INTRODUCTION

These plans are intended to include all pertinent species information for stabilization, serve as a planning document and as an updated educational reference for OANRP staff. In many cases, data or information is still being gathered and these plans will continue to be updated. A brief description of each section is given here:

- **Species Description:** The first section provides an overview of each taxon. The IP stability requirements are given, followed by: taxon description, biology, distribution, population trends, and habitat.
- **Reproductive Biology Table:** This information was summarized by OANRP based on best available data from the MIP, OIP, USFWS 5-year Status Updates, OANRP field observations and other published research. Phenology is primarily based on observations in the OANRP rare plant database. The suspected pollinator is based on casual observations, pollinator syndromes as reported in the MIP and OIP, or other published literature. The information on seeds is from data collected at the Army seed lab and from collaborative research with the Harold L. Lyon Arboretum.
- **Known Distribution & Historic Collections Table:** This information was selected from Bishop Museum specimen records and collections listed in published research, the Hawaii Biodiversity and Mapping Program and other collectors notes.
- **Species Occurrence Maps:** These maps display historic and current locations, MUs, landmarks and any other useful geographic data for each taxon. Other features may be used on public documents to obscure locations of rare elements.
- **Population Units:** A summary of the PUs for each taxon is provided with current management designations, action areas and management units.
- **Habitat Characteristics and Associated Species:** These tables summarize habitat data taken using the Hawaii Rare Plant Restoration Group's Rare Plant Monitoring Form. The data is meant to provide an assessment of the current habitat for the in situ and outplanting sites. Temperature and rainfall estimates are also included for each site when available.
- **Pictures:** These photos document habitat, habit, floral morphology and variation; and include many age classes and stages of maturing fruit and seed. This will serve as a reference for field staff making collections and searching for seedlings.
- **Taxonomic Background:** This section provides information pertaining to the history of the taxonomy of the species.
- **Population Structure & Trends:** Data from monitoring the population structure for each species is presented with a plan to establish or maintain population structure at levels that will sustain stability goals. A review of population estimates for each Population Unit (PU) is displayed in a table. Estimates come from the MIP, OIP, USFWS 5-year Status Updates and OANRP field observations. In most cases, these estimates cannot be used to represent a population trend.
- **Reintroduction Plan:** A standardized table is used to display the reintroduction plans for each PU. Every outplanting site in each PU is displayed showing the number of plants to be established, the PU stock and number of founders to be used and type and size of propagule (immature plants, seeds, etc.). Comments focus on details of propagation and planting strategies.
- **Threats & Stabilization Goals Update:** For each PU, the status of compliance with all stability goals is displayed in this table. All required MFS PUs are listed for each taxon. 'YES, NO or PARTIAL' are used to represent compliance with each stability goal. For population targets, whether or not each PU has enough mature plants is displayed, followed by an estimate on whether a stable population structure is present. The major threats are listed separately for each PU. The boxes are shaded to display whether each threat is present at each PU. A dark shade identifies PUs where the threat is present and the lighter boxes where the threat is not applicable. The corresponding status of threat control is listed as 'YES, NO or PARTIAL' for each PU. A summary of the status of genetic storage collections is displayed in the last column.
- **Genetic Storage Section:** This section provides an overview of propagation and genetic storage issues. A standardized table is used to display information recorded for each taxon or PUs where applicable. The plan for genetic storage is displayed and discussed. In most cases, seed storage is the preferred genetic storage technique; it is the most cost-effective method, requires the least amount of maintenance once established, and captures the largest amount of genetic variability. For taxa that do not produce enough mature seed for collection and testing of storage conditions, micropropagation is considered the next best genetic storage technique. The maintenance of this storage method is continual, but requires much less resources and personnel than establishing a living collection in the nursery or a garden. For those taxa that do not produce storable seed and cannot be established in

micropropagation, a living collection of plants in the nursery or an inter situ site is the last preferred genetic storage option. In most cases, current research is ongoing to determine the most applicable method. For species with substantial seed storage data, a schedule may be proposed for how frequently seed bank collections will need to be refreshed to maintain genetic storage goals. This schedule is based only on storage potential for the species; other factors such as threats and plant health must be factored into this schedule to create a revised collection plan. Therefore, the frequency of refresher collections will constantly be adjusted to reflect the most current storage data. The re-collection interval is set prior to the time period in storage where a decrease in viability is detected. For example, *Delissea waianaeensis* shows no decrease in viability after ten years. OANRP would not have to re-collect prior to ten years as the number of viable seeds in storage would not have yet begun to decrease. The re-collection interval will be 10 years or greater (10+ yrs). If its viability declines when stored collections are tested at year 15, the interval will be set between 10 and 15 years. Further research may then be conducted to determine what specific yearly interval is most appropriate. The status of seed storage research is also displayed and discussed. Collaborative research with the USDA National Center for Genetic Resources Preservation (NCGRP) and Lyon Arboretum Seedlab is ongoing.

- **Management Discussion & 5-Year Action Plan:** A summary of the management approach, overall strategy and important actions for each taxon. This section displays the schedule of actions for each PU. All management is planned by 'MIP or OIP Year' and the corresponding calendar dates are listed. This table can be used to schedule the actions proposed for each species into the OANRP scheduling database. Comments in this section focus on details of certain actions or explain the phasing or timeline in some PUs.

