Species Report for *Sicyos macrophyllus* (ʻānunu)
Version 1.0

Sicyos macrophyllus plant with fruit. Photo
Credit: Forest and Kim Starr, Starr Environmental.

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U.S. Fish and Wildlife Service (USFWS). 2022. Species Report for *Sicyos macrophyllus* (ʻanunu). Pacific Islands Fish and Wildlife Office, Pacific Islands Interior Region 12, Portland OR. 30 pages.

EXECUTIVE SUMMARY

This Species Report for *Sicyos macrophyllus*, was completed to assess the species' overall viability. To assess viability we used the three conservation biology principles of resiliency, representation, and redundancy. We identified the species' ecological requirements for survival and reproduction at the individual, population, and species levels, and described risk factors influencing the species' current condition.

Sicyos macrophyllus (ʻānunu) is a perennial vine in the gourd family (Cucurbitaceae) that once occurred on Maui and Hawaiʻi but is currently only found on the island of Hawaiʻi (Telford 1999, p. 587; Wagner and Shannon 1999, p. 444). This species is found in wet shrubland, mesic forest and shrubland, and dry forest habitats, on the windward slope of the Kohala Mountains, Mauna Kea, and the Mauna Loa - Mauna Kea Saddle (HBMP 2010). Currently, there are 11 populations on the island of Hawaiʻi, located in Hawaiʻi Volcanoes National Park (HAVO), the Hakalau National Wildlife Refuge Kona Unit (Hoʻokena population), and on state managed lands of Puʻu waʻawaʻa (PWW), ʻAinahou, Waiākea Upper, Kukuiopaʻe, and Paʻauilo.

The main threats to *Sicyos macrophyllus* are herbivory by rats, habitat modification and destruction and herbivory by feral ungulates, habitat modification and competition by nonnative plants, habitat modification and destruction by human disturbances and military activities, fire, lack of regeneration, small number of individuals and populations, climate change, and inadequate regulatory mechanisms (USFWS 2016a, p. 67808; USFWS 2020b, p. 12). Conservation actions include storage of seeds, propagation of plants from several populations from Pōhakuloa Training Area (PTA), PWW, and HAVO, and translocation of 45 individuals by HAVO staff (NTBG 2013; PWW 2017; Volcano Rare Plant Facility (VRPF) 2013, 2014, 2016, 2017, 2018; HAVO 2007, 2012, 2013, 2014, 2016, 2019; CEMML 2020).

We define resiliency as a population that has enough reproduction and regeneration to maintain or increase the numbers of individuals in the population giving the population the ability to withstand stochastic disturbance events. We can measure resiliency for *Sicyos macrophyllus* based on the metric of population size in a diversity of good quality and quantity of habitat. Redundancy is having more than one resilient population distributed across the landscape increasing the ability of a species to withstand catastrophic events. We evaluated redundancy for *S. macrophyllus* based on the metrics of the number of populations, resilience of populations, and the distribution of the species across its range. Representation is defined as genetic and ecological diversity secured throughout multiple populations across the range of the species. We can measure representation based on the genetic diversity and habitat variation within and among populations.

Currently, an estimate of 37 to 140 known individuals of *Sicyos macrophyllus* exist in the wild. Seeds representing several individuals are stored at PTA, PWW, HAVO, Volcano Rare Plant Facility (VRPF), and the National Tropical Botanical Garden (NTBG). Propagated plants occurred at PWW, HAVO, and VRPF nurseries. Forty-five individuals were translocated by HAVO staff in 2007; one individual remains as of 2019. In the current condition, the overall viability of this species is very low, as we evaluated resiliency, redundancy, and representation as very low.

TABLE OF CONTENTS

List of Tables

List of Figures

INTRODUCTION

Sicyos macrophyllus (ʻānunu) is a perennial vine in the gourd family (Cucurbitaceae) that once occurred on Maui and Hawaiʻi but is currently only found on the island of Hawaiʻi (Telford 1999, p. 587; Wagner and Shannon 1999, p. 444). This species is found in wet shrubland, mesic forest and shrubland, and dry forest habitats, on the windward slope of the Kohala Mountains, Mauna Kea, and the Mauna Loa - Mauna Kea Saddle. Historically, this species was also found in wet forest and dry shrubland habitats (HBMP 2010). When this species was listed as endangered in 2016 (USFWS 2016a, pp. 67786–67860) *S. macrophyllus* was known at ten occurrences totaling between 24 and 26 individuals on the island of Hawaiʻi (Bio 2008, pers. comm.; Pratt 2008, in litt.; HBMP 2010; Evans 2015, in litt.; Orlando 2015, in litt.). The individual on Maui has not been observed since 1987 (HBMP 2010). Currently, there are eleven populations on the island of Hawaiʻi; they are located at the Hawaiʻi Volcanoes National Park (HAVO), the Hakalau National Wildlife Refuge Kona Unit (Hoʻokena population), and on state managed lands of Puʻu waʻawaʻa (PWW), ʻAinahou, Waiākea Upper, Kukuiopaʻe, and Paʻauilo. Hawaiian Islands Dry Forest habitat status assessment (Javar-Salas et al. 2020, entire), the Hawaiʻi Dry Grasslands and Shrubland habitat status assessment (Peʻa et al. 2020, entire), the Hawaiʻi: Mesic Forests habitat status assessment (Lowe et al. 2020, entire), the Hawaiʻi: Mesic Grasslands and Shrublands habitat status assessment (Ball et al. 2020, entire), Hawaiian Islands Wet Forest habitat status assessment (Clark et al. 2020, entire), and Hawaiʻi: Wet Grasslands and Shrublands habitat status assessment (Nelson et al. 2020, entire) should be referred to for further description and discussion on dry forest, dry shrubland, mesic forest, mesic shrubland, wet forest, and wet shrubland and the threats to these habitats on Maui and Hawaiʻi.

Species Report Overview

This Species Report summarizes the biology and current status of *Sicyos macrophyllus* and was conducted by Pacific Islands Fish and Wildlife Office. It is a biological report that provides an in-depth review of the species' biology, factors influencing viability (threats and conservation actions), and an evaluation of its current status and viability.

The intent is for the Species Report to be easily updated as new information becomes available, and to support the functions of the Service's Endangered Species Program. As such, the Species Report will be a living document and biological foundation for other documents such as recovery plans, status in biological opinions, and 5-year reviews.

Regulatory History

Sicyos macrophyllus was listed as endangered under the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), as amended (ESA) on September 30, 2016 (USFWS 2016a (81 FR 67786–67860)). The recovery outline for the Hawaiian multi-island species was published on August 3, 2020 and includes *S. macrophyllus* (USFWS 2020b). All federal regulatory information can be found at the following link: https://ecos.fws.gov/ecp/species/2768

Methodology

We used the best scientific and commercial data available to us, including peer-reviewed literature, grey literature (government and academic reports), and expert elicitation. To the best of our ability we use the current taxonomy at the time this report was drafted.

To assess the current status and viability of *Sicyos macrophyllus*, we identified population units. The classic definition of a population is a self-reproducing group of conspecific individuals that occupies a defined area over a span of evolutionary time, an assemblage of genes (the gene pool) of its own, and has its own ecological niche. However, due to information gaps, we could not assess the viability of *S. macrophyllus* using this definition. The Hawaiʻi and Pacific Plants Recovery Coordinating Committee (HPPRCC) revised its recovery objectives guidelines in 2011 and included a working definition of a population for plants: "a group of conspecific individuals that are in close spatial proximity to each other (i.e., less than 1,000 meters apart), and are presumed to be genetically similar and capable of sexual (recombinant) reproduction" (HPPRCC 2011, p. 1).

Based on this working definition, maps were created to display population units. In an effort to protect the sensitivity of species data, we created maps with symbol markers rather than displaying species points or polygons. We created the symbols in steps. First, we added a 500-meter buffer around each individual species point and polygon. We then dissolved all buffer areas intersecting each other into a single shape. Next, we created a centroid (i.e., point representing the center of a polygon) within each dissolved buffer area. The symbol marker represents the centroid. Finally, the Disperse Marker tool in ArcGIS Pro was used shift symbol markers that were overlapping so they would all be visible at the scale of the map. All points and polygons were used in this process, regardless of observation date or current status (historical, current, extant, or extirpated), to represent the known range of the species.

