Eugenia koolauensis

- Scientific name: Eugenia koolauensis (Degener)
- Hawaiian name: nioi
- Family: Myrtaceae (Myrtle family)
- Federal status: Listed endangered March 28, 1994

Requirements for Stability:
- 3 Population Units (PU)
- 50 reproducing individuals
- Factors for setting goal as >25 plants for a long-lived perennial: doubled due to threat from rust (P. psidii)
- Stable population structure
- Threats controlled
- Complete genetic representation of all PUs in storage
- Tier 1 stabilization priority

Description and biology: Eugenia koolauensis is a small tree or shrub 2-7 m tall. The oppositely arranged leaves are concave, 2-5 cm long, and 1-3.3 cm wide. The leaf margins are strongly revolute. The upper leaf surfaces have dense brown hairs when young. Older leaves are glossy and hairless, or bear short hairs near the veins. The lower leaf surfaces are densely covered by short brown hairs or rarely moderately covered. The flowers are white, borne 1-2 in the leaf axils, with four petals and about 150 stamens. The berries are yellow to red, ovoid in shape, measure 0.8-2.0 cm in length, and usually contain a single globose seed (though occasionally produces two seeds; OAHF Seed Laboratory observations). The species has been observed with flowers and fruits year round, but peak fruit production usually occurs in the summer. The flowers of Eugenia koolauensis are presumably insect pollinated. The red and yellow fleshy berries suggest that fruit eating birds are the main dispersal agents for the species. Since the seeds are large and lacking a durable seed coat, they would not be expected to remain viable long after the fruit ripens. In fact, seeds are desiccation-sensitive and do not survive drying (OAHF Seed Laboratory observations), which may imply that seeds do not survive for long outside of the fleshy fruit. Immature cultivated plants are slow growing (Lauers pers. comm. 2005), and it seems likely that immature plants in the wild would also be slow growing. Eugenia koolauensis is a long-lived species. A tree in Papali Gulch has been observed for 25 years, but it has not increased very much in size during that time (Lauers pers. comm. 2005).

Eugenia koolauensis

- Known distribution: E. koolauensis has been found on the islands of Oahu and Molokai. On Oahu, the species has been recorded primarily from the northern Koolau Mountains, on both the windward and leeward sides of the mountain range, from 328-1,065 ft in elevation. The species has also been recorded from the Waianae Mountains, inland of Waialua. It was collected in this area by C. Degener in 1922 in the "gully having prominent dyke, north-northeast of Puu Kamakoi" (Wilson 1957), known as Fallows Gulch. In 2000, a few plants were discovered in the same area in Fallows and Kolekole Gulches. Recorded elevations for the species in the Waianae Mountains are from 760-860 ft. Since the species grows in dry forest, it is possible that it formerly also occurred in the region between the two mountain ranges. If the species did indeed occur in that region, the now separated Koolau and Waianae plants would likely have been in genetic communication. On Molokai, the species is known from only two specimens collected by Joseph F. Rock. One of the specimens was collected in 1918, and the other in 1920 (Wilson 1957). Although elevations were not recorded for the West Molokai specimens, the plant or plants were likely located near the summit of Maunaloa, which is 1,381 ft high in elevation. Little native vegetation remains on Maunaloa, and it is unlikely that any E. koolauensis plants survive there today.

- Population trends: The largest number of individuals of E. koolauensis occurs within the U.S. Army Kalakau Training Area (KTA) in the Northern end of the Koolau Mountains. Observations of these sites by OAHF from 1996-2006 showed that nearly all populations contained seedlings and saplings in addition to mature trees. During that period, the numbers of individuals were stable or slightly increasing. Most trees at Kaunale, Puripahihaai, Oio and Kalekeli were fenced; heavy fuels were removed to reduce the risk of fire and weed control was ongoing. Since 2006, the species has been observed to be rapidly declining across its range (see population trend charts below) due to an introduced pathogenic rust, Puccinia psidii. The first sign of rust on E. koolauensis was observed in March 2006 in Kalakau. Stands of Schizophragma, an alien species which hosts Puccinia rust, are abundant in the KTA. Other hosts present in the area are the native Metrosideros polymorpha and three alien species, Pimenta dioica, Eucalyptus robusta, and Melaleuca quinquenervia. The rust affects plants of all sizes and ages. Some small, immature plants were quickly defoliated and all plants show some sign of infection. Few if any trees are considered to be in good health and nearly all new leaves are quickly infected and killed. Some trees are still able to produce flowers, but flowers and immature fruit are also infected and killed. Since 2006, there has been a 70% decline of all known mature and immature plants (excluding seedlings) in the largest PUs. The decline in the number of mature and immature plants has been observed in each of the MFS PUs: Puripahihaai (82%), Oio (78%), Kaunala (65%), and at the Kalekeli (65%) genetic storage FU.
Eugenia koolauensis