Cyanea longiflora

Scientific name: *Cyanea longiflora* (Wawra) Lammers
Hawaiian name: *Haha*
Family: Campanulaceae (Bellflower family)
Federal status: Listed Endangered

Requirements for Stability:

- **3 Populations**
- **75 reproducing individuals in each population (short-lived perennial with fluctuating population numbers and trend of local decline)**
- **Threats controlled**
- **Stable population structure**
- **Complete genetic representation in storage**

Description and biology: *Cyanea longiflora* is a perennial shrub with woody stems 1-3 m long. In juvenile individuals the stems are muricate, eventually becoming smooth with age. The leaves measure 30-55 cm long, 6-12 cm wide, and are elliptic or oblanceolate shaped. The leaves are muricate in juvenile individuals and irregularly cleft or lobed. As the plant matures, the leaves become glabrous with margins entire or callose-crenulate, apex acute, sessile, or on petioles 0.3-3 cm long. The inflorescences are 5-10-flowered, peduncles 30-60 mm long, and pedicles 5-15 mm long. *C. longiflora* has a glabrous, obconical hypanthium 6-10 mm long and calyx lobes connate into an irregularly toothed sheath 2-4 mm long. The corollas are curved, and dark magenta 6-9 cm long. Additionally, the staminal column is also dark magenta and glabrous. The anthers are also glabrous, the lower two with apical tufts of white hairs. The berries are obpyriform, orange at maturity, and measure 10-12 cm long.

Flowering and fruiting specimens have been collected throughout the year, and timing varies among different populations. As with other *Cyanea*s with long tubular flowers, *C. longiflora* is thought to have been pollinated by nectar-feeding birds. It is capable of self-pollination, as evidenced by the fact that isolated plants produce viable seeds. The species' orange berries are indicative of seed dispersal by fruit-eating birds. Each berry typically contains approximately 300 seeds, with a maximum of 865 observed in one fruit. Seeds remain viable in storage at 20% relative humidity and 4 degrees Celsius for up to 10 years, with less than 30% viability loss after five years in storage. The longevity of individual plants has been recorded for up to 10 years for both *in situ* and *ex situ* individuals. Therefore, the species presumably lives for up to 10 years, like other *Cyanea* species of its size, and is thus short-lived for the purposes of the Implementation Plan (MIP 2003).

Figure. 1. Description and *ex situ* Conservation (from left to right): seedlings growing in growth chambers, plants growing in the nursery, dark magenta flowers with apical tufts of white hairs.

Table 1. Reproductive Biology Summary of *C. longiflora*

	Observed Phenology			Reproductive Biology		Seeds*	
Population Unit	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Average Seeds / Fruit	Dormancy
Kapuna to West Makaleha	Feb-Aug	April-Oct	May-Nov	Hermaphroditic	Bird**	359	Not Dormant
Makaha and Waianae Kai	Jan-Sept	April-Sept	May-Jan			488	
Pahole	April-Aug	April-Sept	July-Oct			196	

*There are 31-865 seeds per fruit. Calculations are an average from all collections made in each Population Unit.

**Smith, T.B., L.A. Freed, J.K. Lepson, J.H. Carothers. 1995. Evolutionary Consequences of Extinctions in Populations of a Hawaiian Honeycreeper. Conservation Biology 9: 1, 107-113.

Lammers, T.G. & C.E. Freeman. 1986. Ornithophily among the Hawaiian Lobelioideae (Campanulaceae): Evidence from nectar sugar compositions. American Journal of Botany 73: 1613-1619.

Known distribution: *C. longiflora* has been recorded in both the Waianae and Koolau ranges on Oahu. It is currently known from three general areas in the Waianae range spanning from Pahole to Makaleha to Makaha. Historical points in the Koolau range, dating as far back as the late 1800's, span Palolo to Helemano, but *C. longiflora* hasn't been observed in the Koolau range for almost a century. *C. longiflora* occurs in mesic to wet forest at elevations ranging from 645-836 m (2120-2740ft.)

Figure 2. Map 1. Current and Historical Populations of *C. longiflora* on Oahu.

Table 2. Selected Historic Collections of *C. longiflora* (Bishop Museum Records)

Area	Year	Collector	Population Unit	Notes
Honolulu Harbor	1869	Wawra, H.		Field site unknown
Konahuanui	1884	Lydgate, J.M.		
Makaha Valley	1918	Rock, J.F.C.	Makaha and Waianae Kai	
Makaleha	1918	Rock, J.F.C.	Kapuna to West Makaleha	
Waianae Valley	1951	Loring	Makaha and Waianae Kai	
Pahole	1978	Kimura, B.	Pahole	

Table 3. Population Units for *C. longiflora*. Includes Current and Proposed Management Designations for all populations. MFS = Manage for Stability; GS = Manage for Genetic Storage. MMR = Makua Military Reservation; SBW = Schofield Barracks West Range. See Population Structure and Management Discussion sections below for discussion on proposed changes.