Species Viability
The Species Report assesses the ability of *Sicyos macrophyllus* to maintain viability over time. Viability is the ability or likelihood of the species to maintain populations over time, i.e., likelihood of avoiding extinction. To assess the viability of *S. macrophyllus*, we used the three conservation biology principles of resiliency, redundancy, and representation, or the "3Rs" (Figure 1; USFWS 2016b, entire). We will evaluate the viability of a species by describing what the species needs to be resilient, redundant, and represented, and compare that to the status of the species based on the most recent information available to us.

Definitions
Resiliency is the capacity of a population or a species to withstand the more extreme limits of normal year-to-year variation in environmental conditions such as temperature and rainfall extremes, and unpredictable but seasonally frequent perturbations such as fire, flooding, and storms (i.e., environmental stochasticity). Quantitative information on the resiliency of a population or species is often unavailable. However, in the most general sense, a population or species that can be found within a known area over an extended period of time (e.g., seasons or years) is likely to be resilient to current environmental stochasticity. If quantitative information is available, a resilient population or species will show enough reproduction and recruitment to maintain or increase the numbers of individuals in the population or species, and possibly expand the range of occupancy. Thus, resiliency is positively related to population size and growth rate, and may also influence the connectivity among populations.

Redundancy is having more than one resilient population distributed across the landscape, thereby minimizing the risk of extinction of the species. To be effective at achieving redundancy, the distribution of redundant populations across the geographic range should exceed the area of impact of a catastrophic event that would otherwise overwhelm the resilient capacity of the populations of a species. In the report, catastrophic events are distinguished from environmental stochasticity in that they are relatively unpredictable and infrequent events that exceed the more extreme limits of normal year-to-year variation in environmental conditions (i.e., environmental stochasticity), and thus expose populations or species to an elevated extinction risk within the area of impact of the catastrophic event. Redundancy is conferred upon a species when the geographic range of the species exceeds the area of impact of any anticipated catastrophic event. In general, a wider range of habitat types, a greater geographic distribution, and connectivity across the geographic range will increase the redundancy of a species and its ability to survive a catastrophic event.

Representation is having more than one population of a species occupying the full range of habitat types used by the species. Alternatively, representation can be viewed as maintaining the breadth of genetic diversity within and among populations, in order to allow the species to adapt to changing environmental conditions over time. The diversity of habitat types, or the breadth of the genetic diversity of a species, is strongly influenced by the current and historic biogeographical range of the species. Conserving this range should take into account historic latitudinal and longitudinal ranges, elevation gradients, climatic gradients, soil types, habitat types, seasonal condition, etc. Connectivity among populations and habitats is also an important consideration in evaluating representation.

The viability of a species is derived from the combined effects of the 3Rs. A species is considered viable when there are a sufficient number of self-sustaining populations (resiliency) distributed over a large enough area across the range of the species (redundancy) and occupying a range of habitats to maintain environmental and genetic diversity (representation) to allow the species to persist indefinitely when faced with annual environmental stochasticity and infrequent catastrophic events. Common ecological features are part of each of the 3Rs. This is especially true of connectivity among habitats across the range of the species. Connectivity sustains dispersal of individuals, which in turn greatly affects genetic diversity within and among populations. Connectivity also sustains access to the full range of habitats normally used by the species, and is essential for re-establishing occupancy of habitats following severe environmental stochasticity or catastrophic events (see Figure 1 for more examples of overlap among the 3Rs). Another way the three principles are inter-related is through the foundation of population resiliency. Resiliency is assessed at the population level, while redundancy and representation are assessed at the species level. Resilient populations are the necessary foundation needed to attain sustained or increasing representation and redundancy within the species. For example, a species cannot have high redundancy if the populations have low resiliency. The assessment of viability is not binary, in which a species is either viable or not, but rather on a continual scale of degrees of viability, from low to high. The health, number and distribution of populations were analyzed to determine the 3Rs and viability. In broad terms, the more resilient, represented, and redundant a species is, the more viable the species is. The current understanding of factors, including threats and conservation actions, will influence how the 3Rs and viability are interpreted for *Sicyos macrophyllus.*

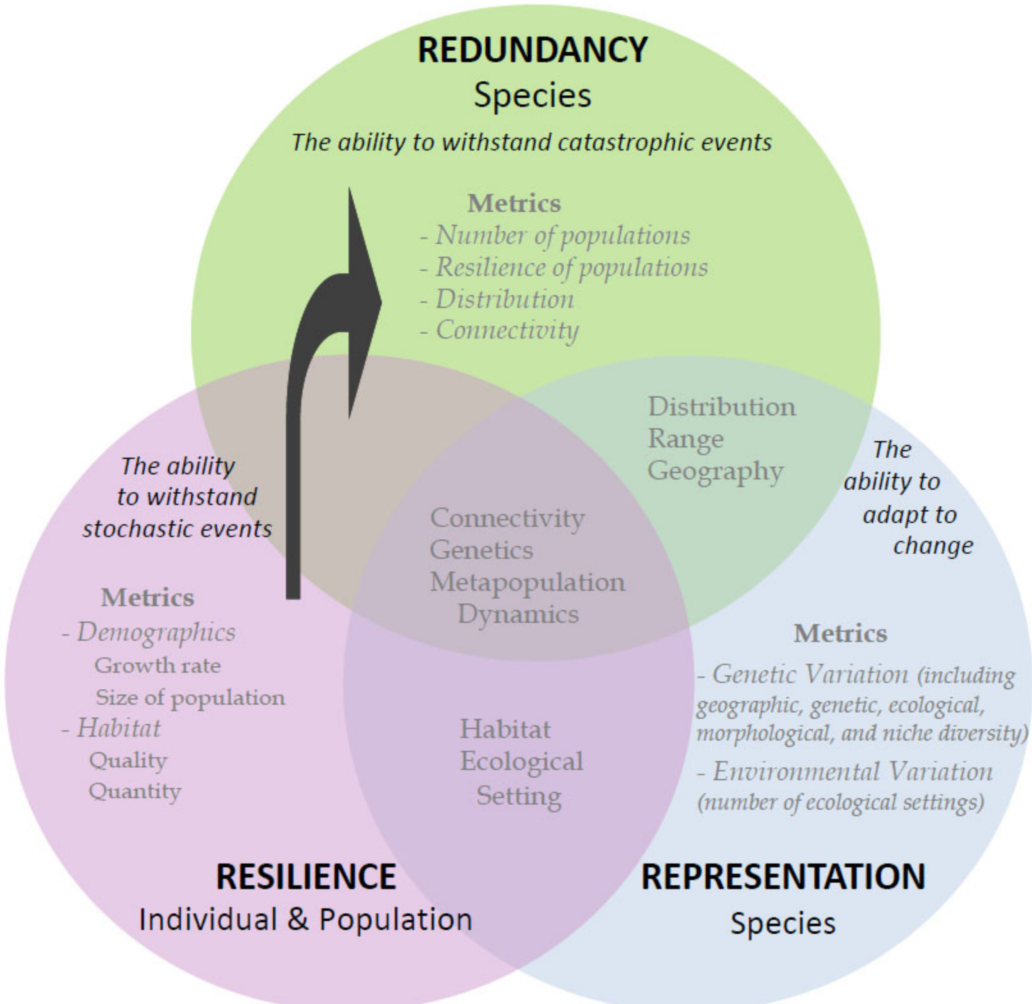

Figure 1. The three conservation biology principles of resiliency, redundancy, and representation, or the “3Rs”.