- **Current status**: *E. koolauensis* is currently recognized as one of only two native Hawaiian species of Eugenia. The other species is the closely related *E. reinwardtiana*, whose range extends beyond Hawaii through much of the tropical Pacific Ocean and Australia. *Eugenia reinwardtiana* had already been known as a rare plant in most regions of Hawaii except for the northern Wai'anae Mountains where it can be locally abundant, but there have not been recent surveys of this taxon since the introduction of *P. psidii*. Therefore, there are certain populations of *Eugenia* in the Ko'olau Mountains with plants whose morphology is intermediate between the two *Eugenia* species. These intermediate population units have not been included among the population units included in this summary. In the Wai'anae Mountains, *E. reinwardtiana* occurs in the same gulleys containing known *E. koolauensis* trees, but in different parts of the gulleys. There appears to be a zone of intergradation in these gulleys between the typical plants of each of the two *Eugenia* species (Lau pers. comm. 2005).
Eugenia koolauensis

- Threats: Feral pigs are a major threat to *E. koolauensis* in both the Koolau and Waianae Range. Feral goats also threaten the Waianae sites. The animals degrade the plants' habitat by hastening the spread of invasive weeds. The PUs at Kainalu, Pahipahinau, Ohio and some plants at Kolekole are now fenced and protected from pigs. Alien plants threaten *E. koolauensis* by altering the species' habitat, competing with it for moisture, light, nutrients, growing space, and serve as a reservoir for *Puccinia psidii*. Also, the spread of highly flammable alien grasses increases the incidence and destructiveness of wildfires. The single tree in Kainalu Gully was killed by the Wai'alae fire in August 2007. The trees in the Pai'alea site were scorched, but were not immediately killed.

- Weed control has been ongoing at the largest PUs to reduce alien cover and favor native habitat. Recently, relatively healthy *E. koolauensis* plants have been observed surviving underneath both native and alien vegetation compared with others in areas more exposed to *Puccinia psidii* spore rain. Because of this and a shift in strategy to focus on propagation, removal of alien plants will be temporarily halted within the fences.

- Threats in the Action Area: Major threats in the action area at KTA due to army training are fire, trampling, and the introduction of competing non-native plant species. Fire in the action area has been documented to have affected populations of this species twice in the last 10 years, and the fuel load near some plants is high. Additionally, some of the onsite populations are threatened by habitat disturbance from motor cross bikes.

Eugenia koolauensis

- Threats (continued): In April 2005, a pathogenic fungus *Puccinia psidii* Winter was documented on cultivated chia plants on Oahu. By August 2005, it was reported to be widespread across the state and considered to be a major threat to native chia forests (Loepp 2008). It was not observed during monitoring of *E. koolauensis* at Kahuku in February of 2005, but was reported to be present at all sites in May 2006. Damage to most trees has been severe and lethal (see pictures below). All trees appear to have at least partially defoliated by infections of *Puccinia psidii* and many smaller immature trees have since died. *Puccinia psidii* has been observed to infect flowers and fruits and certainly affects overall health and fecundity reducing seed production and recruitment. No mature fruit has been collected from any of the trees since 2009. Collections of seed, cuttings, air layers and whole plants have been successfully propagated and established in the OANRP nursery. The threat from *Puccinia psidii* to plants in the nursery is kept under control with a rotation of several fungicides and basic propagation and cultural techniques. Plants can be kept healthy and these are producing flowers and viable fruit. The pathogen appears to be thriving in the habitat for *E. koolauensis* in KTA where there are many other Myrtaceous host plants. Of the 80 known host plants worldwide, 42 occur in Hawaii. Control methods recommended by government agriculture and botanical gardens include: replanting with non-Myrtaceous species or using fungicides. There are currently no fungicides approved by the Hawaii Department of Agriculture for use in natural areas. While repeated fungicide applications have been shown to be effective in controlling the rust (Martin 2011), rotating bi-weekly applications of several different chemicals (to prevent resistance) onto wild trees in remote natural areas is not considered a sustainable effort at this time. Instead *inter-situ* sites with access to these management options will be established to manage a living collection.
**Eugenia koolauensis**

