Engaging Community with Wild Seed Collection
to Protect Genetic Diversity and Develop Disease Resistance
for ʻŌhiʻa *(Metrosideros sp.),* a Keystone Native Hawaiian Tree.

August 12, 2021-December 31, 2025

INTRODUCTION

ʻŌhiʻa lehua, *Metrosideros polymorpha*, is arguably one of the world's best examples of a 'foundation species.' It is a tree species essential for native forest ecosystem function and provides habitat to the rich endemic biodiversity of Hawaii's forests. Consequently, ʻōhiʻa has long held enormous cultural significance to native Hawaiians. The widespread dominance of ʻōhiʻa in Hawaiian forests has generated concern... that if something were to drastically reduce the health and abundance of ʻōhiʻa forest stands, the result would be ecologically catastrophic (Loope, L. 2016, pg.iv).

ʻŌhiʻa growing on lava field. Credit: Maui Nui Botanical Gardens

ʻŌhiʻa thus provides the foundational and functional framework for Hawaii's forested terrestrial ecosystems and the diversity of the native fauna and flora, roughly 90% of which is endemic, occurring nowhere else in the world (Loope, L. 2016, pg.3). ʻŌhiʻa forests recharge watersheds. It adapted as one of the few, and first, plants to grow on newly cooled lava flows. Summarized by Luiz, B. et al (2022), There is perhaps no other species in the US that supports more threatened and endangered taxa or that plays such a geographical dominant ecological keystone role (Luiz, B. et al 2022, pg.639). The importance of ʻŌhiʻa lehua, intertwined within the Hawaiian culture over centuries, representing deities, rain, wind, stars, a warrior, a beloved, an expert and found in song, as well as poetical proverbs known as ʻōlelo nōʻeau (Abbott, I. 1992), (Pukui, M. 1983), (Pukui & Elbert 1986). The useful wood is hard, hence its descriptive genus name includes *sideron*, iron (Wagner, W. et al 1999).

THE GOAL: Protect Genetic Diversity

In the Hawaiian Islands, the genera *(Metrosideros)* developed into 14 endemic (found nowhere else in the world) taxa represented by five species, and nine varieties. Endemism developed on these isolated islands, emerging over millions of years, in a vast ocean. The Hawaiian islands reached heights of over 13,000 feet elevation (4,000 meters). Unique ecosystems evolved on each island, resulting in over 90% of native Hawaiian plants becoming endemic. This speciation developed out of varied habitats: from coastal to sub-alpine; from deserts to rainforests; and from windward to leeward**.**

This paper tells of the endeavor focused on the islands of Maui Nui (Maui, Molokaʻi and Lānaʻi). These islands differ from each other in age, topography and rainfall, resulting in differing ecosystems, and speciation. Moloka'i rises to 4,970 foot elevation (1,510 meters). Lānaʻi rises to 3,366 feet (1,026 meters). Maui rises to 10,023 feet (3,055 meters). The Maui Nui complex has seven of the *Metrosideros* taxa.

Leaf Variety. Some of the most beautiful lei have been made with leaves alone. The color, texture, shape and size of ʻōhiʻa leaves vary greatly. Leaves may be round to narrow (elliptic), tips blunt to pointed. Leaves often with differently textured upper versus lower surfaces (dorsiventral). Leaf surfaces range from smooth (glaberous), to rugose (wrinkled), or having soft fine hairs (appressed pubescent), to dense woolly hairs. Leaf hairs range from white, to tan, to reddish brown. Leaf edges may be undulate (wavy), or revolute (edges curved under), or entire (smooth). Leaf width may range from 0.5-3 cm wide. (Wagner, W. et al 1999, pgs 964-5). Lehua lau liʻi is an ʻōhiʻa with very small leaves. Leaf colors may be solid, or blend shades of green, peach, pink, crimson red to dark red. Leaf colors may change with age.

Lehua kūmakua is an ʻōhiʻa with heart-shaped (cordate) leaves. Leaves are attached directly to the stem (sessile), lacking the stalk (petiole) that attaches leaf to stem. To view a sessile leaf, see the first of the leaf photos.

Leaf varieties. First five photos by M. M. Chau, sixth photo by C. Davenport.

Flower Variety. The flowers supply nectar to birds and a variety of insects. Flower colors range within the many shades of red, including a dark red named lehua ʻāpane, the same red color as the ʻāpapane bird (*Himatione sanguinea)*. In the many shades of yellow, lehua mamo is the same yellow found in the feathers of the extinct mamo bird (*Drepanis pacifica*). Colors include shades of orange, to perhaps white. Some flowers appear bi-colored because the singular central pistil is a different color than the many surrounding stamens.

ʻŌhiʻa lehua (blossoms). Photos by M. M. Chau.

Environment & Morphology. ʻŌhiʻa adapted to many environmental zones (Fig.1). It grows along the warm coast, or up into 8,000 foot elevation within brief periods of sleet and snow (SOH 2025). It grows in windward and leeward areas. ʻŌhiʻa is one of the first, and few plants adapted to grow on newly cooled lava flows. In high elevation, montane bogs, ʻōhiʻa is a full grown tree, blooming at less than six inches tall. Yet it will grow 80 feet tall in rainforests and dryforests. In sub-alpine areas, and along scree slopes, trees will be shorter or bushy.