SPECIES ECOLOGY

Species Description

Sicyos macrophyllus (‘ānunu) is a perennial vine in the gourd family (Cucurbitaceae) that is currently found on the island of Hawai‘i (Telford 1999, p. 587) (Figure 2). Stems may be up to 49 feet (ft) (15 meter [m]) long, 1.5 inch (in) (4 centimeter [cm]) in diameter, sparsely pubescent, glabrate, and black-spotted. Leaves are broadly ovate to cordate, 2.8 to 9.8 in (7 to 25 cm) long, 2.4 to 10 in (6 to 26 cm) wide, and shallowly to deeply 3–5-lobed. Staminate flowers are in sparsely to densely pubescent panicles, 3.1 to 9.8 in (8 to 25 cm) long. Corolla is a greenish yellow color, 5-lobed, and 0.2 in (4 to 5 millimeter (mm) in diameter. Fruit is green, ovoid, 0.5 to 0.7 in (13 to 18 mm) long, 0.2 in (4 to 6 mm) in diameter, 5–6-ribbed, minutely puberulent, and usually beaked (Telford 1999, p. 587).

Sicyos macrophyllus is monoecious with unisexual flowers of both genders on the same plant (USGS 2010, p. 101). This vine has an annual or sub-annual pattern of flowering. Male and female flower production peak twice a year in fall and spring, but flowering is also seen throughout the intervening winter months. During summer months plants produce virtually no buds or flowers. Male flowers were produced in greater abundance slightly earlier than female flowers. Fruit production is seasonal, showing an annual pattern with a peak in winter and no or little fruit production in late summer or early fall (USGS 2010, p. 95). Green, immature fruit as well as brown mature fruit were most abundant in the late spring and fall (USGS 2010, p. 82).

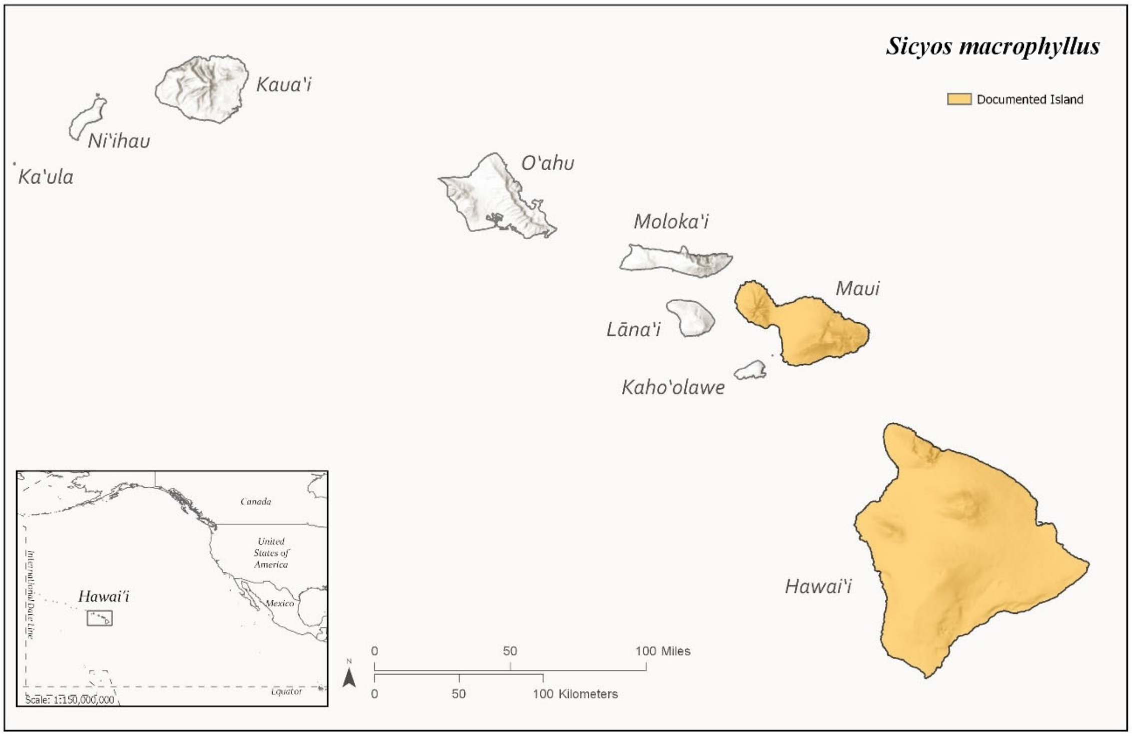

Figure 2. Map of Hawaiian Islands showing which islands *Sicyos macrophyllus* historically and currently occur.

Individual Needs

Little is known about the life stages (seed, seedlings, immature plants, and flowering plants) of *Sicyos macrophyllus*. Populations occur in habitats that recieve 24 to 268 in (612 to 6,810 mm) of annual rainfall and various level of sunlight, under open to closed canopies. Habitat temperatures range between 11 and 18 degree Celsius (HBMP 2010). Competition with other species (including native plants) and/or nonnative invasive species can limit seedlings, immature plants, and flowering plants from getting water, soil, and sunlight that they need.

In addition to the above habitat charactersitics, individuals of *Sicyos macrophyllus* occur in a wide range of habitat types, and were found between 2,415 to 7,415 ft (736 to 2,260 m) on flat to moderate slopes (0 to 37 percent slopes) in wet forest, wet shrubland, mesic forest, mesic shrubland, dry forest, and dry shrubland habitats on the islands of Maui and Hawaiʻi. *Sicyos macrophyllus* populations were found in closed *Acacia* (koa) -*Metrosideros* (ʻōhiʻa) forest and open *Chamaesyce olowaluana* (akoko) - *Sophora chrysophylla* (māmane) forest. Associated plants include *Myoporum sandwicense* (naio), *Rubus hawaiiensis* (ʻākala), *Coprosma* spp.

(pilo), *Myrsine* spp. (kōlea), *Pipturus* spp. (māmaki), and *Pteridium* spp. (kīlau) (HBMP 2010). We can assume that individuals of *S. macrophyllus* are adapted to these habitat characteristics to grow and become reproductive.

Several insects were observed visiting *Sicyos macrophyllus* individuals at Kīpuka Kī in 2006. They were all nonnative. These include *Allograpta exotica* (syrphid fly), *Apis mellifera* (honey bee), *Polistes aurifer* (golden paper wasp), *Nysius sp*. (seed bug), and an unknown species in the Phlaeothripidae family (thrips) (USGS 2010, pp. 79–80). All visitors were observed exclusively feeding on the nectar of both male and female flowers. During visits, smaller insect taxa crawled into the corolla while larger taxa straddled the flower and probed with their proboscis. The diminutive size and shallow corolla cup of a *S. macrophyllus* flower enabled frequent contact of insect body parts with either the anthers or the stigma when smaller insect taxa entered and exited the corolla and when larger insect taxa crawled from flower to flower in an inflorescence (USGS 2010, p. 81). Native pollinators are unknown.

Population Needs
Resiliency is interconnected, healthy populations across a diversity of good quality and quantity of habitat. A healthy population consists of abundant individuals within habitats of adequate area and quality to maintain survival and reproduction in spite of disturbance. To be resilient, *Sicyos macrophyllus* would need a large number of individuals in close proximity to ensure pollination (out-crossing) connectivity between populations, and enough suitable, healthy habitats to promote stable or increasing population growth and contain levels of genetic diversity to withstand stochastic events.

Suitability of the habitat types where *Sicyos macrophyllus* populations have occured has declined, based on the Habitat Status Assessments and changes in quality and quantity of the habitat types identified above. While wet forest habitat are relatively stable in size and quality, dry and mesic forest, and dry, mesic, and wet shrubland habitats are decreasing in size and quality due to the many threats influencing these areas (Ball et al. 2020, pp. 3–22; Clark et al. 2020, pp. 14–15; Javar-Salas et al. 2020, pp. 11–14; Lowe et al. 2020, pp. 8–22; Nelson et al. 2020, pp. 3–10, Pe‘a et al. 2020, pp. 9–10) as described below in the **FACTORS INFLUENCING VIABILITY** Section.

Species Needs and Ecology
In order for a species to be redundant and represented, it would need to have multiple resilient populations occurring throughout the known range of the species, representing all known ecological and genetic diversity.