- **Outplanting Considerations:** Future outplantings could be at risk of being genetically swamped by *E. reinwardtiana* if outplanted close to *E. reinwardtiana*. In addition, *E. reinwardtiana* is a host for *Puccinia psidii*. Wild stands of this tree are also infected by *Puccinia psidii* and like the prognosis for *E. koolauensis*, is not positive. Outplantings of *E. koolauensis* are not currently planned, but in the Koolau Mountains should be limited to the portion of the mountain range where only *E. koolauensis* has been found (see map below). For the Waialae Mountains, a line to designate appropriate planting areas has been drawn that approximates the upper edge of the area occupied exclusively by *E. koolauensis* (see map below).

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### Map removed to protect rare resources, available upon request

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## Selected Historic Collections of *E. koolauensis*

*Data compiled from Bishop Museum Herbarium Records provided by Bishop Museum, 2014.*

<table>
<thead>
<tr>
<th>Area (All in the Koolau Mountains)</th>
<th>Year</th>
<th>Collector</th>
<th>Pop. Reference Code/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupukea</td>
<td>28 Sep 1925</td>
<td>H. St. John</td>
<td>PAU-C</td>
</tr>
<tr>
<td>Pupukea</td>
<td>28 Sep 1925</td>
<td>Judd, C.S.</td>
<td>PAU-C</td>
</tr>
<tr>
<td>Pupukea</td>
<td>2 Nov 1925</td>
<td>Brown, F.B.H.</td>
<td>PAU-C</td>
</tr>
<tr>
<td>Hauula</td>
<td>8 Sep 1926</td>
<td>Judd, C.S.</td>
<td>on top of small cliff</td>
</tr>
<tr>
<td>Kahawainui Gulch</td>
<td>2 Mar 1928</td>
<td>Judd, C.S.</td>
<td></td>
</tr>
<tr>
<td>Kaipapau Valley (North Slope)</td>
<td>11 Oct 1931</td>
<td>Degener, O.</td>
<td>Isotype</td>
</tr>
<tr>
<td>Papali Gulch</td>
<td>1933</td>
<td>Judd, C.S.</td>
<td>on trail</td>
</tr>
<tr>
<td>Small valley E of Waipio Stream</td>
<td>7 Jul 1935</td>
<td>Degener, O.</td>
<td>HAU-A</td>
</tr>
<tr>
<td>Kamananui Stream (North fork, South slope)</td>
<td>16 Apr 1949</td>
<td>H. St. John</td>
<td>Not visited yet</td>
</tr>
<tr>
<td>Kamananui Stream (North fork, South slope)</td>
<td>18 Nov 1952</td>
<td>Wilson, K.A.</td>
<td>Not visited yet</td>
</tr>
<tr>
<td>Waialae Nui</td>
<td>23 Jan 1988</td>
<td>Takeuchi, W.N.</td>
<td></td>
</tr>
</tbody>
</table>

### Remaining Unsurveyed Historic Locations for *E. koolauensis*

<table>
<thead>
<tr>
<th>Area</th>
<th>HNHP EOCODE</th>
<th>Last Observed</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaipapau</td>
<td>PDMRT030J0.002</td>
<td>1931</td>
<td>610,861,817 2,390,154,791</td>
</tr>
<tr>
<td>Papali*</td>
<td>PDMRT030J0.005</td>
<td>1994</td>
<td>612,142,289 2,388,442,462</td>
</tr>
<tr>
<td>Waima (Kamananui)</td>
<td>PDMRT030J0.003</td>
<td>1952</td>
<td>601,995,477 2,391,754,927</td>
</tr>
<tr>
<td>Malaekahana (Ohiaai)</td>
<td>PDA00030030.026</td>
<td>1933</td>
<td>605,569,445 2,394,857,376</td>
</tr>
<tr>
<td>Malaekahana (Kahawainui)*</td>
<td>PDMRT030J0.006</td>
<td>1928</td>
<td>608,978,388 2,392,755,762</td>
</tr>
<tr>
<td>Waialae Nui</td>
<td>n/a</td>
<td>1994</td>
<td>No point location available</td>
</tr>
</tbody>
</table>