The tenacity of a sprawling variety, clinging to steep, windy ridges was named accordingly by both the Hawaiian and scientific community. The lehua ʻāhihi, was given the species name *tremuloides*, from its tremulous, or trembling habit of growth in that windy, precarious environment. The Hawaiian mele (song) Pua ʻĀhihi tells a story of quivering emotions (Appendix D.1).

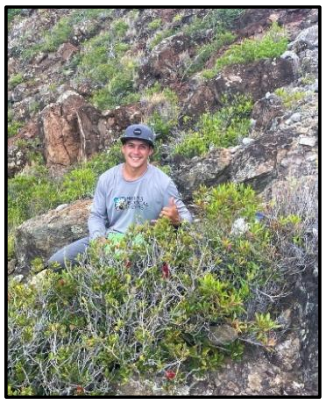
At times, scientific nomenclature honors the Hawaiian name. As in lehua makanoe (named var. *makanoiensis*), of the misty-faced lehua, found only in the high montane bogs of one island. Because the scientific and Hawaiian view agree that ʻōhiʻa lehua has many species and varieties, then perhaps the word ʻōhiʻa should be treated as a genus name, and written with an initial capital, as ʻŌhiʻa (I. Abbott, personal communication, 2006).

ʻŌhiʻa growing on cooled lava flow.
Credit M.M. Chau.

Rainforest ʻōhiʻa.
Credit M.M. Chau.

Dryforest ʻōhiʻa.
Credit MNBG.

ʻŌhiʻa in montane bog.
Credit MNBG.



ʻŌhiʻa on scree slope.
Credit J. Tabura.

Sub-alpine ʻōhiʻa.
Credit MNBG.