Redundancy is having more than one resilient population distributed across the landscape, thereby minimizing the risk of extinction of the species, and therefore, the ability to withstand catastrophic events. We evaluate redundancy of *Sicyos macrophyllus* based on of the number of resilient populations and the distribution of those populations across the landscape; their proximity to one another. Historically, nineteen wild populations occurred on Maui and Hawai‘i. Currently, eleven extant populations for *S. macrophyllus* occur on Hawai‘i Island.
Representation is having more than one resilient population of a species occupying the full range of habitat types used by the species, therefore, the ability to adapt to change. We evaluated

representation of *Sicyos macrophyllus* on variation in the habitat conditions for each population. There are six distinct habitat types where this species had occurred; populations were found in the wet forest, wet shrubland, mesic forest, mesic shrubland, dry forest, and dry shrubland. Therefore, multiple resilient populations should exist within each of the six habitat types to be considered represented. The population at Kaukauʻai on Maui occupied in wet forest habitat (T; see Table 1), and two populations occupied wet forest habitat on Hawaiʻi (H, I). Also on Hawaiʻi, three populations occupied dry forest habitat (C, R, S), one population occupied dry shubland habitat (P), one population occupied a combination of dry forest and mesic shrubland habitat (M), three populations occupied mesic shrubland habitat (L, N, O), six populations occupied mesic forest habitat (A, D, E, F, J, K, and G (an outplanted individual)), one population occupied a combination of mesic forest and wet shrubland habitat (Q), and one population occupied wet shrubland habitat (B).

FACTORS INFLUENCING VIABILITY

Threats

The immediate and potential threats facing *Sicyos macrophyllus* include herbivory of seeds and plants by rats, habitat modification and destruction and herbivory by feral ungulates, habitat modification and competition with nonnative plants, habitat modification and destruction by human disturbances and military activities, fire, lack of regeneration, limited numbers of populations and individuals, climate change, and inadequate regulatory mechanisms (USFWS 2016a, p. 67808; USFWS 2020b, p. 12). Further discussion on the impacts these threats have to dry shrubland, dry forest, mesic shrubland, mesic forest, wet shrubland, and wet forest habitats can be found in Hawaiʻi: Dry Grasslands and Shrublands habitat status assessment (Peʻa et al. 2020, pp. 9–11), Hawaiian Islands Dry Forest habitat status assessment (Javar-Salas et al. 2020, pp. 11–14), Hawaiʻi: Mesic Grasslands and Shrublands habitat status assessment (Ball et al. 2020, pp. 9–12), Hawaiʻi: Mesic Forests habitat status assessment (Lowe et al. 2020, pp. 13–17), Hawaiʻi Wet Grasslands and Shrubland habitat status assessment (Nelson et al. 2020, pp. 6–10), and Hawaiian Islands Wet Forest habitat status assessment (Clark et al. 2020, pp. 9–11).

Herbivory by rodents

Seed predation and plant herbivory by rats (*Rattus* sp.) negatively affects the remaining individuals of *Sicyos macrophyllus* (USFWS 2016a, p. 67808; USFWS 2020b, p. 12). Rats impact native plants by eating seeds, flowers, leaves, roots, and other plant parts and can substantially affect regeneration (Atkinson and Atkinson 2000, p. 23).

Herbivory and habitat modification and destruction by introduced ungulates

Introduced pigs (*Sus scrofa*), mouflon (*Ovis gmelini musimon*), and cattle (*Bos taurus*) are a threat to the ecosystems known to support *Sicyos macrophyllus* (USFWS 2016a, pp. 67808, 67827–67830; USFWS 2020b, p. 12). The effects of these nonnative animals include herbivory of plant species, the destruction of vegetative cover, trampling of plants and seedlings, soil disturbance, dispersal of alien plant seeds on hooves and coats and through the spread of seeds in feces, and creation of open, disturbed areas conducive to further invasion by nonnative pest plant species (Cuddihy and Stone 1990, p. 94). All of these impacts lead to the subsequent conversion of native plant communities to plant communities dominated by nonnative species.

Habitat modification and competition with nonnative plants

Nonnative plant species are a threat to *Sicyos macrophyllus* due to their ability to compete with the species for water, space, nutrients, and light. Invasive nonnative plant species are responsible for modifying the availability of light; altering soil-water regimes; modifying nutrient cycling; altering the fire regime affecting native plant communities; and ultimately, converting native-dominated plant communities to nonnative plant communities (Smith 1985, pp. 180–181; Cuddihy and Stone 1990, p. 74; D'Antonio and Vitousek 1992, p. 73; Vitousek et al. 1997, p. 6).

Invasive plant species include *Cenchrus setaceus* (fountaingrass), *Delairea odorata* (German ivy), *Ehrharta stipoides* (Meadow rice grass), and *Pennisetum clandestinum* (kikuyu grass), (HBMP 2010; USFWS 2016a, p. 67808; USFWS 2020b, p. 12).

Habitat destruction and modification by fire
Alteration of fire regimes represents an ecosystem-level change caused by the invasion of nonnative grasses (D'Antonio and Vitousek 1992, p. 73; Ball et al. 2020, p. 14; Javar-Salas et al. 2020, p. 13; Lowe et al. 2020, p. 17; Pe'a et al. 2020 p. 10). Beginning in the late 18th century, Europeans and Americans introduced alien grasses for pasturage and ranching (D'Antonio and Vitousek 1992, p. 67). Although fires were historically infrequent in mountainous regions, extensive fires have occurred in the last half of the 20th century in lowland mesic areas, leading to grass-fire cycles that convert forest to grasslands (D'Antonio and Vitousek 1992, p. 77). Fires are a continued threat to the endangered plants and habitat that occupy the Pōhakuloa area and occur in the area periodically (Beavers 2010, entire). *Sicyos macrophyllus* is at risk of the negative impacts by fire because it occurs in or near areas that were burned in previous fires (USFWS 2016a, p. 67,796). Fires, depending on occurrences and intensity, can be fueled by and promote the spread of introduced invasive species (Brown and Smith, 2000, p. 182). Many invasive plants, particularly fire-tolerant grasses, outcompete native plants and inhibit their regeneration (D'Antonio and Vitousek 1992, pp. 70, 73–74); Tunison et al 2002, p. 122). Additionally, fire often destroys dormant seeds, demolishing the soil seed bank (D'Antonio and Vitousek 1992, p. 68). Successive fires burn farther into native habitat and alter microclimatic conditions creating conditions favorable to nonnative plants. The threat from fire is unpredictable but is increasing in frequency in ecosystems that have been invaded by nonnative plants and fire-tolerant nonnative grasses.

Climate change
Climate change poses a threat to all habitat types known to support *Sicyos macrophyllus*. Changes in environmental conditions that may result from global climate change include increasing temperatures, decreasing precipitation, and increasing storm intensities (Intergovernmental Panel on Climate Change (IPCC) 2014, pp. 6–11). This species has small population sizes and low numbers of individuals. The consequent impact on *S. macrophyllus* related to changes in microclimatic conditions include a decline in native species richness associated in this species' habitat due to direct physiological stress. Additional long-term impacts include the decline in annual precipitation resulting in a reduction in moisture availability, an increase in drought frequency and intensity, and a self-perpetuating cycle of nonnative plants (such as nonnative grasses adapted to fire and dry conditions) intruding and displacing native plant communities. In a climate change vulnerability study, *S. macrophyllus* was found to have a low level of vulnerability to predicted climate change (Fortini et al. 2013, entire). We do expect the effect of climate change to exacerbate the threats to *S. sandwicensis.*

Increased inter-annual variability of ambient temperature, precipitation, and hurricanes, would provide additional stresses on the habitat and to this species because *Sicyos macrophyllus* is highly vulnerable to invasion of invasive plant species. The probability of this species to go extinct as a result of such factors increases when its range is restricted, habitat decreases, and population numbers decline (IPCC 2014, pp. 6–11).

Human Disturbances
Human disturbances may be a potential threat to *Sicyos macrophyllus*. Several individuals in the Mauna Loa Forest Reserve on the backside of Puʻu Huluhulu have been impacted by humans. In 2019, four individuals were either cut or removed from koa trees in the area (Honolulu Star Advertiser 2019).