*Priority for OAHPP relocation surveys, other areas have known sites nearby that will already be represented in the living collection.*
Map removed to protect rare resources, available upon request
Puccinia psidii rust on E. koolauensis
Chapter 2

Puccinia psidii rust on E. koolauensis

(below left-right) rust on new growth, seedling, flowers, fruit

Puccinia psidii rust on E. koolauensis
## Population Units

<table>
<thead>
<tr>
<th>Manage for Stability Population Units</th>
<th>PU Type</th>
<th>Which Army Action Area is the PU inside?</th>
<th>Management Unit(s) designated for threat control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaunala</td>
<td>in situ</td>
<td>OIP (KTA)</td>
<td>Kaunala</td>
</tr>
<tr>
<td>Oio</td>
<td>in situ</td>
<td>OIP (KTA)</td>
<td>Oio</td>
</tr>
<tr>
<td>Pahipahialua</td>
<td>in situ</td>
<td>OIP (KTA)</td>
<td>Pahipahialua</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Genetic Storage Population Units</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aimuu</td>
<td>in situ</td>
<td>OIP (KTA)</td>
<td>None</td>
</tr>
<tr>
<td>Hanaimoa</td>
<td>in situ</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Kawaihoale and Kamanu</td>
<td>in situ</td>
<td>OIP (KTA)</td>
<td>None</td>
</tr>
<tr>
<td>Kaleleiki</td>
<td>in situ</td>
<td>OIP (KTA)</td>
<td>None</td>
</tr>
<tr>
<td>Malaekahana</td>
<td>in situ</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Oiaa and East of Oio</td>
<td>in situ</td>
<td>OIP (KTA)</td>
<td>None</td>
</tr>
<tr>
<td>Palikea and Kaimuhole</td>
<td>in situ</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Papali</td>
<td>in situ</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
Habitat Characteristics at Manage for Stability Population Units

<table>
<thead>
<tr>
<th>Population Unit</th>
<th>in situ Population Reference Code</th>
<th>Elev. (ft.)</th>
<th>Slope</th>
<th>Canopy Cover</th>
<th>Topography</th>
<th>Aspect</th>
<th>Average Annual Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaunala</td>
<td>KNL-B</td>
<td>680-800</td>
<td>Moderate to Steep</td>
<td>Intermediate-Closed</td>
<td>Mid to Upper-Slope</td>
<td>East to Northeast</td>
<td>1696</td>
</tr>
<tr>
<td>Oio</td>
<td>OIO-F</td>
<td>700-800</td>
<td>Moderate</td>
<td>Intermediate-Closed</td>
<td>Mid to Upper-Slope</td>
<td>East to Northeast</td>
<td>2047</td>
</tr>
<tr>
<td>Pahipahialua</td>
<td>PHI-A</td>
<td>680-780</td>
<td>Moderate</td>
<td>Intermediate</td>
<td>Mid to Upper-Slope</td>
<td>Northeast</td>
<td>1619</td>
</tr>
</tbody>
</table>

Information was compiled from OANRP observation forms & GIS data; Rainfall data compiled from Rainfall Atlas of HI (Giambelluca et al. 2013).