Population Unit	Management Designation	PU Type	Action Area	Management Units for Threat control
Kapuna to West Makaleha	MFS	*In situ* and Reintro	MMR	Kapuna Upper Makaleha West
Makaha and Waianae Kai	MFS	*In situ* and Reintro	None	Makaha II
Pahole	MFS	*In situ* and Reintro (Proposed)	MMR	Pahole

Map removed to protect rare resources

Figure 3. Map 2. Populations of *C. longiflora* in the Northern Waianae Mountains.

Habitat: *C. longiflora* is found in both mesic and wet forests. The majority of plants are found on north facing slopes and range in location from lower slope to the top of upper slopes. Plants found in mesic vegetation and on moderate slopes tend to have intermediate canopy cover, while plants found on steeper slopes favor a closed canopy that is comprised of more native species. A mix of native grasses, shrubs, and trees comprise the general habitat of the mesic and wet forest containing *C. longiflora*. However, like most rare plant habitat, these native patches face encroachment from alien species.

Table 4. Habitat characteristics of each Population Unit. Average Annual Rainfall data is from the Rainfall Atlas of Hawaii (Giambelluca et al. 2013). All other data from OANRP observations.

Population Unit	Population Reference Codes	Elev. (ft.)	Slope	Canopy Cover	Topography	Aspect	Average Annual Rainfall (mm)
Manage for Stability Population Units							
Kapuna to West Makaleha	LEH-A, B; PIL-B, C, F	2140-2740	Moderate - Vertical	Intermediate-Closed	Lower Slope-Upper Slope	N	1681
Makaha and Waianae Kai	MAK-B; WAI-A	2400 - 2520	Moderate	Intermediate	Upper Slope	N	1698
Pahole	PAH-A, H, I	2120-2370	Moderate-Steep	Intermediate-Closed	Lower Slope-Upper Slope	N	1582

Table 5. List of Associated Species (six letter code = first three letters of genus, followed by first three letters of species) for each Population Unit for both canopy and understory. Species observed by OANRP staff are listed in alphabetical order.

Population Unit	Population Reference Codes	Canopy	Understory
Kapuna to West Makaleha	LEH-A, B; PIL-B, C, F	AcaKoa, AlySte, AntPla, BidTor, BobEla, BroArg, BudAsi, ChaObo, ChaTom, CibCha, CibGla, CopFol, CyrDen, CopFol, DioHil, GreRob, GynTri, IleAno, Kadaff, MetPol, MetTre, PerSan, PipAlb, PisSan, PisUmb, PlaSan, PsiCat, PsiGua, PsyMar, PsyOdo, Schter, WikOahOah XylHaw	AdiRad, AdeCon, AgeAde, AlySte, AntPla, AspAcu, AspMac, AthMic, BidTor, BleApp, CarWah, CibCha, CliHir, CycPar, CopFol, CycDen, DepPet, Diclin, DipSan, Dodvis, DooKun, DryFus, DryGla, KadAff, LanCam, MelOah, MetTre, MicStr, NepBro, NepExaHaw, OplHir, PasCon, PepMem, PisSan, Psicat, PsiGua, RubRos, SchTer, SphChi, StaAus, VerLit, VioCha, VanDav, WikOahOah
Makaha and Waianae Kai	MAK-B; WAI-A	AcaKoa, AntPla, BobEla, CibCha, DodVis, GreRob, KadCor, Metpol, NesSan, Psicat, Syzsan, XylHaw	AlySte, Bidtor, BleApp, CarWah, CibCha, Clihir, CopFol, CyaAcu, DicLin, DodVis, DooKun, EupMul, KadAff, NepBro, PlaCorDec, PsiCat, PsyMar, RubArg, VioCha, WikOahOah
Pahole	PAH-A, H, I	AcaKoa, AntPla, BobEla, CibCha, CibGla, CyrDen, GreRob, IleAno, KadAff, MelPed, MelPol, PlaSan, PsiCat, PsiGua, PsyHat, PsyMar, SchTer, VioCha, XylHaw	AlySte, AntPla, AspCau, AspMac, AspNid, AthMic, BidAlb, BidTor, BleApp, CarWah, CibCha, CibGla, CliHir, CopFol, CopLon, CycPar, CyrDen, DepMar, DicLin, DooKun, DryGla, EupMul, FreArb, KadAff, MelMin, MicStr, NepExaHaw, OdoChi, PsiCat, RubRos, Schnut, WikOahOah

Figure 4. *C. longiflora* development from seedlings to immature plants, displayed left to right.

Figure 5. Phenotypic variation among *C. longiflora* mature plants.

Figure 6. Flower shape and distribution along the stem for *C. longiflora*.

Figure 7. *C. longiflora* fruit development and maturity. Immature fruit is generally yellow and matures to an orange-purple color. Top left picture shows size of seeds (yellow circle) in relation to the fruit.

Taxonomic background: *C. longiflora* is endemic to the island of Oahu, and was formerly known as *Rollandia longiflora*. The species was historically found across both the Koolau and Waianae Mountain Ranges. Some historic populations in the Koolau Mountains have since been described as a separate species, *C. sessilifolia*. Currently managed populations are restricted to Waianae Mountains, and range from Pahole to Makaha to Makaleha. Although there are some phenotypic variation in plants, no genetic studies have been undertaken to determine if genetic separation exists between different population units.