Military activities
Populations of *Sicyos macrophyllus* at PTA may be impacted by Army training activities. These include construction of military facilities, bulldozing new roads and maintaining old roads which may be useful as firebreaks but could also act as a corridor to facilitate the intrusion of invasive weeds, as well as cover plants in dust as a result of vehicular traffic, and military maneuvers. The firing of weapons and large number of troops in the area increases the likelihood that fires could ignite, leading to destruction of habitat (Cuddihy and Stone 1990, p. 99).

Lack of Regeneration
Populations of *Sicyos macrophyllus* at PTA have been observed to have little to no regeneration (CEMML 2020, p. 41; USAG 2020, pp. 107, 167).

Limited Number of Individuals per Population
There are current and ongoing threats to this species due to factors associated with limited numbers of individuals and populations (USFWS 2016a, p. 67808; USFWS 2020b, p. 12). Currently, *Sicyos macrophyllus* can only be found on the island of Hawaiʻi with eleven extant wild populations. Three populations totaling 21 individuals are located at HAVO, one individual is located at Ho'okena in the Hakalau National Wildlife Refuge Kona Unit, and six populations are located on state managed lands (two individuals at Kukuiopaʻe, an unknown number at Waiākea Upper, one individual each at Puʻu waʻawaʻa – Aiea and Puʻu waʻawaʻa - Southeast of Puʻu Iki, nine patches at Paʻauilo, and 10 to 100 individuals at ʻAinahou) (see Table 1).

Due to this limited population size, *Sicyos macrophyllus* may experience: (1) reduced reproductive vigor due to ineffective pollination or inbreeding depression; (2) reduced levels of genetic variability, leading to diminished capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence; and (3) a single catastrophic event may result in extirpation of remaining populations and extinction of the species (USFWS 2016a, p. 67808).

Inadequate Regulatory Mechanisms
Inadequate Habitat Protection
Nonnative feral ungulates pose threat to *Sicyos macrophyllus* through destruction and degradation of the species' habitat and herbivory but regulatory mechanisms are inadequate to address this threat (USFWS 2016a, p. 67808). The State of Hawaiʻi provides game mammal

(feral pigs, goats, and mouflon sheep) hunting opportunities on 38 State-designated public hunting areas on the island of Hawai‘i (HDLNR 2015, pp. 19–21 and 66–77). However, the State's management objectives for game animals range from maximizing public hunting opportunities (e.g., "sustained yield") in some areas to removal by State staff, or their designees, in other areas (HDLNR 2015, entire).

Introduction of Nonnative Plants and Insects
Currently, four agencies are responsible for inspection of goods arriving in Hawai‘i (USFWS 2016a, p. 67808). The Hawai‘i Department of Agriculture (HDOA) inspects domestic cargo and vessels and focuses on pests of concern to Hawai‘i, especially insects or plant diseases. The U.S. Department of Homeland Security-Customs and Border Protection (CBP) is responsible for inspecting commercial, private, and military vessels and aircraft and related cargo and passengers arriving from foreign locations (USFWS 2016a, p. 67808). The U.S. Department of Agriculture-Animal and Plant Health Inspection Service-Plant Protection and Quarantine (USDA-APHIS-PPQ) inspects propagative plant material, provides identification services for arriving plants and pests, and conducts pest risk assessments among other activities. (HDOA 2009, p. 1). The Service inspects arriving wildlife products, enforces the injurious wildlife provisions of the Lacey Act (18 U.S.C. 42; 16 U.S.C. 3371 *et seq*.), and prosecutes CITES (Convention on International Trade in Wild Fauna and Flora) violations. The State of Hawai‘i allows the importation of most plant taxa, with limited exceptions (USFWS 2016a, p. 67808). It is likely that the introduction of most nonnative invertebrate pests to the State has been and continues to be accidental and incidental to other intentional and permitted activities. Many invasive weeds established on Hawai‘i have currently limited but expanding ranges. Resources available to reduce the spread of these species and counter their negative ecological effects are limited. Control of established pests is largely focused on a few invasive species that cause significant economic or environmental damage to public and private lands, and comprehensive control of an array of invasive pests remains limited in scope (USFWS 2016a, p. 67808).

Conservation Actions
Hawai‘i Volcanoes National Park (HAVO)
Conservation activities by HAVO staff consist of monitoring populations, collecting and storing seeds, propagating plants in their nursery, translocating individuals of *Sicyos macrophyllus* on park property, and fencing the Kahuku Unit of Hawai‘i Volcanoes National Park expands across lava fields, pastures, forests, shrubland and mesic, subalpine, alpine, and desert environments.

Seeds and fruits have been collected since 2007 from wild individuals at Kīpuka Kī to Kīpuka Kulalio. By 2019, hundreds of fruits were collected and in storage or propagation representing six founders from both wild and nursery-grown plants. (HAVO 2020, p. 4).

In 2007, HAVO staff propagated and translocated 25 individuals to Kīpuka Kī and 20 individuals to Kīpuka Puaulu (HAVO 2007). One outplanted individual remains within the boundary Kīpuka Ahi as of 2019 out of the five individuals planted in 2017. It had several seasons of seeding however, no seedlings have been observed (HAVO 2020, p. 28).

Plant Extinction Prevention Program (PEPP)

The Plant Extinction Prevention Program (PEPP) supports conservation of plant species by securing seeds or cuttings (with permission from the State, Federal, or private landowners) from the rarest and most critically endangered native species for propagation and translocation. The PEPP focuses on species that have fewer than 50 plants remaining in the wild including *Sicyos macrophyllus*. Funding for this program is from the State of Hawaiʻi, Federal agencies (e.g., Service), and public and private grants (*http://pepphi.org*). The PEPP botanists conduct surveys and monitors plant populations, control threats, collect propagules, and conduct outplantings for these rare endangered plants. The PEPP botanists have conducted extensive surveys for *Sicyos macrophyllus* where wild populations were known to exist historically. Three plants were discovered in 2015 at Kukuiopaʻe (PEPP 2015, p. 164) and in 2017, seeds were collected from the wild individuals at the Kukuiopaʻe and Hoʻokena populations (PEPP 2018, p. 6). PEPP staff assisted landowners in building exclosures at Hoʻokena and Kukuiopaʻe (PEPP 2017, p. 213; PEPP 2018, pp. 6–7).

Puʻu waʻawaʻa (PWW)
Conservation activities by PWW staff consist of collecting and storing seeds, propagating plants in their nursery, building fences, and translocating individuals of *Sicyos macrophyllus* at PWW in coordination with PEPP staff and staff at State of Hawaiʻi Department of Land and Natural Resources Division of Fish and Wildlife (DLNR-DOFAW) (VanDeMark 2020, in litt.). Individuals are located at the Waihou I exclosure (HDLNR-DOFAW 2015, p. 133). In 2017, 112 propagated plants from one founder were located in their nursery (PWW 2017).

Pōhakuloa Training Area (PTA)
Staff collected and stored 479 fruits from one wild *Sicyos macrophyllus* individual (CEMML 2020, p. 36). In 2019, two germination trials on two individuals using 25 seeds from each individual were conducted. No seeds germinated during these trials (CEMML 2020, p. 40). Seeds were sent to Lyon Arboretum micropropagation laboratory and Army Natural Resources Program on Oʻahu for additional germination attempts. Several plants resulting from these attempts are currently at the Oʻahu nursery facility (Kawelo 2020, pers. comm.). This single wild individual died in 2017 (CEMML 2020, p. 26)

The PTA is actively working to control and eradicate invasive plants through the Invasive Plants Program under the PTA Natural Resources Office. This program is comprised of three sections: vegetation control by mechanical removal and herbicide application (CEMML 2016, p. 165), fuel break management, and invasive plants survey and monitoring. The program not only controls invasive plants but works to reduce the fire fuel created by invasive plants. Additional actions include the implementation and maintenance of fire breaks, fuel breaks, and fuel monitoring corridors (CEMML 2016, pp. 83–84).