Associated Species at Manage for Stability Population Units

<table>
<thead>
<tr>
<th>Population Unit</th>
<th>PRC</th>
<th>Canopy</th>
<th>Understory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaunala</td>
<td>KNL-B</td>
<td>AcaKoa, BobEl, CasEnu, CasOlu, ChrHal, ChvOli, CorFr, DioEl, DioSan, EucRob, GreRob, LepTim, MelQui, MetPol, NesSan, PasSub, PitCon, PlaSan, PsCat, PsGuta, PsyMar, PsyOdo, RauSan, SanFreFr, SapDah, SidPol, XylHaw</td>
<td>AdelHy, AlySte, AndEl, ApyNid, CarMey, CarWah, CasOlu, ChrHal, ChvOli, CibBha, ChlH, CorBou, CorFr, CycP, FreArb, LepTim, ChlH, PasF, PasSub, PlaSan, PsCat, PsGuta, PsyMar, PsyOdo, SetPal, SynCh</td>
</tr>
<tr>
<td>Oio</td>
<td>OIO-F</td>
<td>CasEnu, CasOlu, ChvOli, GreRob, PasF, PasSub, PinDio, PsCat, PsGuta, SyzTim, BobEl, ChrHal, DioSan, NesSan, PsyOdo, RauSan</td>
<td>AndEl, ArtGy, ChlH, CorFr, CyG, CyP, LanC, LibL, MacMap, Cha, PasF, PasSub, PinDio, PsCat, PsGuta, RubRos, Spec, AlySte, CarMey, CarWah</td>
</tr>
<tr>
<td>Pahipahialua</td>
<td>PHI-A</td>
<td>AleMel, AndEl, CasEnu, CorFr, GreRob, BobEl, BobTim, ChrHal, LepTim, MetPol, Myrtes, NesSan, PasSan, PitCon, PitFr, PlaSan, PasSub, PsCat, SchlHr, PsyOdo, RauSan, SanFreFr, XylHaw</td>
<td>AndEl, ArtGy, CasEnu, ChlH, CibBha, CocOrb, ConBou, CorFr, CyG, CyP, DoolH, FreArb, LanC, ChlH, PasF, PasSub, PsCat, SetPal, SynCh, StahlR, AlySte, CarMey, CarWah, CibBha, LepTim, MetPol, NepBro, PsyNud, PsyOdo, Spec, ScaGau, SetPal</td>
</tr>
</tbody>
</table>

Species are listed in alphabetical order by exotic, then native, as observed by OANRP; non-native taxa are underlined.
Population Structure

- Currently, none of the Population Units have more than the number of mature plants required to meet stability goals (50 mature individuals) and immature plants are not expected to survive to maturity due to poor health from infection by Puccinia psidii.

- Many immature plants and seedlings have been observed at most PUs. The Kaunala PU, Kaleleiki PU and the Pahipahialua PU have had many immature plants and seedlings and still currently have more seedlings and immature plants than mature plants.

- *Puccinia psidii* is present on all plants at all sites and is negatively impacting population structure by slowing or stopping production of viable seeds and by killing plants. Since 2006, in the largest PUs, there has been a 70% decline of all known mature and immature plants (excluding seedlings). Over the last 4 years, there has been a 54% reduction in the total number of plants (mature, immature, seedlings).

- Without control methods for *P. psidii*, the trees are unlikely to produce more viable seeds, hence no new seedlings are expected at any of the sites. As the populations decline, collections of cuttings will be made from trees of all size classes. New growth on trees is ideal for cuttings, however *P. psidii* prevents new growth, hence making rooting success more difficult and at a slower rate by forcing the use of old (and likely infected) growth for cutting material.

- Soil seed bank potential has been studied at the OANRP seed laboratory. Radicles will emerge from seeds kept dark and imbibed (moist) for at least one year, but cotyledons will not emerge. Once these half-germinated seeds are exposed to light, cotyledons emerge and the seedlings continue to grow. This suggests that, despite the fact that seeds cannot tolerate desiccation, a seed/seedling soil seed bank can exist for at least one year as long as conditions remain wet enough so that the seeds do not dry out. However, no mature fruit has been observed on the wild trees since 2009.

- Population trends (see charts above and table below) document the decline observed at four of the larger PUs. The increase seen at the PUs during the 2010 observations was due to an increase in the amount of time spent searching and counting every plant.