Population Structure and Trends: Shortly after the finalization of the Makua Implementation Plan, the total number of mature plants plummeted from about 180 plants to just 60 in the span of three years. However, since 2003, the total number of mature *in situ* plants has remained fairly stable, increasing in the Pahole PU, while a slight decline occurred in Kapuna to West Makaleha PU. Population structure for *C. longiflora* is relatively weak. OANRP staff have observed seedlings in only three of nine Population Reference Sites. With the exception of 2014, when over 70 seedlings were observed across the Pahole PU, less than 20 seedlings have been seen since, and similar numbers observed across the remaining PUs. The high number of seedlings found in 2014 was the result of increased monitoring, however, many of the seedlings did not survive to the following year. The low number of seedlings observed in the Pahole PU since 2014 is surprising, since molluscicide has been used to control slug predation of developing seedlings. Rat damage to stems has also been observed across populations, and may contribute to a lack of seedling establishment and a decrease in overall plant numbers (Figure 12). While few seedlings were observed during monitoring, some seedlings are expected to have survived, as fruit has been observed on mature plants at all PUs, and the number of immature plants has remained stable or increased across all PUs. Reintroductions in the Kapuna to West Makaleha PU and the Makaha and Waianae Kai PU have resulted in an increase in the total number of immature and mature plants. However, a limited number of seedlings have been observed in these reintroduction sites.

Population Trends

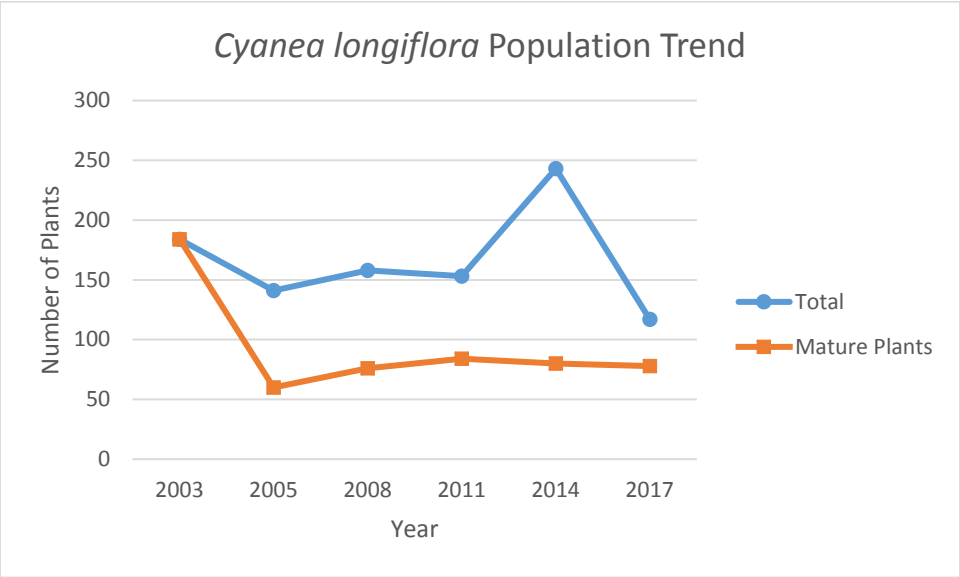

Figure 8. Overall combined total number of *in situ* plants compared with mature in situ plants only for all PUs.

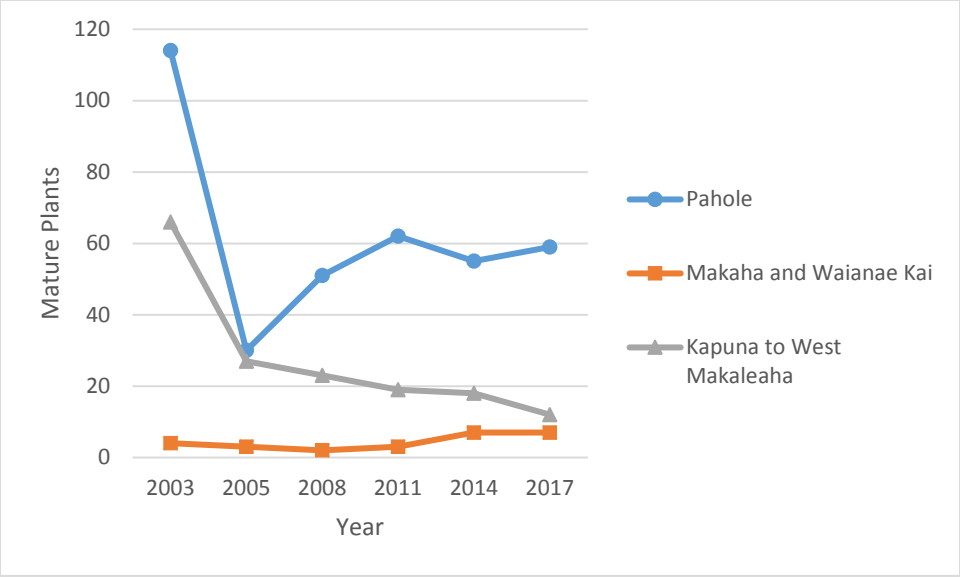

Figure 9. Number of *in situ* mature plants separated by PU.

