, all from Kaala.



7.3.5 *Vespula pensylvanica*

This highly invasive social predatory wasp is considered a major factor in the decline of picture wing *Drosophila* on Maui and Hawaii. Little is known of its impacts on Oahu, where it is present but much less conspicuous. The typical life cycle of a yellowjacket colony consists of an individual fertilized queen starting a nest in the spring, building up numbers of workers slowly at first but with exponential growth, peaking in the fall when new reproductives (males and the next generation of queens) are produced. After the reproductives leave the colony it typically declines and the workers die off, but in warm climates such as Hawaii they may persist through the winter and grow to an exceptionally large size during a second summer, with tens or hundreds of thousands of workers.

Ten traps baited with heptyl butyrate are monitored monthly at Palikea and Puu Hapapa. Numbers at the two sites are relatively modest compared to upper elevations of Hawaii or Maui. Still, they show a significant number of *Vespula* are usually present at both during the summer, coinciding with the low period of *Drosophila* numbers. It is unclear if there is any causal relationship; *Vespula* numbers in 2016 were high at Palikea but absent at Hapapa, while *Drosophila* were also high and low respectively. This suggests that the benefit to each from weather or other conditions outweighs the negative effect on *Drosophila* from *Vespula* predation. Almost no *Vespula* have been seen so far in 2017, but the spike occurs in the late summer and fall.

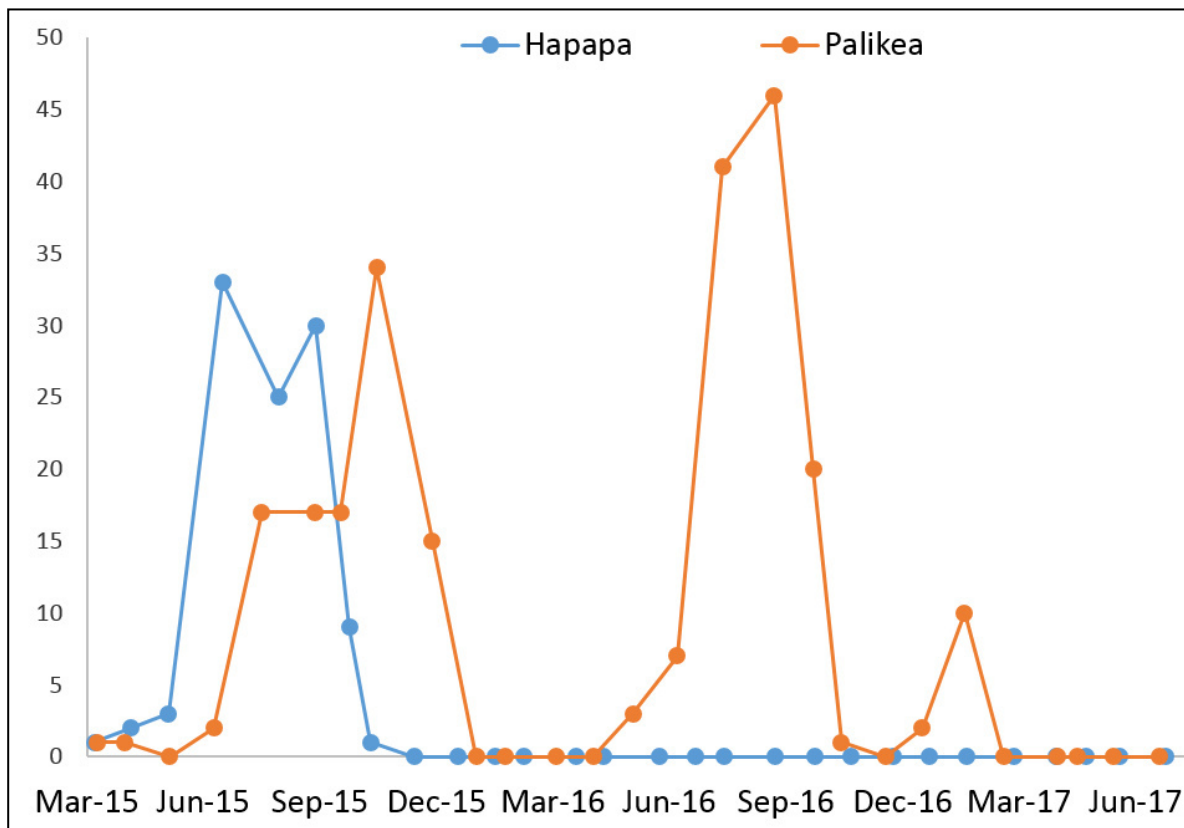


Figure 8. *Vespula pensylvanica* numbers at Palikea and Puu Hapapa (monthly total across 10 traps at each site).