### Population Estimates for the Largest PUs

<table>
<thead>
<tr>
<th>Year</th>
<th>Kaunala</th>
<th>Oio</th>
<th>Pahipahialua</th>
<th>Kaleleiki</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mat</td>
<td>Imm</td>
<td>See</td>
<td>Mat</td>
<td>Imm</td>
</tr>
<tr>
<td>2007</td>
<td>36</td>
<td>45</td>
<td>89</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>2010</td>
<td>54</td>
<td>108</td>
<td>131</td>
<td>22</td>
<td>17</td>
</tr>
<tr>
<td>2012</td>
<td>38</td>
<td>93</td>
<td>54</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>2014</td>
<td>23</td>
<td>39</td>
<td>31</td>
<td>7</td>
<td>5</td>
</tr>
</tbody>
</table>

Mat: Mature Plants, Imm: Immature Plants, See: Seedlings

This table shows results from population estimates conducted by OANRP at the four largest PUs: Kaunala, Oio, Pahipahialua and Kaleleiki from 2007-2014. *Puccinia psidii* was detected on the wild trees in 2006, more thorough surveys were completed of these sites. As a result of more staff hours dedicated to thorough surveys in 2007-2010, more plants were discovered and counted. This is shown in the increases in the numbers of plants at Kaunala, Oio and Pahipahialua from 2007 to 2010. At the Kaleleiki PU, size classes were not standardized during monitoring in 2010 and 2012 when the sites were thoroughly searched. During that time, new trees were discovered close to the known fenced site. Since 2010, despite new finds and thoroughly searching each site, the total population has declined steeply and this trend is expected to continue because the plants that are still alive are in poor health.
Population Estimate History for other PUs

<table>
<thead>
<tr>
<th>Population Unit</th>
<th>Population Monitoring History (Mature/Immature/Seedling)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aimu</td>
<td>5/3/0</td>
</tr>
<tr>
<td>Hanaimoa</td>
<td>1/0/0</td>
</tr>
<tr>
<td>Kaiwilo and Kamananui</td>
<td>16/16/15</td>
</tr>
<tr>
<td>Malekahana</td>
<td>Not known</td>
</tr>
<tr>
<td>Ohiai and East of Oio</td>
<td>5/7/57</td>
</tr>
<tr>
<td>Palakea and Kaimuhole</td>
<td>3/0/0</td>
</tr>
<tr>
<td>Papali</td>
<td>1/0/0</td>
</tr>
</tbody>
</table>
### Reproductive Biology Table

<table>
<thead>
<tr>
<th>Population Unit</th>
<th>Observed Phenology</th>
<th>Reproductive Biology</th>
<th>Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vegetative</td>
<td>Flower</td>
<td>Immature Fruit</td>
</tr>
<tr>
<td>ALL</td>
<td>Dec-Mar</td>
<td>Mar-Sep</td>
<td>May-Oct</td>
</tr>
<tr>
<td>Oio</td>
<td>April-Aug</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kaunala</td>
<td>Jan-Feb</td>
<td>Mar-Aug</td>
<td>May</td>
</tr>
<tr>
<td>Pahipahialoa</td>
<td>Jan-Mar</td>
<td>April-Sept</td>
<td>May-Sept</td>
</tr>
<tr>
<td>Kaleoliki</td>
<td>Mar-Sept</td>
<td>no plants have been seen reproductive</td>
<td></td>
</tr>
<tr>
<td>Ainau</td>
<td>May</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hanaihoa</td>
<td>June</td>
<td></td>
<td>Aug</td>
</tr>
<tr>
<td>Kawaiholoe &amp; Kamananui</td>
<td>No data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malakahana</td>
<td>No data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ohiain &amp; East of Oio</td>
<td>April-Aug</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palikea &amp; Kaimuhoole</td>
<td>May</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Papali</td>
<td>No data</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Genetic Storage Plan

<table>
<thead>
<tr>
<th>What propagule type is used to meet genetic storage goals?</th>
<th>What is the source for the propagules?</th>
<th>What is the Genetic Storage Method used to meet the goal?</th>
<th>What is the proposed re-collection interval for seed storage?</th>
<th>Is seed storage testing ongoing?</th>
<th>Plan for maintaining genetic storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursery/living collection</td>
<td>in situ</td>
<td>Collecting seeds and cuttings</td>
<td>N/A</td>
<td>Yes</td>
<td>Collect seeds and maintain living collection in the nursery and an inter situ collection</td>
</tr>
</tbody>
</table>