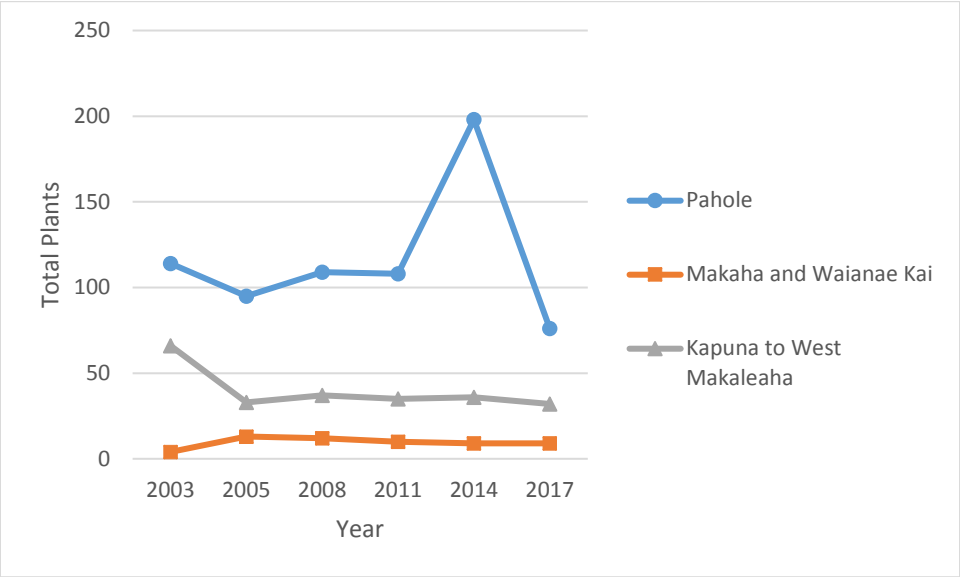

Figure 10. Total number of *in situ* plants separated by PU.

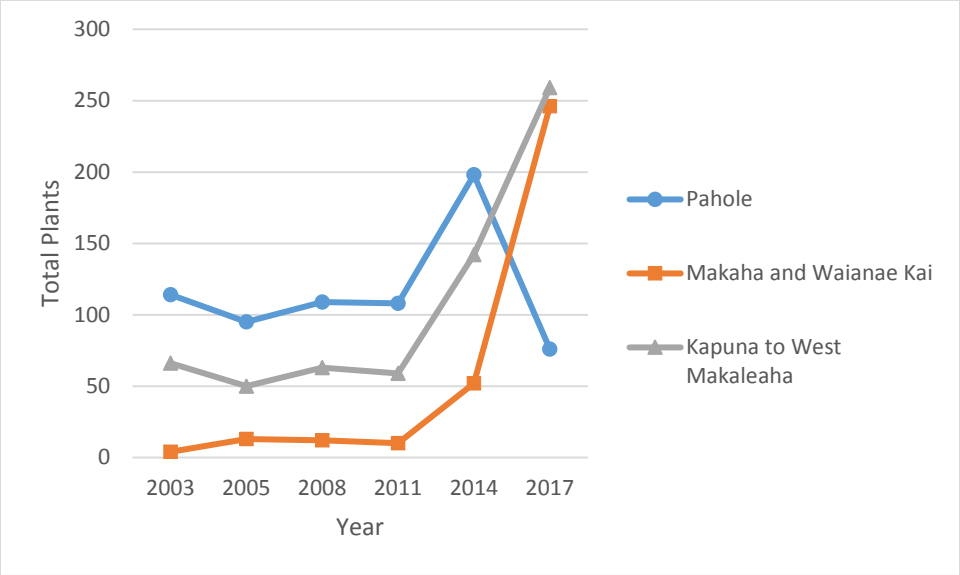

Figure 11. Total number o*f wild* and reintroduced plants separated by PU.

Figure 12. Rat damage observed on stems of *C. longiflora* in Pahole PU.

Current status:

The known population units of *C. longiflora* in the Waianae Mountains totals 581 plants, consisting of mature and immature plants, and seedlings. About 30% of this total is represented by *wild* plants, and the remaining 70% from reintroduced populations. Currently, only one PU (Makaha and Waianae Kai) has more than 75 reproducing individuals. While the total number of mature plants in the Pahole PU has steadily increased over time since 2005, a lack of seedling development and immature plant survival has led to a decrease in overall plant numbers in the PU. The threat of fire is highest for the Makaha and Waianae Kai PU and Pahole PU. Fire damage has been observed in the Makaha and Waianae Kai PU in the past and lead to a decrease in mature plants post-fire (Figure 13). With the addition of reintroduction sites from 2013-2015, plant numbers have increased and are expected to remain stable based on high plant survival following reintroduction.

Figure 13. Mature *C. longiflora* plants damaged by fire at the Makaha and Waianae Kai PU.