We plan to continue monitoring at Palikea and Hapapa, since the current regime of maintaining 10 traps at each site can be done in conjunction with the monthly fly monitoring without significant additional effort. No other sites have both significant *Drosophila* populations and relatively open canopy suited to

Vespula monitoring. At present, there are no plans to conduct control of *Vespula*, but this may be considered if populations increase in the future.

7.4 DROSOPHILA MONTGOMERYI MANAGEMENT PLAN UPDATE

MIP Year 14-17, OIP Year 11-13; July 2017 – June 2020

Management Goals

- Manage three population units (PUs) with stands of host trees (minimum 50 at each site), with natural recruitment and reproduction occurring.
- Control direct and indirect threats at managed PUs, including ungulates, weeds, fire, and alien invertebrates.
- Monitor fly populations over time for stability and management effectiveness.

Accomplishments

The previous three-year management plan outlined in the 2014 YER called for managing three population units for *Drosophila montgomeryi* – Palikea, Pualii, and Kaluaa, the last with three subunits (Central, North, and Puu Hapapa). Actions scheduled for each included weed control, monthly (Kaluaa, Palikea) or quarterly (Pualii) monitoring, threat evaluation and control, and outplanting of hosts *Urera glabra* and *U. kaalae* at all sites (*U. kaalae* plantings are now done primarily by OPEPP).

These have largely been accomplished. Weeds, primarily *Rubus rosifolius* at all sites and *Ipomoea cairica* at Kaluaa, occasionally become an issue but periodic sweeps have kept them to a manageable level. Monitoring at Kaluaa and Palikea has been consistent, though it was stopped at Pualii after July 2016 following the loss of most mature *Urera* trees there. Outplantings have been done largely as planned and as scheduled; Central Kaluaa was done early and with more *U. glabra* and fewer *U. kaalae*, while no plantings have been done at Hapapa yet since it is a lower priority, as a large number of both species are already present. Nearly all of the outplants are thriving, with only a few mortalities from

<i>Urera</i> Outplantings for <i>Drosophila montgomeryi</i>			
Population Unit	winter 2014–15	winter 2015–16	winter 2016–17
Palikea	<ul style="list-style-type: none"> • goal: 50 Uregla • planted: 55 Uregla 	<ul style="list-style-type: none"> • goal: 50 Urekaa • planted: 80 Urekaa 	<ul style="list-style-type: none"> • planted: 50 Urekaa • planted: 48 Uregla
Pualii	<ul style="list-style-type: none"> • goal: 50 Uregla • planted: 50 Uregla 	<ul style="list-style-type: none"> • goal: 50 Urekaa • planted: 98 Urekaa 	
Kaluaa			
Central Kaluaa	<ul style="list-style-type: none"> • planted: 35 Uregla 	<ul style="list-style-type: none"> • goal: 50 Uregla • planted: 61 Uregla • planted: 29 Urekaa 	<ul style="list-style-type: none"> • goal: 50 Urekaa
North Kaluaa	<ul style="list-style-type: none"> • goal: 50 Uregla • planted: 52 Uregla 	<ul style="list-style-type: none"> • goal: 50 Urekaa • planted: 50 Urekaa 	
Hapapa			<ul style="list-style-type: none"> • goal: 50 Urekaa

treefalls, notably at Palikea and North Kaluaa; however, the *U. glabra* at Pualii and North Kaluaa are in shaded areas and not growing as fast as elsewhere. *Urera glabra* is also being used for general habitat restoration, and plantings in other locations may become future *D. montgomeryi* reintroduction sites.