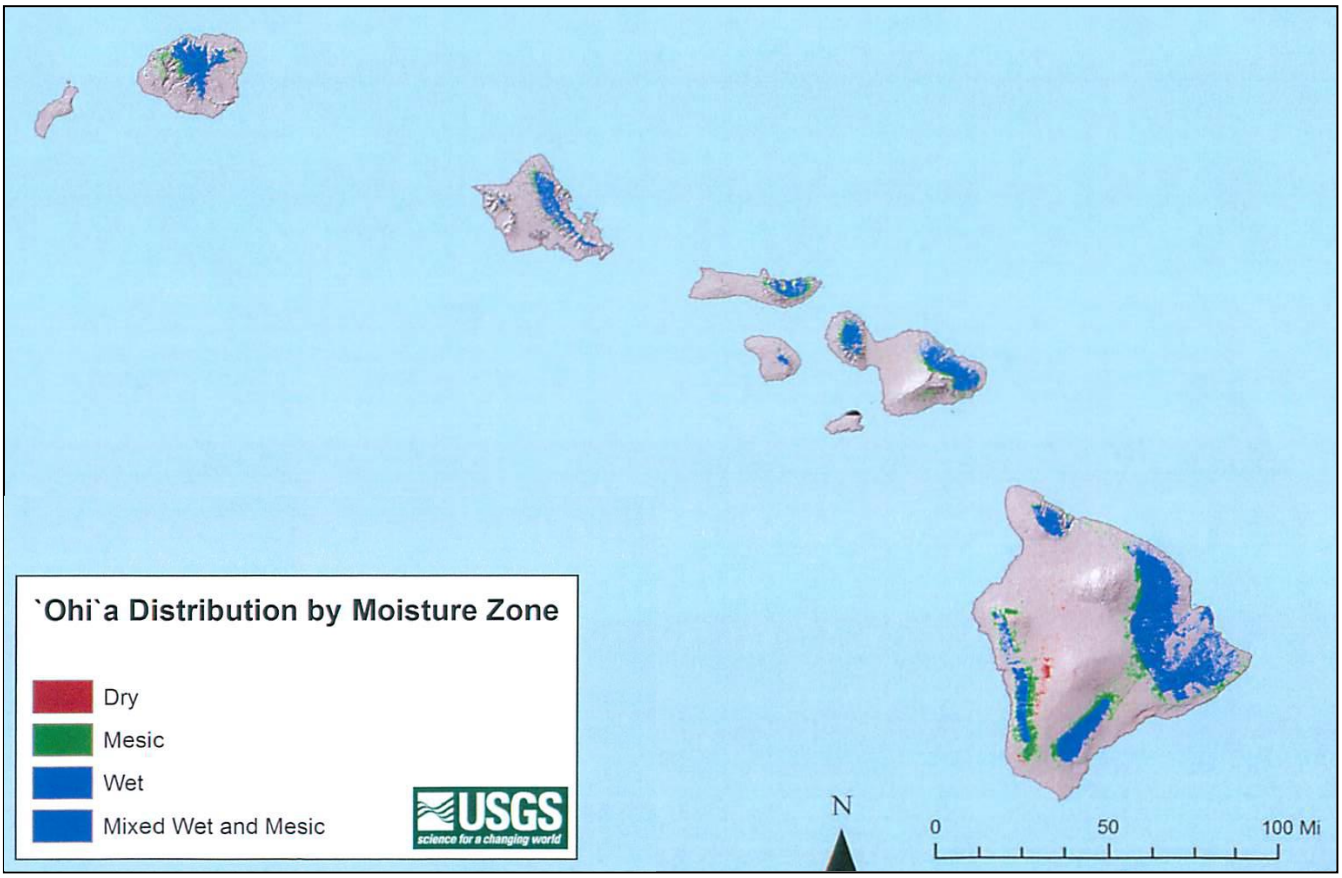


Fig.1. **ʻŌhiʻa Distribution by Moisture Zone.**
Credit: "Importance of ʻŌhiʻa and Rapid ʻŌhiʻa Death" powerpoint by Ambyr Mokiao-Lee, Statewide Outreach Coordinator, U.H. Mānoa.

THE PROBLEM: Rapid ʻŌhiʻa Death (ROD), a virulent fungal plant disease threatening Hawaiian forests

ʻŌhiʻa forests, particularly on Hawaiʻi Island, have been severely impacted by Rapid ʻŌhiʻa Death (ROD), which is caused by the fungal pathogens *Ceratocystis lukuohia* and *Ceratocystis huliohia*. ROD is characterized by branch dieback, crown wilting, and mortality (Blaine et al 2022 pg. 637). The fungal infection blocks off xylem vessels, blocking nutritional transport. Tree wounds, opened by mostly beetles and invasive ungulates, allow infected wood dust to spread by wind, on animals, vehicles, tools and footwear. With the loss of tree canopy, lower story plants lost protection, changing the environment and species within.

The disease was first identified in Puna (Hawaiʻi Island) in 2014. In less than 10 years ROD devasted over 175,000 acres of forest, destroying over a million trees, affecting mostly Hawaiʻi Island, far less so on Kauaʻi and Oʻahu.