STABILIZATION EFFORTS

The following section uses the above information, plus additional information we have learned about this taxon, to determine appropriate stabilization efforts for the next five years (July 2017 – June 2022). The following actions are requirements for stabilization:

- **3 Populations (PU)**
- **75 reproducing individuals in each population**
- **Threats controlled**
- **Stable population structure**
- **Complete genetic representation in storage**

Population Units: Three Manage for Stability Population Units (MFS PU) are required for this taxon as it is found in the Makua Action Area. All PUs are MFS, as there are no Genetic Storage Population Units.

Table 6. Stabilization Goal Status

	PU Stability Target			**MU Threat Control**				Genetic Storage
Population Unit	75 reproducing plants	Stable Population Structure	Ungulate	Slugs	Rodent	Fire	Weeds	% Completed
Kapuna to West Makaleha	No	No	Yes	No	Partial	Yes	Yes	77%
Makaha and Waianae Kai	Yes	No		No	Yes		Yes	40%
Pahole	No	No		Yes	No		Yes	96%

Outplanting considerations from 2003 MIP: "*Cyaneas* and *Cyanea* relatives potentially occurring with or near *C. longiflora* in the Waianae Mountains include *C. grimesiana* subsp. *obatae*, *C. superba* subsp. *superba*, *C. angustifolia*, *C. membranacea*, *C. calycina*, *C. acuminata*, *Delissea waianaensis*, and the *Clermonitias; C. persicifolia* and *C. kakeana*. It is common to find several *Cyanea* species and *Cyanea* relatives growing together, yet to date there is no good evidence of hybridization occurring between species of *Cyanea* or between a Cyanea and *Delissea* or *Clermontia* species. Consequently, concerns are minimal with respect to the possibility of inadvertently allowing unnatural hybridization to occur through the outplanting of *C. longiflora*. Additionally, *C. longiflora* has never been found in the southern Waianae Mountains and consequently, that region is not considered to be a part of *C. longiflora's* natural range. An outplanting line has been drawn across the mid-section of the Waianae Mountains restricting potential reintroduction sites to the northern Waianae Mountains. Reintroduction to the Koolau Mountains should not be considered unless Koolau plants are rediscovered."

Figure 14. Map 3. Outplanting considerations for *C. longiflora* from 2003 Makua Implementation Plan

Current Outplanting considerations and plan: There have been four outplantings of *C. longiflora*. Three of these have been in the Kapuna to West Makaleha PU, and one in the Makaha and Waianae Kai PU. The Kapuna to West Makaleha PU outplantings began in 2005, located at 3-Points (LEH-B), followed by two separate locations in Keawapilau (PIL-E and PIL-F). The lone outplanting in the Makaha and Waianae Kai PU was an augmentation in Makaha (MAK-B). The 3-Points (2005) and Keawapilau PIL-E (2008) reintroductions are the oldest plantings, and as such, have the lowest survival rate at 27%. Important to note is that these outplantings consisted of founders from single PUs, while later outplantings consisted of mixture of founders from all three PUs. In contrast, more recent outplantings at Makaha (2013) and

Keawapilau PIL-F (2013), showed higher survival rates at 60% and 55%, respectively. However, initial outplanting survival (first 3 years) for all reintroductions is comparable (Figure 15). Survival data shows that founder stock from Pahole PU had the highest outplanting survival compared to founder stock from the other two PUs in the mixed-founder outplantings (Figures 16). Of note is that in the Keawapilau PIL-E outplanting, only 1 of 91 outplants from 2013 survived, while over 60% of outplants from 2014 have survived. The 2014 outplanting at this site included individuals from Pahole and Kapuna founders, while the 2013 outplanting was restricted to Keawapilau founders. These results indicate success of reintroductions may not only be restricted to location, but also the founder stock. The Kapuna to West Makaleha PU also has shown a decline in mature *in situ* plants over the past 10 years, while Pahole PU has shown an increase in mature plants.

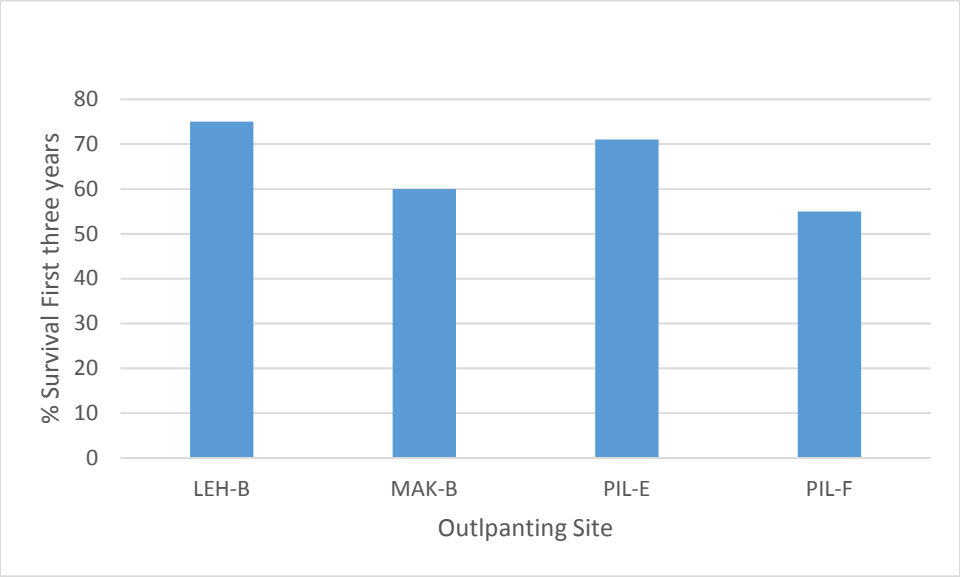

Figure 15. Initial outplanting survival in first three years post-planting.