Threat management is still in progress. Western yellowjackets (*Vespula pensylvanica*) are monitored at Palikea and Hapapa but are in relatively low numbers (sometimes nearly absent) and do not seem to be a major threat; rather, there are more *Drosophila* in years when there are more *Vespula*, suggesting both fluctuate in response to general trends. Recent research has shown that *Solenopsis papuana*, a ubiquitous but cryptic ant, has a significant impact on *Drosophila* reproductive success (see Appendix ES-10). In addition, *Pheidole megacephala*, the big-headed ant, was found at one of the outplanting areas at Pualii that is viewed as a potential reintroduction site if the *D. montgomeryi* population there has been extirpated. Control at this site is being attempted in the summer of 2017.

Population Status

The populations at Kaluaa are persisting, though at extremely low levels in Central and North for the past two years. Hapapa has been relatively stable, often with more *D. montgomeryi* than the “common” species also found there. No *D. montgomeryi* have been seen at Pualii since May 2014 or at Palikea since March 2015. These populations may be extirpated. However, while Pualii is quite isolated, none had been seen at Palikea in over a year of regular monitoring prior to the first detection there, suggesting they may also occur at, and potentially disperse from, the inaccessible *Urera* patches on the cliffs nearby.

In unmanaged areas, the SBW site at South Haleauau has not been surveyed since 2014 due to difficult access. In Waianae Valley, the largest population at Kumaipo Gulch subgulch 4 has suffered severe reduction due to repeated rockfalls and subsequent boring beetle attacks and weed invasion. With this site threatened and difficult to protect, and the Pualii and Palikea populations possibly no longer extant, other sites in Waianae may need to be considered as management areas.

Future Actions

A significant area has been weeded at Pualii below the *D. montgomeryi* site, and is a prime spot for outplanting and restoration if ant control can be successful. At North Kaluaa, a large treefall has opened up a large light gap in a previously densely shaded, heavily native area that is likewise an excellent opportunity to put in *Urera*. These are the sites where the current plantings have been least successful due to heavy shade (mostly from native trees), so this should allow for much better growth. In addition, a number of *Urera* and other outplants were killed or damaged by treefalls at the Palikea banyan restoration site over the past two years (primarily from invasive trees that had been killed and left standing), allowing weeds to move in. Planting more at this site where the surviving plants have grown quickly should fill in the site and lead to better habitat quality. While Hapapa has the most mature plants, there has been significant mortality of *U. kaalae* there over the past two years, so additional plants will be put in there. *Pipturus albidus* (mamaki) is generally considered a highly beneficial native restoration tree, but at Hapapa it supports unusually high densities of leafhoppers which results in a thick layer of sooty mold on all plants below them, suppressing photosynthesis. Replacement with other canopy or subcanopy species should be considered to promote the growth of future outplants.

Other actions will remain largely the same as in the previous plan. Fly monitoring and weed control will be ongoing, and threats from invasive invertebrates (ants, yellowjackets) will be monitored and control undertaken if warranted. In particular, surveys will be conducted for *Solenopsis papauana* to determine if control would be beneficial. Since the impact seems to be mainly on larvae, only relatively small areas of control around breeding hosts may be necessary, similar to rat control around elepaio nests.

Three Year Action Plan for <i>Drosophila montgomeryi</i>					
Population Unit	Occd. Area (ha)	Addl. Area (ha)	OIP YEAR 11 July 2017 – June 2018	OIP YEAR 12 July 2018 – June 2019	OIP YEAR 13 July 2019 – June 2020
Palikea	—	4.7	<ul style="list-style-type: none"> • plant 50 Uregla • weed control • threat evaluation • monitor monthly 	<ul style="list-style-type: none"> • plant 50 Urekaa • weed control • threat evaluation • monitor monthly 	<ul style="list-style-type: none"> • weed control • threat evaluation • monitor monthly
Pualii	—	2.3	<ul style="list-style-type: none"> • plant 50 Uregla • weed control • ant control 	<ul style="list-style-type: none"> • plant 50 Urekaa • weed control • threat evaluation 	<ul style="list-style-type: none"> • plant 50 Uregla • weed control • threat evaluation
Kaluaa					
Central Kaluaa	0.7	1.8	<ul style="list-style-type: none"> • weed control • threat evaluation • monitor monthly 	<ul style="list-style-type: none"> • weed control • threat evaluation • monitor monthly 	<ul style="list-style-type: none"> • weed control • threat evaluation • monitor monthly
North Kaluaa	0.2	1.5	<ul style="list-style-type: none"> • plant 50 Uregla • weed control • threat evaluation • monitor monthly 	<ul style="list-style-type: none"> • plant 50 Urekaa • weed control • threat evaluation • monitor monthly 	<ul style="list-style-type: none"> • weed control • threat evaluation • monitor monthly
Hapapa	0.2	0.5	<ul style="list-style-type: none"> • weed control • threat evaluation • monitor monthly 	<ul style="list-style-type: none"> • plant 50 Urekaa • weed control • threat evaluation • monitor monthly 	<ul style="list-style-type: none"> • weed control • threat evaluation • monitor monthly