In 2013, 14 conservation fence units were installed in PTA encompassing 15,300 hectares (ha) of dryland habitat. By 2017, all conservation fence units were considered ungulate free (Fleishman 2019, p. 1). Today, fences are maintained through the Fence Maintenance Project run by the PTA Natural Resources Office.

Volcano Rare Plant Facility (VRPF)
The Volcano Rare Plant Facility has propagated individuals of *Sicyos macrophyllus* since 2005 from PWW, HAVO, Hakalau National Wildlife Refuge Kona Unit (Hoʻokena population), and from the population at Paʻauilo. Two dozen plants have been propagated for translocations to Kipahoehoe Natural Area Reserve, HAVO, and PWW. Currently, there are several plants from Kukuiopaʻe and seeds are in storage from eight founders from Paʻauilo (VRPF 2013, 2014, 2016, 2017, 2018, 2019).

National Tropical Botanical Garden (NTBG)
The NTBG's focus is on identifying, documenting, understanding, and conserving the diversity of tropical plants and their habitats. Their collections (living, herbarium, and library) provide valuable resources. The NTBG's conservation initiatives include collecting expeditions throughout Hawaiʻi and the Pacific region to identify plant species that are at risk of extinction, to collect seeds and plant material for propagation and conservation in the living collections, ecological restoration of degraded habitats, protecting the endemic species that still exist, and reintroducing species which have not survived on their own (*https://ntbg.org/science*). The NTBG's botanists conduct extensive surveys for rare plant species in areas where wild populations were known to exist historically. The population of *Sicyos macrophyllus* from Puʻu Huluhulu was monitored by NTBG in 1992, and an unknown amount of seeds are stored in their seed bank (NTBG 2013).

Endangered Species Act (ESA)
The USFWS in 2016 determined endangered status under the Endangered Species Act of 1973 (ESA), as amended, for 49 plants on 2016 including *Sicyos macrophyllus* (USFWS 2016a, p. 67808). The primary purpose of the ESA is the conservation of endangered and threatened species and the ecosystems upon which they depend. The ultimate goal of such conservation efforts is the recovery of these listed species, so that they no longer need the protective measures of the ESA. Conservation measures provided to species listed as endangered or threatened under the ESA include recognition of threatened or endangered status, recovery planning, requirements for Federal protection, and prohibitions against certain activities. The ESA encourages cooperation with the States and requires that recovery actions be carried out for all listed species. The ESA and its implementing regulations in addition set forth a series of general prohibitions and exceptions that apply to all endangered wildlife and plants. For plants listed as endangered, the ESA prohibits the malicious damage or destruction on areas under Federal jurisdiction and the removal, cutting, digging up, or damaging or destroying of such plants in knowing violation of any State law or regulation, including State criminal trespass law. Certain exceptions to the prohibitions apply to agents of the USFWS and State conservation agencies. The USFWS may issue permits to carry out otherwise prohibited activities involving endangered or threatened wildlife and plant species under certain circumstances. With regard to endangered plants, a permit must be issued for scientific purposes or for the enhancement of propagation or survival. For federally listed species unauthorized collecting, handling, possessing, selling, delivering, carrying, or transporting, including import or export across State lines and international boundaries, except for properly documented antique specimens of these taxa at least 100 years old, as defined by section 10(h)(1) of the ESA, is prohibited. Damaging or destroying any of the listed plants in addition is violation of the Hawaiʻi State law prohibiting the take of listed species. The State of Hawai'i's endangered species law (HRS, Section 195-D) is automatically

invoked when a species is Federally listed, and provides supplemental protection, including prohibiting take of listed species and encouraging conservation by State government agencies. *Sicyos macrophyllus* occurs on both Federal and non-Federal lands.

CURRENT CONDITION

Historical Condition

Pre-human Habitat Distribution

Dry, mesic, and wet forests were more extensive historically, particularly in the lowlands, and contained inclusions of native grasslands and shrublands throughout the areas they occurred. They were comprised of a wide range of species and diversity. This high quality and large size would have helped dry, mesic, and wet forests tolerate natural, annual variations in the environment and recover from periodic disturbances (i.e., floods, minor fires, etc.). Should a periodic disturbance occurred, the seed source had a large enough range and diversity of species to allow the dry, mesic, and wet forests to recover, thus making them resilient (Clark et al. 2020, p. 7; Javar-Salas et al. 2020, pp. 3–6; Lowe et al. 2020, pp. 3–8).

Dry, mesic, and wet shrublands were more extensive historically and occurred as inclusions within dry, mesic, and wet forests; it is likely that shrublands and forests were found together throughout the lowlands. Species richness was considered low to moderate so although it was composed entirely of native vegetation, it may have had lower numbers of species present than forests. However, the large size of these habitat in the main Hawaiian islands made it resilient to stochastic events like flooding or minor fires (Ball et al. 2020, pp. 2–3; Nelson et al. 2020, p. 4; Peʻa et al. 2020, pp. 3–5).

We refer to the Pre-Human Condition section of the habitat status assessments for wet forest (Clark et al. 2020, pp. 4–7), wet grassland and shrubland (Nelson et al. 2020, p. 4), mesic forest (Lowe et al. 2020, pp. 3–8), mesic grassland and shrubland (Ball et al. 2020, pp. 2–3), dry forest (Javar-Salas et al. 2020, pp. 3–8) and dry grassland and shrubland (Peʻa et al. 2020, pp. 3–5) for further discussion on the pre-human habitat distribution and description of wet forest, wet scrubland, mesic forest, mesic shrubland, dry forest, and dry shrubland on Maui and Hawaiʻi.

Historic Trends of Sicyos macrophyllus

Collections of *Sicyos macrophyllus* on the island of Hawaiʻi occur in wet forest habitat at Puʻu Makaʻala-Olaʻa (1918) and Hōnaunau (1980); wet shrubland habitat at Hoʻokena (1958) and Laupāhoehoe (1977); mesic forest habitat at Laupāhoehoe (1977), Kukuiopaʻe (1978, 2018), Waiākea (2004), ʻAinahou (2017), Kīpuka Kī (2019), Keauhou Burn (2019), Kīpuka Kulalio West (2019), and Kīpuka Ahi (2019); mesic shrubland habitat at Puʻu waʻawaʻa - Cinder Cone (1909), Puʻu waʻawaʻa - Halekula (1975), Puʻu waʻawaʻa-Aiea (1991), and Puʻu waʻawaʻa-Southeast of Puʻu Iki (1992); dry forest habitat at Kapāpala Lower (1911), Puʻu waʻawaʻa-Southeast of Puʻu Iki (1992), Paʻauilo - South (1996), and Paʻauilo – North (1997); and dry shrubland habitat at Keʻāmuku (2015). The only known population on Maui occur in wet forest habitat at Kaukauʻai (1919) but has not been observed since 1987 (HBMP 2010; USFWS 2020a; Table 1; Figure 3 and Figure 4).

Sicyos macrophyllus was known in HAVO from only two wild populations: one in lower Kīpuka Kī, discovered in 1996–2000; and a second site near 1,550 m elevation on the western edge of Kīpuka Maunaiu (Kīpuka Kulalio West – F in Figure 3) discovered in 2005. Within Kīpuka Kī, four sites are located with this vine climbing on native trees; previous population size is unknown, but live plants have persisted at the four sites (HAVO 2020).

PTA Botanical Program staff surveyed 54 kilometers (km) of gulches in Ke‘āmuku Maneuver Area and found one location of *Sicyos macrophyllus* in June of 2015. This population had not been observed since the early 1980s *(*CEMML 2016, p. 20). One of the two plants appeared to be old and may possibly be the individual from the 1981 record. To protect the individuals found, the Army approved the construction of a small-scale fence unit (~0.5 ha) (CEMML 2016, p. 57). In 2017, the last known individual died. The cause of loss is unknown (CEMML 2020 p. 26).

In 2015, the PEPP biologist revisited the Kukuiopa‘e population and discovered three individuals (PEPP 2015, p. 164). In 2017, the PEPP biologist revisited the Ho‘okena population and located two individuals (one adult and one seedling). PEPP also revisited the ‘Ainahou population and observed over 100 individuals, most were seedlings (PEPP 2017, p. 213).