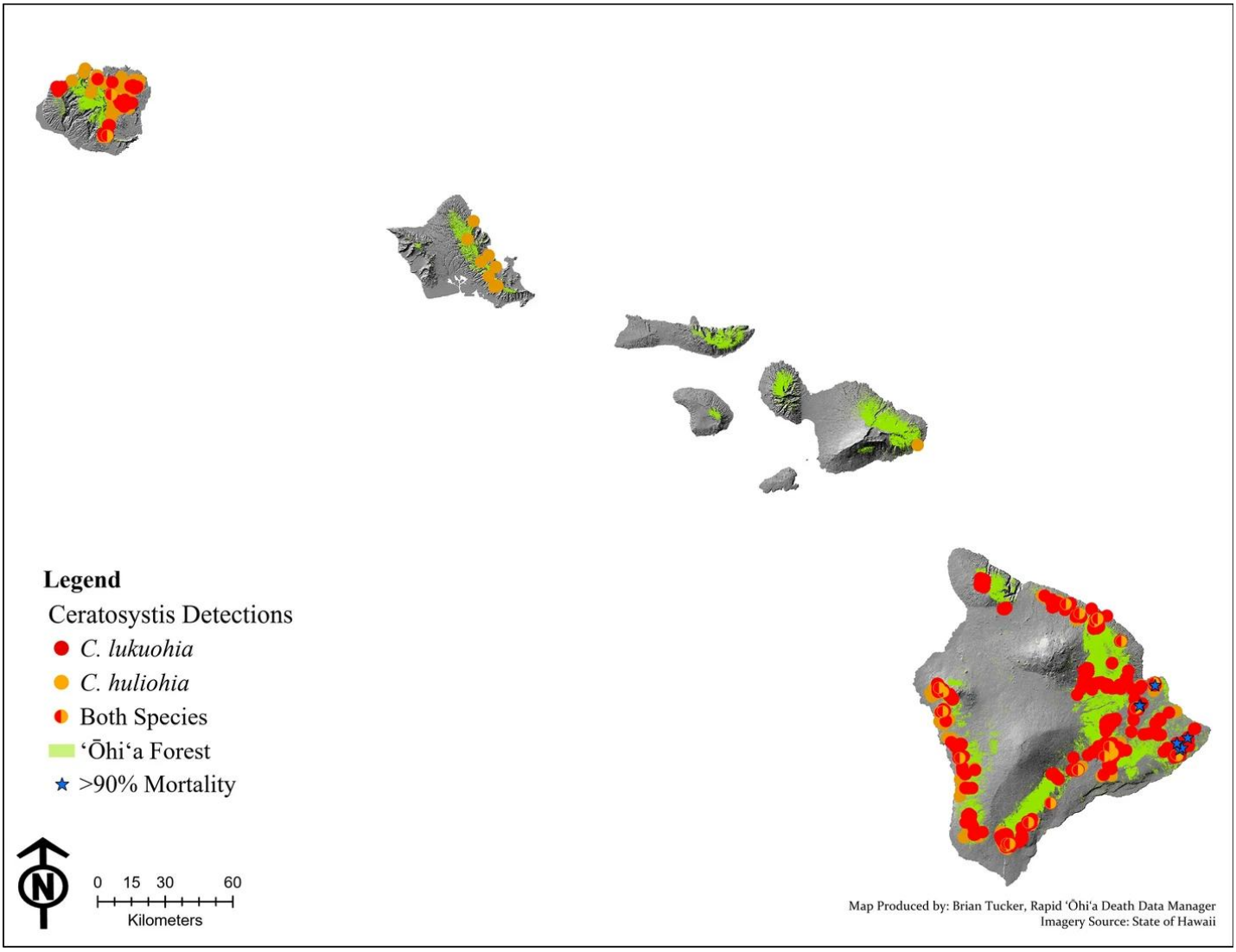


Fig. 2. The distributions of *Ceratocystis lukuohia* and *C. huliohia* positive diagnostic detections in relation to the distribution of ʻōhiʻa (*Metrosideros polymorpha*) forest across the state of Hawaiʻi. (Luiz, B. et al 2022).

Initial disease resistance screening of four varieties of *M. polymorpha* with *C. lukuohia* demonstrated that varieties may differ in susceptibility. Pāhoa, on the island of Hawaiʻi, was the worst-case scenario, but still had survivor trees. Several survivors of field or screening-based infections existed, providing strong impetus for the establishment of the ʻŌhiʻa Disease Resistance Program (Blaine et al 2022 pg.637). Researchers established the ʻŌDRP in 2018, a collaboration between federal, state, nonprofit, and academic partners. The ʻŌDRP identifies and propagates ʻōhiʻa with genetic resistance to ROD.

Healthy forest, 2005.
Credit: M.M. Chau

Diseased forest, 2015.
Credit: M.M. Chau

A few disease-resistant trees remain.
Photo: J.B. Friday

THE SOLUTION: Finding and developing disease resistant plants

METHODOLOGY

Collect seed from naturally occurring (wild) trees. These are trees not planted by people. The ROD Seed Banking Initiative was established to collect and store *Metrosideros* seeds from naturally occurring trees throughout Hawai'i, with the goal of preserving the genetic diversity of these taxa for restoration and disease research efforts (Chau, M. 2020). As a widespread species, collect from populations across the distribution, and capture each ecoregion (CPC 2019, pg.1-18).

***Disease Resistance Testing*.** The program initially concentrated on screening survivor trees in hard-hit areas of Hawai'i Island. Over time, the team expanded their efforts to include testing across the state. There is so much diversity in 'ōhi'a, there has to be resistance, states Ryan Belcher, Operations Specialist for the 'ŌDRP (MISC 2025). Seed banking provides the 'ŌDRP easy access to seeds from a diverse set of *Metrosideros* taxa and genotypes (Chau, M. 2020).