7.5 DROSOPHILA SUBSTENOPTERA MANAGEMENT PLAN UPDATE

MIP Year 14-17, OIP Year 11-13; July 2017 – June 2020

Management Goals

- Manage three population units (PUs) with stands of host trees (minimum 50 at each site), with natural recruitment and reproduction occurring.
- Control direct and indirect threats at managed PUs, including ungulates, weeds, fire, and alien invertebrates.
- Monitor fly populations over time for stability and management effectiveness.

Accomplishments

The previous three-year management plan outlined in the 2014 YER called for managing three population units for *Drosophila substenoptera* – Palikea, Kaala, and Lower Opaaula. Active management for this species is more limited than for *D. montgomeryi* because the factors causing its rarity are uncertain. The

plan has been largely followed as outlined, with fly monitoring, weed control, and threat monitoring and evaluation. Weed control specifically around *Drosophila* areas has been primarily done at Palikea, where the threat is greatest and where it overlaps with *D. montgomeryi* and several rare plant sites. At Lower Opaëula, the site where *D. substenoptera* is known from has relatively few weeds, but weeding elsewhere has opened up new areas that may be suitable habitat as native trees move in. Kaala has relatively low levels of weeds, with aggressive invaders such as sphagnum moss and kahili ginger controlled across the area.

Population Status

As noted above, no flies have been detected at Kaala or Lower Opaëula since May 2015, but it is rare at these sites (the latter has only been visited once per year since 2015, as trips have been reduced there in general). The Palikea population is somewhat below its numbers in previous years, but still occurs in similar proportion to the other species found there. In addition to the generally poor weather, it may be due in part to the more open, drier conditions at the restoration site where one of the monitoring sites is. There has been a noticeable shift in *D. substenoptera* sightings from this site to others where they had formerly been rarely seen. As native canopy replaces the former christmasberry (*Schinus terebinthifolius*) cover over the next several years, we expect this area to become cooler and wetter, becoming more hospitable to *Drosophila*.

Future Actions

Actions will remain largely the same as in the previous plan. Fly monitoring and weed control will be ongoing, and threats from invasive invertebrates (ants, yellowjackets) will be monitored and control undertaken if warranted. In particular, surveys will be conducted for *Solenopsis papauana* to determine if control would be beneficial. Additional outplanting of common native species (including *Urera glabra*, as part of *D. montgomeryi* conservation efforts) will take place at Palikea to improve the microclimate.

Three Year Action Plan for <i>Drosophila substenoptera</i>				
Population Unit	Area (ha)	OIP YEAR 11 July 2017 – June 2018	OIP YEAR 12 July 2018 – June 2019	OIP YEAR 13 July 2019 – June 2020
Palikea	5.0	<ul style="list-style-type: none"> • weed control • threat evaluation • monitor monthly 	<ul style="list-style-type: none"> • weed control • threat control • monitor monthly • plant cover trees 	<ul style="list-style-type: none"> • weed control • threat control • monitor monthly
Kaala	~85	<ul style="list-style-type: none"> • weed control • threat evaluation • monitor quarterly 	<ul style="list-style-type: none"> • weed control • threat control • monitor quarterly 	<ul style="list-style-type: none"> • weed control • threat control • monitor quarterly
Lower Opaëula	2.0	<ul style="list-style-type: none"> • weed control • threat evaluation • monitor as possible 	<ul style="list-style-type: none"> • weed control • threat control • monitor as possible 	<ul style="list-style-type: none"> • weed control • threat control • monitor as possible