Genetic Storage Plan Comments:
- Seeds have a slight level of physiological dormancy, as seeds take longer than 30 days to germinate. Average germination, however, is high (91%). Seed storage would be the preferred genetic storage method, however, seeds are desiccation-sensitive. Seed banking must utilize cryopreservation techniques. Cryopreservation protocols will be researched at the National Center for Genetic Resources Preservation (NCGRP, Fort Collins, CO), once enough seeds can be harvested from the OAMRP living collection. In lieu of this, a collection of Syzygium sandwicensis was sent to NCGRP to initiate protocol development (Mirtaceae; desiccation-sensitive) and living collections of plants are kept at the nursery to represent each of the PU. Once nursery plants are cloned, replicates will be planted at an inter situs site at Waimauka Botanical Garden where they can continue to be treated with fungicides. The living collection at the nursery will expand to include new founders as they become available. If cryopreservation protocols cannot be established for seeds of *E. koolauensis*, it will be attempted for buds and other meristematic tissues at NCGRP.

- Cuttings will be collected from all sites to establish a living collection in the OAMRP nursery. Currently, OAMRP has clones of 33 individual founders. In some cases, when propagules from larger plants are not available, whole plants will be removed from wild sites. Protocols for determining when whole plants can be removed from the wild have not been developed by the HPRPG. These methods will be used to dig up and transport small whole plants to the OAMRP nursery for propagation as part of the living collection. The HPRPG Salvage decision tree (below), however, only allows for salvaging whole plants of species with less than 50 individuals (PEPP species). Given the security of the *P. psidii* infections, which has ceased reproduction of *E. koolauensis* at all sites, made clonal propagation nearly impossible, and caused the rapid decline of this species, OAMRP proposes applying the whole plant harvesting (salvaging) to *E. koolauensis*. Salvaging now with 428 plants (64 mature/112 immature /252 seedling) remaining will allow for ex situs representation from remnant plants at most known sites. A total of 150 founders (117 additional founders) will be secured from across the known range. The collection strategy will be to represent every population site and sample from individuals growing across each site to maximize the chances of capturing the most genetic diversity. Both known founders from the Waimauka Mountains are already secured and collections from the other sites will be a priority over the next few years.
Collecting cuttings from *Eugenia koolauensis*
Cuttings rooted with Clonex on OANRP mist bench. Rooting occurs in 1-10 months in perlite/vermiculite.

Note that cuttings have only one leaf each and no new leaves. This is often the only material remaining.
Mature fruit will be sent to the USDA-ARS National Center for Genetic Resources Preservation in Ft. Collins, CO for research. Seedlings resulting from successful processing will be returned to OANRP.

**Inter situ Management Plan**

<table>
<thead>
<tr>
<th>Proposed <em>in situ</em> Outplanting Sites</th>
<th>Population Reference Site Codes for <em>in situ</em> Sites</th>
<th>Number of Plants</th>
<th>Propagate Type</th>
<th>Propagate Population Source</th>
<th>Number of Founders in Source Population</th>
<th>Plant Size</th>
<th>Pot Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaiwaiokoe and Kamananui</td>
<td>NMH-C</td>
<td>50</td>
<td>Outplants grown from cuttings of wild plants and seedlings from nursery stock</td>
<td>ALL Koolau Sites</td>
<td>150</td>
<td>30-100 cm</td>
<td>0.5 gallon 'shorty'</td>
</tr>
<tr>
<td>Waimea Botanical Garden</td>
<td>WAH-B</td>
<td>50</td>
<td>Outplants grown from cuttings of wild plants and seedlings from nursery stock</td>
<td>ALL Koolau Sites</td>
<td>150</td>
<td>30-100 cm</td>
<td>0.5 gallon 'shorty'</td>
</tr>
</tbody>
</table>

* The **Puccinia rust** is the primary threat to this species and would rapidly infect and kill any outplants. Because of this, no outplanting is planned in the next five years. Although chemical controls are effective for plants kept in cultivation, no control methods are available to treat wild trees or outplants in natural areas. According to the Hawaii Department of Agriculture, there is currently no fungicide that is labeled for use in a “Natural Area” in Hawaii. However, products used legally and effectively in the OANRP nursery are also labeled for use on trees and shrubs in a “landscape.” The *in situ* sites above are considered managed landscape areas where chemicals labeled for that use can be applied. These sites at Kaiwaiokoe and Kamananui and within the public gardens at Waimea Botanical Garden (WBG) will be used to develop propagation and planting techniques, test rust control methods and collect fruit for storage trials. They are both on WBG property and staff that maintain the existing collections there are eager to partner and expand the collection. The management unit fence constructed by WBG around some of the trees in the Kaiwaiokoe and Kamananui PU and this site will be used as a managed outplanting. The site is preferred because of the partnership with WBG, close proximity to an access road and ongoing intensive management of the landscape there. A new site will also be developed within WBG to secure additional founders. Stock will be propagated from all wild Koolau founders. Once replicated, stock would be available for conservation use by other agencies wanted to help with this taxon.