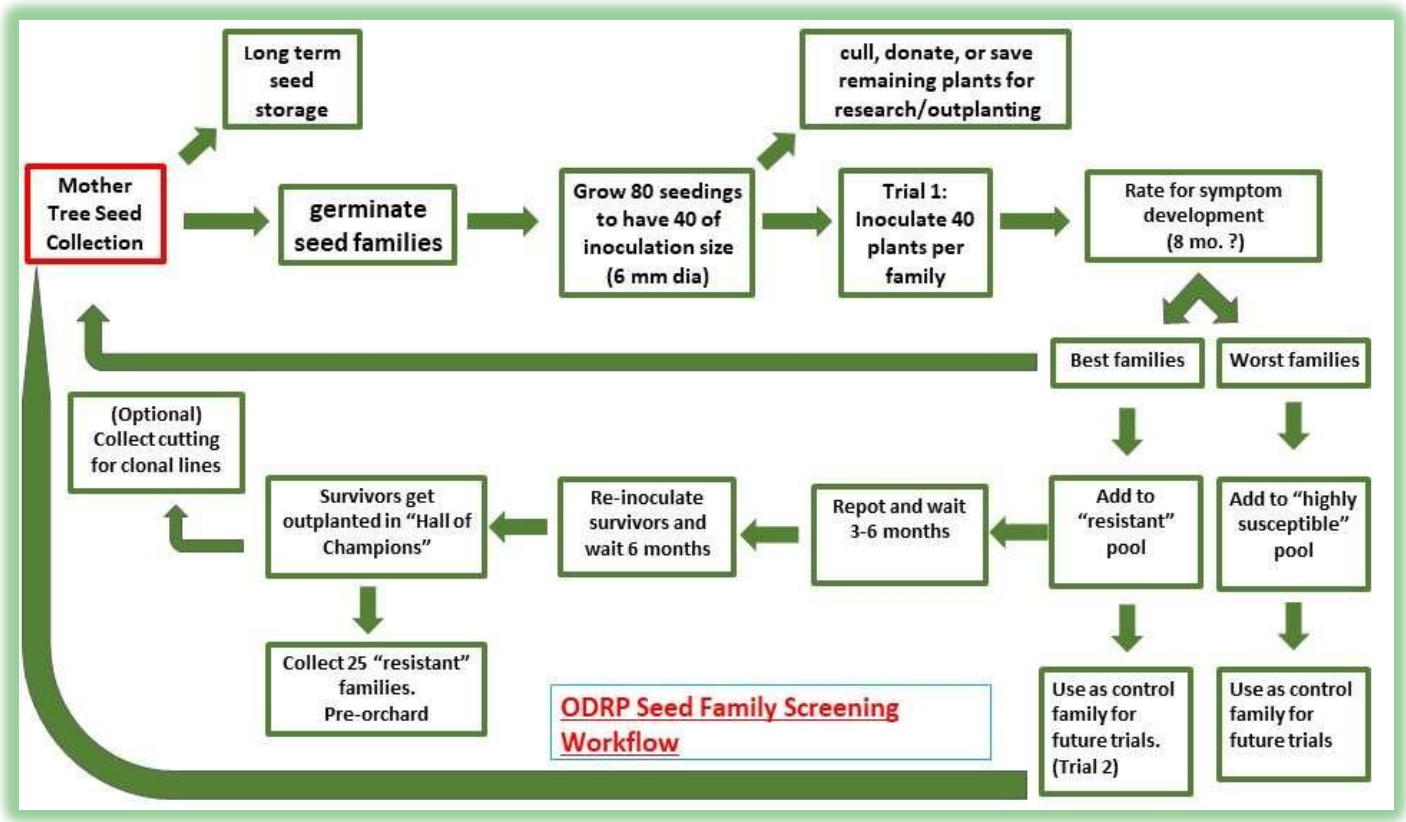
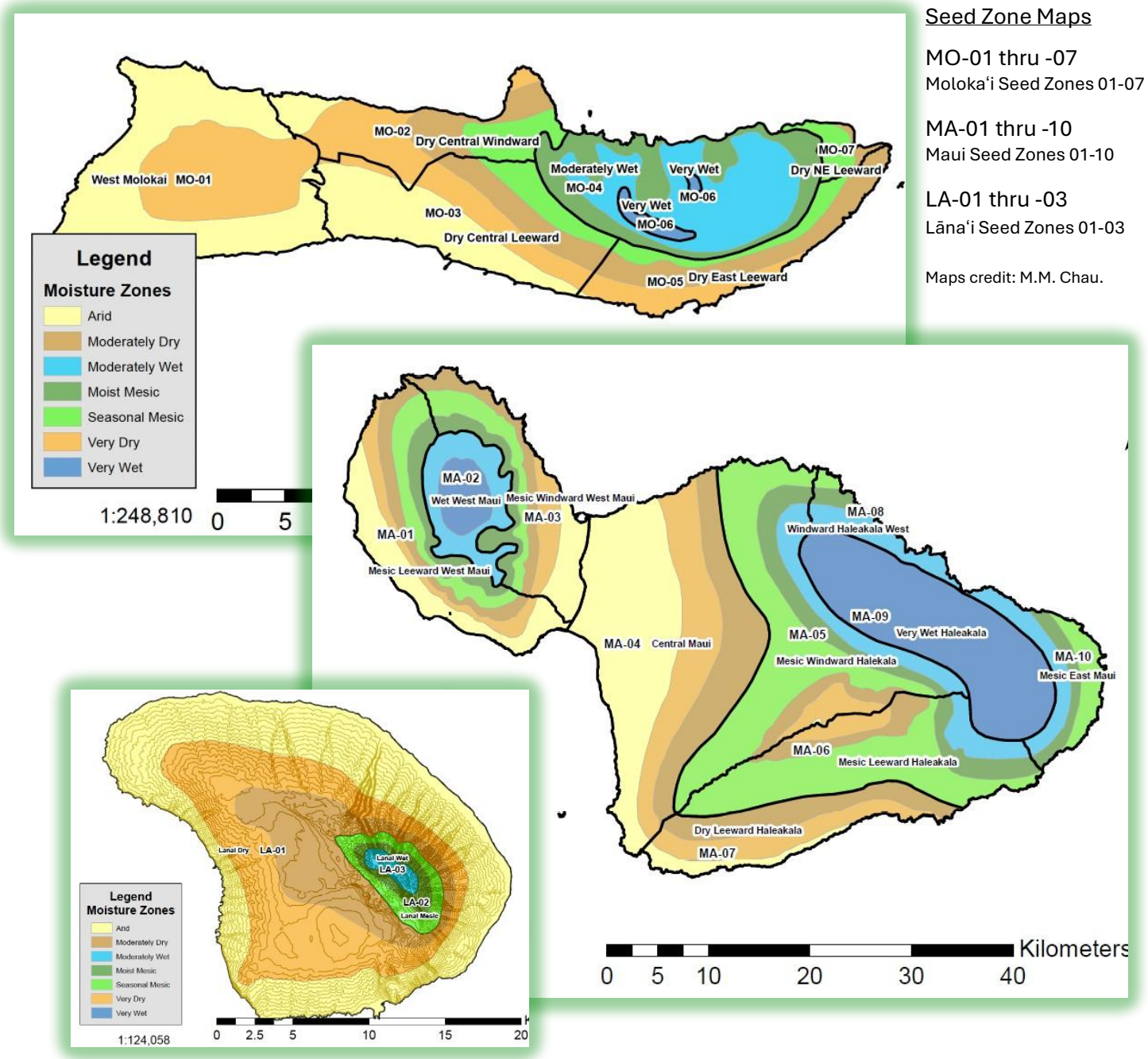