Currently, known wild individuals of *Sicyos macrophyllus* are restricted to small areas on Hawai‘i Island. There are eleven populations with an estimate of 37 to 140 individuals which inhabit wet shrubland, mesic forest and shrubland, and dry forest habitats. Populations at Ho‘okena (B), Kīpuka Kī (D), Keauhou Burn (E), Kīpuka Kulalio West (F), Kīpuka Ahi (G), ‘Ainahou (K), Pa‘auilo-South (R), and Pa‘auilo-North (S) are protected by fencing. Table 1 lists wild historic and current population units of *S. macrophyllus* and one outplanted site (G) in HAVO.

Table 1. Known wild population units and outplated site of *Sicyos macrophyllus.*

Population Units	**Population Map Letter**	**Extant***	**Last Observation Date**	**Habitat Type**	**Estimated Number of Individuals**
Hawai‘i					
Kukuiopa‘e	A	Y	2018	mesic forest	2
Ho‘okena	B	Y	2017	wet shrubland	1
Kapāpala Lower	C	N	1911	dry forest	0
Kīpuka Kī	D	Y	2019	mesic forest	15
Keauhou Burn	E	Y	2019	mesic forest	5
Kīpuka Kulalio West	F	Y	2019	mesic forest	1
Kīpuka Ahi	G	UNK	2019	mesic forest	1 outplanted
Hōnaunau	H	UNK	1980	wet forest	1
Pu‘u Maka‘ala-Ola‘a	I	N	1918	wet forest	0
Waiākea Upper	J	Y	2004	mesic forest	many vines
‘Ainahou	K	Y	2017	mesic forest	between 10–100

Population Units	Population Map Letter	Extant*	Last Observation Date	Habitat Type	Estimated Number of Individuals
Pu‘u wa‘awa‘a - Aiea	L	Y	1991	mesic shrubland	1
Pu‘u wa‘awa‘a - Southeast of Pu‘u Iki	M	Y	1992	mesic shrubland, dry forest	1
Pu‘u wa‘awa‘a - Halekula	N	UNK	1975	mesic shrubland	occasional to plentiful
Pu‘u wa‘awa‘a - Cinder Cone	O	N	1909	mesic shrubland	0
Ke‘āmuku	P	N	2017	dry shrubland	0 (last one died in 2017)
Laupāhoehoe	Q	UNK	1977	mesic forest, wet shrubland	1
Pa‘auilo - South	R	Y	1996	dry forest	1
Pa‘auilo – North	S	Y	1997	dry forest	9 patches
Maui					
Kaukau‘ai	T	N	1919	wet forest	0

* Y = likely extant; N = likely extirpated; UNK = unknown

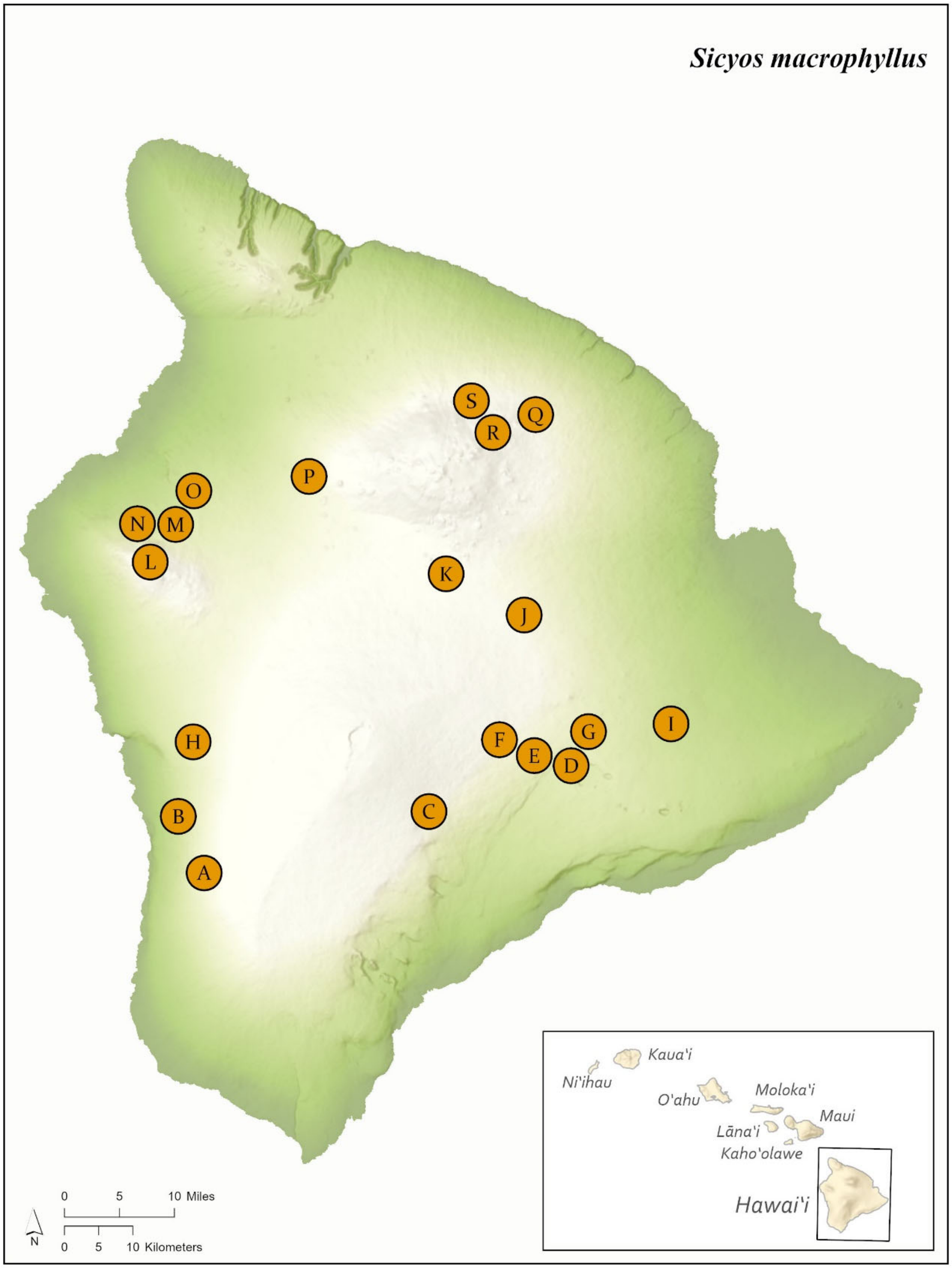

Figure 3. Distribution of *Sicyos macrophyllus* on Hawaiʻi.