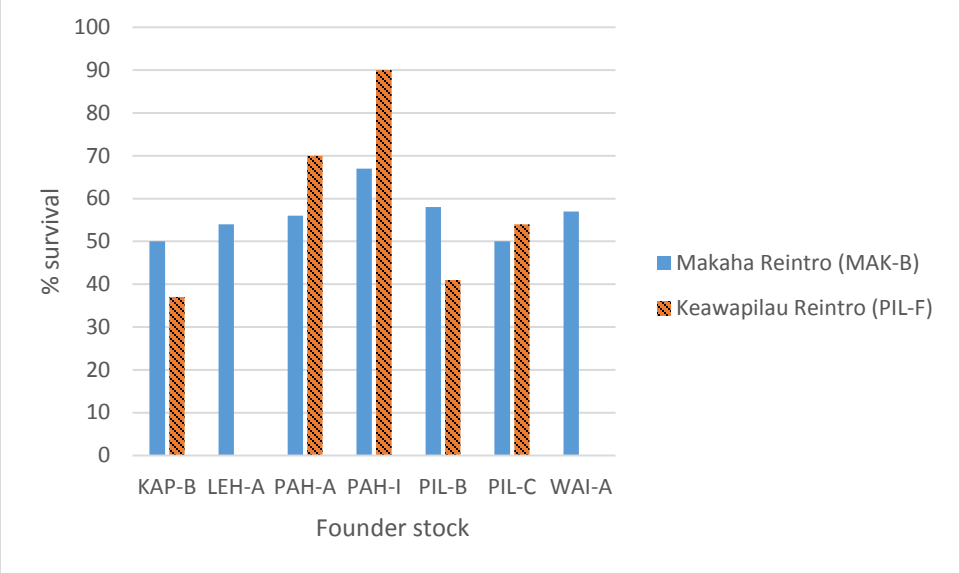

Figure 16. Outplanting survival of individuals separated by founder plant PU
(Note: LEH-A and WAI-A founder stock not used in Keawapilau PIL-F reintroduction)

Figure 17. Reintroduction of *C. longiflora*

Reintroduction Plan

The proposed outplanting sites are designed to meet the stability goal for the number of reproducing individuals, as currently only one meets this goal.

We plan to monitor the newer Makaha (MAK-B) and Keawapilau (PIL-F) reintroduction sites to see how they perform over the next two years before making additional plantings to these sites. Both sites have shown an increase in immature plants, and as they mature, both of these PUs should reach stability goals, barring unexpected die-off. We recognize that the Pahole PU will need to be augmented to reach that PU's stability goal, and propose to proceed with augmentation over a three year timeframe to develop population structure into the site. As the Pahole *in situ* stock appears to be the healthiest, we should pursue site selection and proceed with a single source outplanting in this PU. Additionally, this stock has the most overall founders of all PUs and highest outplanting survival at previous outplanting sites, so it may also be beneficial to incorporate more Pahole founders into outplantings at other PUs in the future. The Pahole population is lower in elevation than other sites, but in a similar rainfall range with the majority of sites. It will also be important to determine the impact of drought on the ability for a plant to survive outplanting, and choose sites accordingly. Initial plant survival and outplanting survival over time suggest that previous outplantings at non-Pahole PUs may be sufficient to produce enough reproducing individuals to meet stabilization goals. Site selection for Pahole augmentation will be critical, as the current *in situ* population is in a native, sensitive habitat, and should not be disturbed during outplanting. The proposal is for 300 total outplants, and is based on data from reintroductions in 2005 and 2008, showing 27% of outplants reaching maturity. Given this rate of survival to maturity, 300 outplants should yield a sufficient number of reproducing mature plants to meet the stabilization goals for the Pahole PU.

Table 7. Current and Proposed Outplantings of *C. longiflora* to meet stabilization goal of 75 reproducing individuals per Population Unit (PU). The propagule type for each planting will be immature plants grown from seeds collected from wild or outplanted plants. An asterisk (*) indicates outplantings that have not yet been initiated. Note: We know how many mature plants are currently at population reference sites, but we recognize that the number of actively reproducing individuals (a requirement for stability) would likely be lower than the total number of mature plants.