Fig. 3. **'Ōhi'a Disease Resistance Program (ŌDRP) Workflow Chart**, Hilo, Hawai'i Island. *Credit 'ŌDRP.*

The plan, to grow and test seedlings from three *Metrosideros* taxon, per seed zone, in which the taxon occurs. Due to constraints in growing and screening space, seed zones highly threatened by ROD were prioritized (Luiz, B. et al 2022, pg.648). In a secured facility, ʻōhiʻa seed is grown to a woody stage (about 6 mm diameter, which takes about two years), then the plant is inoculated with ROD disease to test for resistance. Some plants were still surviving three to five years after inoculation (MISC 2025).

Seed Zones. Partners from the Hawaiʻi Seed Bank Partnership and the Laukahi Network worked together to create the ʻōhiʻa seed zones (Laukahi 2025). ʻŌhiʻa seed zones were created based on climatic, elevational, rainfall (Appendix B.4.9) and geographical data, along with local knowledge of ʻōhiʻa distribution. Seed zones may be modified and used for other flora or fauna that are critical for restoration efforts (Chau, M. 2020). ʻŌhiʻa Disease Resistance Program screenings rely on seed zone based strategies that account for environmental variation found across the *Metrosideros polymorpha* range (Luiz, B. et al 2022, pg.649).



Seed Zone Maps

MO-01 thru -07
Molokaʻi Seed Zones 01-07

MA-01 thru -10
Maui Seed Zones 01-10

LA-01 thru -03
Lānaʻi Seed Zones 01-03

Maps credit: M.M. Chau.

Engaging the Community. This project was successful beyond expectations due to the ingrained respect, care (mālama) and kuleana (responsibility) many people of Hawai‘i have for their natural resources and the Hawaiian culture. This project empowered them with skills and education to support this project. 310 individuals volunteered, some individuals volunteered more than once, resulting in volunteer participation 702 times.

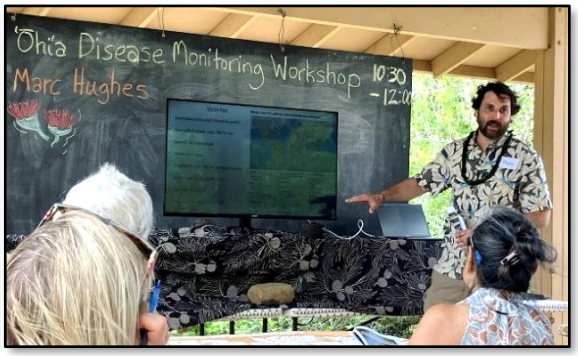
Our Community

In the Maui Nui islands, 28% of the residents are Native Hawaiian and/or Other Pacific Islander (SOH 2024). On Moloka‘i, 65% are Native Hawaiian (OHA 2024). On Lāna‘i, 13% are Native Hawaiian or Pacific Islander (WPR 2025). The Hawaiian culture, so prevalent and prevailing, many kama‘aīna (island-born) residents identify as culturally Hawaiian, though not genetically (kōkō). In the Maui Nui Islands, 23% of Native Hawaiians could converse in the Hawaiian language (OHA 2023). In addition there are Hawaiian language speakers, that are not Native Hawaiian. In this project we reached out to engage the local, rural and native communities in an all-inclusive, community-involved conservation effort.

Outreach and Workshops

The Hale ‘Ōhi‘a (House of ‘Ōhi‘a) booth was set up as part of an annual Arbor Day event, educating the public about this project, while giving away over 1,000 ‘ōhi‘a to the public. (The annual Arbor Day event was not hosted by this project.)

Free ‘Ōhi‘a Seed Conservation Workshop classes were offered, giving 12 workshops with 180 attendees, including 76 high school students of Hawaiian ancestry from Kamehameha Schools. Many of the workshops were held at the Maui Nui Botanical Gardens, which sits within the Wailuku district, home to 51% of Maui Island‘s Native Hawaiians or other Pacific Islanders. Each workshop had two parts, a presentation, and a field class. Needing innovation during Covid, a ‘Hybrid‘ class was developed, where people could watch a zoom class at home, or come to an outdoor venue to watch the class, sitting at a safe distance from each other.



(left to right) Marian Chau teaching workshop class. Marc Hughes teaching ‘ōhi‘a disease class. Credits MNBG

Hale ‘Ōhi‘a booth. Credit MNBG

Multitudes of ‘Ōhi‘a perpetuate the health and wellness of our native forests.