* As the living collection is secured and replicated at the OANRP nursery, partnerships with other agencies should be developed to establish sites within other existing fences such as: Mauauli, Kuleleki, Waiula, and Upper Kapuna to replicate the collections and develop **Puccinia rust** control methods. Partnerships with other botanical gardens to donate replicates of the living collection will be pursued.
Stabilization Goals Update for MFS PUs

<table>
<thead>
<tr>
<th>Population Units</th>
<th>PU Stability Target</th>
<th>MU Threat Control</th>
<th>Genetic Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Has the Stability Target for mature plants been met?</td>
<td>Does population structure support long-term population stability?</td>
<td>Ungulates</td>
</tr>
<tr>
<td>Kaumala</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Oio</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Pahipahialua</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Partial (100%): All of the plants in the PU have this threat partially controlled (fuel reduction)
There is currently no PU that meets the requirements for stability. All plants are fenced at the three MFS PUs. Weeds are managed periodically within all enclosures, however this may in fact increase spore rain on smaller plants that are covered (protected) by weeds so most weeding efforts will be discontinued. Genetic Storage goals will be met by establishing a nursery and garden living collection.

5 Year Action Plan

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Oio</td>
<td>•Collection for Nursery Living Collection</td>
<td>•Collection for Nursery Living Collection</td>
<td>•Census monitoring</td>
<td></td>
<td>•Outplanting into inter-situ sites at Waimea Botanical Garden and Kaivikoele and Kamananui fence</td>
</tr>
<tr>
<td>Kaumala</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pahipahialua</td>
<td></td>
<td></td>
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</tbody>
</table>

Genetic Storage Population Units

- Ainuu
- Hanaimoa
- Kaivikoele and Kamananui
- Kaleleiki
- Malaokahanu
- Ohiaa and East of Oio
- Paileka and Kaimuhole
- •Collection for Nursery Living Collection
- •Collection for Nursery Living Collection
- •Census monitoring
- •Census monitoring
Management Discussion for *E. koolauensis*

The primary efforts for stabilization of *E. koolauensis* include: A) securing founders in a nursery living collection; B) monitoring of mature plants at *in situ* populations; C) *in situ* habitat protection (maintain fences); D) research on cryopreservation techniques for *ex situ* seed storage; and E) outplanting where needed to establish new *in situ* sites to help hold replicates of the founders and research threat control methods. *Eugenia koolauensis* is in decline throughout its range and no management is currently available to reduce or eliminate infections by *Puccinia psidii*.

The immediate strategy for this taxon is to salvage collections from 150 wild founders from across the known range. Collections will be made from plants of all size classes and ages. When necessary, whole plants will be removed from wild sites, secured in cultivation at the OAHPP nursery and established as a living collection. Infections of *Puccinia psidii* are considered 100% lethal and no new plants are expected to be established on site. Monitoring will continue at all MFS PUs and complete census monitoring will continue every two years. The existing fences will be maintained around the MFS PUs, but the habitat protection and management will be discontinued until the wild plants and outplants can be protected from infection or be sufficiently controlled with legal application of fungicide chemicals. Once a living collection is established in the nursery, *inter situ* sites should be used to conduct experimental outplanting and as a back-up to the nursery collection. Fruit collected from these plants will be submitted to the USDA-ARS NCGRP for testing and to develop protocols for long-term genetic storage. In the longer term, the genetic storage goals will be met using the nursery living collection until collections are established at botanic gardens (or other *inter situ* sites), or when mature seeds can be collected and stored. Once plantings have been established at the *inter situ* sites, management strategies may have to be adapted to maintain healthy plants and control other host species of *P. psidii*.

References