Population Unit	Reintroduction Site(s)	Number of Plants Outplanted	Existing Mature Plants in PU	Propagule Population(s) Source
Kapuna to West Makaleha	LEH-B PIL-E PIL-F	36 11 334	61	LEH-A PIL-B/ PIL-C KAP-B/ PAH-A/ PAH-I/ PIL-B/ PIL-C/ PIL-D
Makaha and Waianae Kai	MAK-B	385	116	KAP-B/ LEH-A/ PAH-A/ PAH-B/ PAH-H/ PAH-I/ PIL-B/ PIL-C/ PIL-D/ WAI-A
Pahole	PAH-J*	300 total* (100/year)	59	PAH-A/ PAH-B/ PAH-H/ PAH-I

Threats: The primary threats to *C. longiflora* that were known at the time the Makua Implementation Plan was finalized (2003) included feral pigs and goats. All populations are currently in ungulate-free fenced areas, which are monitored for damage from treefall and potential ungulate ingress under fences due to erosion. Various alien plant species threaten *C. longiflora* by altering its habitat and competing with it for sunlight, moisture, nutrients, and growing space. Also, the spread of highly flammable alien grasses increases the potential for incidence and destructiveness of wildfires. Weed control is essential to maintain reproducing populations and continued recruitment of immature plants. However, care must be taken not to alter native habitat in steeper terrain where *C. longiflora* occurs. Predation of plants and seedlings by rodents and slugs has been documented, and have had a negative effect on seedling survival and plant development. Rats have girdled plants in many MUs, and slugs have been seen on seedlings. Rat and slug control has been initiated in many populations where native snails are absent, however, results from these threat control methods have been limited to few seedlings and immature plants. Fungal pathogens are not currently an issue with this species but should be monitored for any potential impacts. Long-billed, nectar-feeding native Hawaiian birds, which are the presumed pollinators of *C. longiflora*, have been totally eliminated from the taxon's historic range in Waianae Mountains. OANRP would like to identify effective pollinators and dispersers and investigate whether or not there are other sites on Oahu where pollinators and fruit dispersers are more abundant. We will continue to assess how these threats are impacting population stability as we monitor the populations, and the effects of rat predation and climate change on population survival is unknown.

Genetic Storage Plan

Besides collections of fruit made for genetic storage and propagation, all other fruit has been left to mature on the plants. The fruit not eaten by rats was left to senesce and fall below the plants where new regeneration has been observed. Fruit at some PUs have been hand-dispersed by OANRP staff while conducting work in the area via smearing fruits across various substrates, although results were limited to a few seedlings, and it was unclear if these were from fruit smears or natural germination of fruit falling to the ground.

Table 8. Action plan for how to maintain genetic storage representation, and provide propagules for reintroduction, for *C. longiflora*

What propagule type is used to meet genetic storage goals?	What is the source for the propagules?	What is the Genetic Storage Method used to meet the goal?	What is the proposed re-collection interval for seed storage?	Is seed storage testing ongoing?	Plan for maintaining genetic storage
Seeds	*in situ* & outplantings	Collecting infructescences	10 years	Yes	Collect seeds and maintain reintroductions for re-collecting

Management discussion

The primary strategy for this taxon for the next five years will be to collect fruit from wild and reintroduction sites to meet genetic storage goals and for propagation of outplants for Pahole PU. Pahole PU will need reintroductions in order to achieve goals for mature plant numbers. Management efforts will also include monitoring as well as seed collections from diverse founders to store for future outplanting as needed The remaining PUs' management will focus on monitoring and collecting from wild and reintroduced plants over the next few years to meet genetic storage goals as well as increase the number of founders available if additional outplantings are needed at established populations. Collections will be prioritized in the next few years to secure genetic storage of the remaining unrepresented founders for all PUs. OANRP will use results from *in situ* monitoring to finalize timeline, stock, and locations for the next reintroductions. In order to establish restoration sites that become stable, the following should be considered to improve plant survival and reproduction.

Habitat site selection (large scale and micro-site locations): OANRP proposes selecting a new introduction site for the Pahole PU. Habitat and micro-site conditions that promote recruitment and stage class transitions to immature and mature plants should be prioritized. New outplanting sites should take into account the effects of climate change and drought, as well as weed control strategies, for long-term survival and reproduction.

Lack of pollinators: OANRP could conduct pollinator observations to determine if certain sites have more visitation than others, or if areas have more potential pollinators than others. Fruit set in most populations seems to be adequate for reproduction, given the high amount of seed per propagule. However, focusing on rodent and slug control should be prioritized instead.

Fruit Dispersal: OANRP could support ongoing fruit disperser research to identify species and quantify fruit dispersal. Human-assisted fruit dispersal has been done in the past opportunistically, however, OANRP could conduct trials to better determine how efficient this method is at increasing seedling abundance.

Threat Control: OANRP will review ongoing threat control methods for rodents and slugs to determine if increased efforts or alternative methods could have a positive effect on recruitment. Dieback of some outplants has been observed recently and the cause has been undetermined. Root rot may have led to insect infestations which damaged the stem and leaf tops of the plants, however, this is speculative and the exact cause is unknown. Plant disease and insect threats should be monitored to determine their impacts if additional dieback is observed in the future. All outplantings are contained in fences to control ungulates, have weed and rat control, and receive slug control if rare native snails are not present. Increased frequency and time spent on control methods may be necessary in the future if natural recruitment and goals for population structure are not met.

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