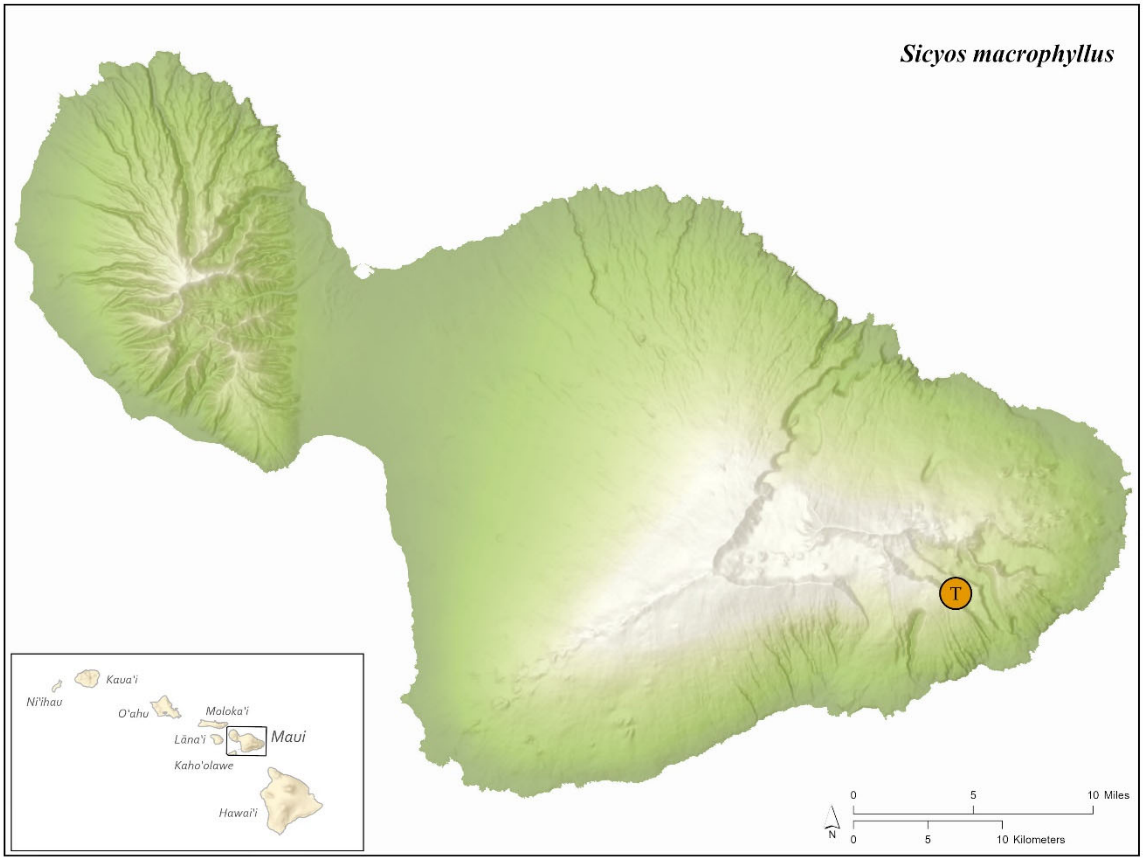

Figure 4. Distribution of *Sicyos macrophyllus* on Maui.

Current Condition

Currently, dry forests are in decline, both in size and quality of diverse native species. Forty-five percent of the dry forest plant species in Hawaiʻi are at risk of endangerment. Twenty-five percent of the endangered plant taxa in the Hawaiian islands are from the dry forests, and approximately 20 percent of dry land plant taxa in the Hawaiian Islands are known to be extinct which has reduced the resiliency and representation of this forest (Javar-Salas et al. 2020, p. 9).

Dry shrublands are in decline, both in size and quality of diverse native species. One factor contributing to these changes are the introductions of nonnative species, which resulted in new sub-types referred to as introduced grasslands and shrublands that were likely once forest. There are still remnants of native-dominated dry grasslands and shrublands but they are greatly reduced in size, as introduced grasslands and shrublands have become very widespread (Peʻa et al. 2020, p. 8).

Mesic forests and shrublands are in decline, both in size and quality of diverse native species. It is estimated that only 40 percent of the original mesic forest habitat and 10 percent of the original native vegetation of mesic shrublands in the Hawaiian Islands currently remain. Much of the lowland mesic forest and shrublands have since been converted to pasture, military or agricultural use, or have been lost to urbanization or fire. Intensive human disturbance in the lowlands and shrublands has resulted in the majority of intact native mesic forests and shrublands remaining only at higher elevations (Ball et al. 2020, p. 9; Lowe et al. 2020, p. 8).

Wet shrublands have declined. Approximately only 48 percent of wet grassland and shrubland habitat today is native species dominated (defined by native species cover >50 percent) (Nelson et al. 2020, p. 4).

Wet forests today is largely similar in extent across all islands as the prehuman condition, except for substantial loss of lowland rainforest on the islands of Oʻahu and Kauaʻi. There are 373,764 ha of wet forest in the Hawaiian islands with 65 percent on the island of Hawaiʻi. Seventy-eight percent is native species dominated, the remaining portion of wet forest is nonnative species dominated (Clark et al. 2020, p. 8).

Currently, known wild individuals of *Sicyos macrophyllus* are restricted to small areas on Hawaiʻi Island. There are eleven populations, with an estimate of 37 to 140 individuals, and inhabit wet shrubland (Hoʻokena (B)); mesic forest (Kukuiopaʻe (A), Kīpuka Kī (D), Keauhou Burn (E) , Kīpuka Kulalio West (F), Waiākea Upper (J), ʻAinahou (K)), mesic shrubland (Puʻu waʻawaʻa - Aiea (L) and Puʻu waʻawaʻa - Southeast of Puʻu Iki (M)), and dry forest (Paʻauilo– North (S)). There is one outplanted individual in HAVO (Kapāpala Lower (G)). Outplanting sites may exist at PWW but this information is unknown (HBMP 2010; USGS 2010, p. 74; PEPP 2015, p. 164, 2017, p. 213; USFWS 2020a; VanDeMark 2020, in litt.).

SPECIES VIABILITY SUMMARY

Resiliency

For *Sicyos macrophyllus* to maintain viability, the populations must be resilient. The definition of resiliency is the ability of the population to withstand stochastic events, meaning they must have healthy, stable populations, and good quality and quantity of habitat.

We determine resiliency for *Sicyos macrophyllus* based on the metrics of the population size. Eleven known extant populations exist but majority of these consist of five individuals or less (Kukuiopaʻe (A), Hoʻokena (B), Keauhou Burn (E), Kīpuka Kulalio West (F), Puʻu waʻawaʻa – Aiea (L), Puʻu waʻawaʻa - Southeast of Puʻu Iki (M), and Paʻauilo – South (R)). Only four populations (Kīpuka Kī (D), Waiākea Upper (J), ʻAinahou (K), and Paʻauilo – North (S)) consist of ten individuals or more. Populations at Hoʻokena (B), Kīpuka Kī (D), Keauhou Burn (E), Kīpuka Kulalio West (F), Kīpuka Ahi (G), ʻAinahou (K), Paʻauilo-South (R), and Paʻauilo-North (S) are protected by fencing while ungulates continue to pose a threat to the other populations. Threats of competition of nonnative plants and rodent predation exist at all populations. Outplanting sites were created at HAVO, but only one out of forty five individuals remain as of 2019 (HAVO 2020, p. 28). Outplanting sites may exist at Puʻu waʻawaʻa but this was not confirmed (VanDeMark 2020, in litt.). Additionally, very low rates of seed germination have been observed in trials performed *ex situ* (CEMML 2020, p. 40). Therefore, *S. macrophyllus* has very low resilience due to small numbers of individuals at majority of the eleven populations, the presence of threats at populations, and very low to no regeneration that the species experience.

Redundancy
We evaluate redundancy for *Sicyos macrophyllus* based on the metrics of the number of populations, their resiliency, and their proximity to one another. Currently, there are eleven likely extant populations ranging from very low to low resiliency. Several populations are in close proximity of each other and the likelihood that a single catastrophic event would cause the species to go extinct is high. While outplanting sites have been created survival has been very low and no recruitment has been documented. Therefore, *S. macrophyllus* has very low redundancy due to its limited range, close proximity of populations to each other, and small number of individuals at majority of its populations.

Representation
We define representation for *Sicyos macrophyllus* based on the genetic diversity and habitat variation within and among the populations. Currently, eleven populations occupy four habitat types. Historically, this species existed in two other habitat types (dry shrubland and wet forest), but are now extirpated. These habitats could be considered extreme ends of the habitat range where *S. macrophyllus* occurs. Mesic forests are well represented with six populations occurring in this habitat but populations have very low resiliency which translates to very low representation. The remaining three habitat types (wet shrubland, mesic shrubland, dry forest) are represented by one or two populations. Representation of this species exists in *ex situ* seed collections from HAVO, Hakalau National Wildlife Refuge Kona Unit Hoʻokena population, PTA, Paʻauilo, and PWW founders, propagation of individuals at various nurseries, and one translocated individual at HAVO. Studies on genetic diversity have not been conducted, and thus, genetic variation within this species is unknown. Therefore, the species has very low representation.

Species Viability Summary
The current condition of *Sicyos macrophyllus* is described as having eleven known extant populations, with an estimate of 37 to 140 individuals, in four habitat types. As this species has very low resiliency, redundancy, and representation in the current condition, the overall viability of this species is very low.

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