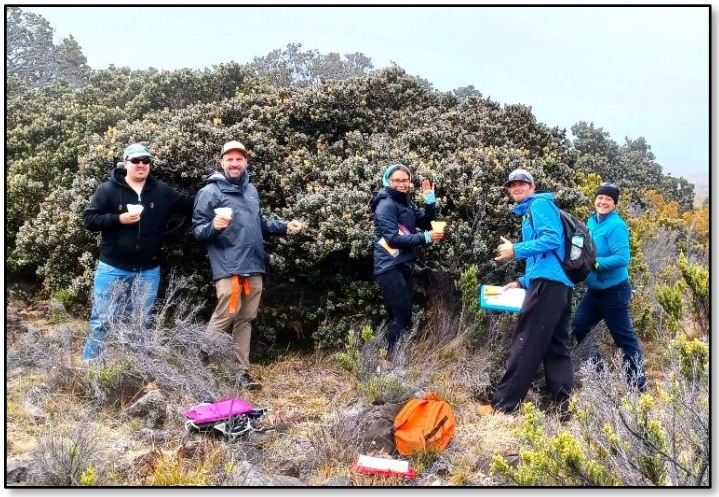
Keiki with ‘ōhi‘a. Credit MNBG

Educational Sheets – For the community, volunteers and partners, posters were created advertising Training and Fieldwork classes (Appendix A.1). Flyers explained the Rapid ʻŌhiʻa Death Project (Appendix A.2). Information was freely downloadable on the Laukahi website (Laukahi 2025), including ʻōhiʻa photo identification sheets (Appendix B.4.8), and botanical keys to the ʻōhiʻa taxa (Appendix B.4.7). Marian M. Chau gave webinars, classes, taught the presentation section of the ʻŌhiʻa Conservation Workshops, and so much more. Cathy Davenport taught the field class section of the workshops, and organized the MNBG seed collection field trips, and ran the Seed Lab.

Empowering Partners. Developed close, transparent collaborations with 27 partners, 13 of which newly came aboard for this project. Preparing partners with the skills, education and tools for this project, empowered partners who work in remote, nearly inaccessible areas, the ability to opportunistically collect seed for this project, because ʻōhiʻa seeds intermittently. This allowed MNBG to seed bank ʻōhia seed from a wide range of environments and taxa. A small, lightweight field kit was created for partners working in remote areas. Seven of our partners collected seed during 33 remote field trips. Taking the time and making this effort attests to their heart.

Remote field work collaborations with four different Partner Organization groups, giving their invaluable personnel time, effort, skills, and use of 4WD transportation. Photo credit MNBG.

Collection of Wild Seeds. Wild seeds are from wild plants (plants not planted by people). Protocol is, collection of no more than 10% of a seed crop in any year, and no more than 5 out of 10 years (CPC 2019, pg.121). Sanitize equipment and footwear to not spread disease or injurious pests. Use cleaned clothing. Follow 'Seed Collection Protocol' (Appendix B.4.2.).



Collecting ʻōhiʻa seed in sub-alpine environment.
Photo credit: MNBG

Seed Ownership. The landowner is the seed owner. As seed owner, they are also the owner of the plant that emerges from that seed. The landowner determines where or to whom their seed or plant is distributed. In requesting permission to enter their property and collect ʻōhiʻa seed, the landowner was told they would always be the owner of the seed/plant. They were asked if some of their seed collected could be used to search for disease resistance to Rapid ʻŌhiʻa Death (ROD). To this they graciously agreed.

The seed owner was told some of their seed would be sent to Hilo, on the island of Hawaiʻi, at the ʻŌhiʻa Disease Resistance Program (ʻŌDRP). In a secured facility there, the seed would be grown to a woody stage (about 6mm), then inoculated with disease, to determine resistance. The remainder of their seed would be stored for them, at the MNBG Seed Bank. The MNBG Seed Bank processes and stores seed according to Best Practices established by the Center for Plant Conservation (CPC 2025).

Memorandum of Understanding (MoU). MNBG has a Memorandum of Understanding with some organizations. An MoU is desirable to let the next generation understand the intent of the agreement (Appendix B.1).

Ownership of the Next Generation of Seed. Ownership and/or financial profits from ROD disease resistant seed was not discussed or determined.

Germination Trials. Hilo ʻŌDRP would be growing the seed in their nursery. Hilo ʻŌDRP determined a certain number of plants were needed for testing. To have the number of plants they needed, MNBG needed to know how many seeds to send to Hilo ʻŌDRP). Therefor germination estimates needed to be known (Appendix B.2). Germination estimates varied from 0-18%. MNBG, having limited nursery space, received help from the Maui Native Nursery to do many of the germination trials in their nursery.

Seedlings from Germination Trials. Often organizations do not keep seedlings resulting from germination trials. Raising plants takes time and space. If the seedling is kept, then the seed owner becomes the seedling owner, and makes the decisions for the future of their plant.

For some of the germination trial seedlings grown at MNBG, permission was received from the seed/seedling owner to use the plants for Sentinel Plots or Fire Restoration. Two state organizations chose to plant their ʻōhiʻa for conservation and restoration, totaling 115 ʻōhiʻa trees. In these cases, the seed was collected from the same land, or land nearby, ensuring genetic integrity.

Field Work. This project required field work on three islands. Each island is very different in terrain, cultural character and availability of resources. Qualities needed: respect and adaptability. Strategize logistics. Transport supplies and people, safely, including Covid protocol. Availability of transport: 4WD vehicles, borrow or rent (MNBG had no 4WD vehicle). Need skilled 4WD drivers on difficult terrain. Helicopter training. Schedule hike time/distance, food breaks, supplies, allow for unexpected delays. Completed 29 remote field trips by MNBG, 599 volunteer hours, 139 times a volunteer participated (out of 85 individuals).

Permits & Release Forms

Land Access permit. Private land, governmental land, or from the conservation group that managed the land.

Loan Agreement permit. A 'Loan Agreement' permit was required by the National Park, because MNBG removed the National Park's specimens ('ōhi'a seed) off-site, to be stored off-site, in the MNBG Seed Bank. Technically the National Park was loaning their seed to MNBG.

Investigator's Annual Report (IAR). This yearly report was required by the National Park. It reported on the activities and findings (spreadsheets and photos) done during the National Park access permit dates.

Waivers and Release Forms signed by participants. These were required by MNBG and/or by landowners/land managers.

Training – Helicopter. Helicopter safety, aviation training for selected personnel. Interagency Aviation Training (IAT) A-100 Basic Aviation Safety. The MNBG field work organizer held the required roles of Unit Aviation Training Administrator (UATA) and Supervisor.

Training – First Aid. Basic First Aid-Training – Red Cross.
Remote First Aid Training – Red Cross.

Travel inter-island. Each island is very different in terrain, cultural character and availability of resources. Bring respect for the host island, and adaptability. Prevail positively during unexpected changes.

Schedule: Flights, ground transportation, gasoline, grocery, time to eat, hike time/distance, weather, collect seed, allow for unexpected cancellations and delays (flights, vehicles, housing, weather, etc).

Using a fruit picker to reach 'ōhi'a seed capsules up high, or over a steep gully. Credit: MNBG.

Marine transportation. There was a commercial ferry from Maui to the island of Lāna'i. Though the drive time to meet the ferry, find parking, pay for parking and mileage, add to that travel time on the water, docking and waiting in lines with other passengers, a better decision was to fly to the island, into a small, uncrowded airport. There was no commercial ferry from Maui to the island of Moloka'i.

Airlines. Small airplanes. Few flights. Flight cancellations (not enough people, weather). Small cargo holds, packaging requirements for transport of tools. Sanitize tools, clean clothing and boots, so no plant disease or injurious pest introduction from one island to another.

Ground transportation. 4WD jeeps were not always available to rent. Few gasoline stations, limited hours.

Housing. Sleeping compatibility, privacy, snoring. Few rentals available on the island of Moloka'i. On the island of Lāna'i, the organization of Pūlama Lāna'i graciously offered housing, and transportation.

Nourishment. Food and water. Schedule grocery shopping, at times only two grocers on island, with limited hours open. Schedule breakfast, lunch, dinner and snacks. Address personal nutritional and medical requirements.

Supplies. Designate separate tools (fruit pickers) for each island. Prioritize sanitation of tools and clothing so as not to transport plant disease or injurious pests from one island to another.

Hawaiian Protocol. Give respect (ha'aha'a). Chant (oli) to request entry, activity. Have gratitude (mahalo). (Appendix B.4.5**)**

Hiking Trail. Safety protocol, maps, GPS units, field kit, cell phone numbers, sanitized tools and boots, clothing, food, water, personal nutritional and medical needs, hygiene supplies.

Field Kits. Given to partners, borrowed by volunteers. Use bright colors to find while immersed in vegetation. See a list of items (Appendix B.4.4) and a pre-planning time-line (Appendix B.4.1), and efficient data collection tools (Appendix B.4.3).

Simplified field kit, light-weight, smaller.

A complete field kit. Photograph by M. M. Chau.

In the Seed Lab

'Ōhi'a seeds are orthodox (they can remain viable after dried and frozen). Some 'ōhi'a seeds stored for 18 years, remained viable. In this way, Seed Banks can store genetic diversity, safeguarding whole ecosystems, in a small space.

Meticulous studies storing Hawaiian seeds began in 1995 at Lyon Arboretum. The impetus for this research was two-fold. The high rate of extinction in Hawai'i, and few studies had been done on tropical seed freeze storage.

The Hawaiian study represented the largest number of species within a regional flora to be assessed for real-time seed longevity, with over 20 years of data. It was one of the few studies to assess seed storage behavior for a large sampling of native tropical flora and the first to find a large proportion of species with freeze-sensitive seed storage behavior (Chau, M. et al 2019, pg.1261).

With parameters from that study, MNBG processed 'ōhi'a seed. The small, eye-lash sized seed was separated from other plant material (capsules, stems, etc). Seeds were weighed for a total count, dried to a certain relative humidity (RH), over a certain length of time, then sealed in an air-tight foil package, labeled, filed and frozen (Laukahi 2025). MNBG gratefully, has its own database, previously created by a volunteer. Detailed map data was stored such as the Geographic Reference Areas (Appendix B.4.6).

For this project, 139 times volunteers participated in the seed lab (by 27 individuals), giving 435 volunteer hours. The total 'ōhi'a seed stored at MNBG by the end of the project was 6,800,000+. Given a seed germination and survival rate of 5%, stored were potentially 300,000+ 'ōhi'a trees.

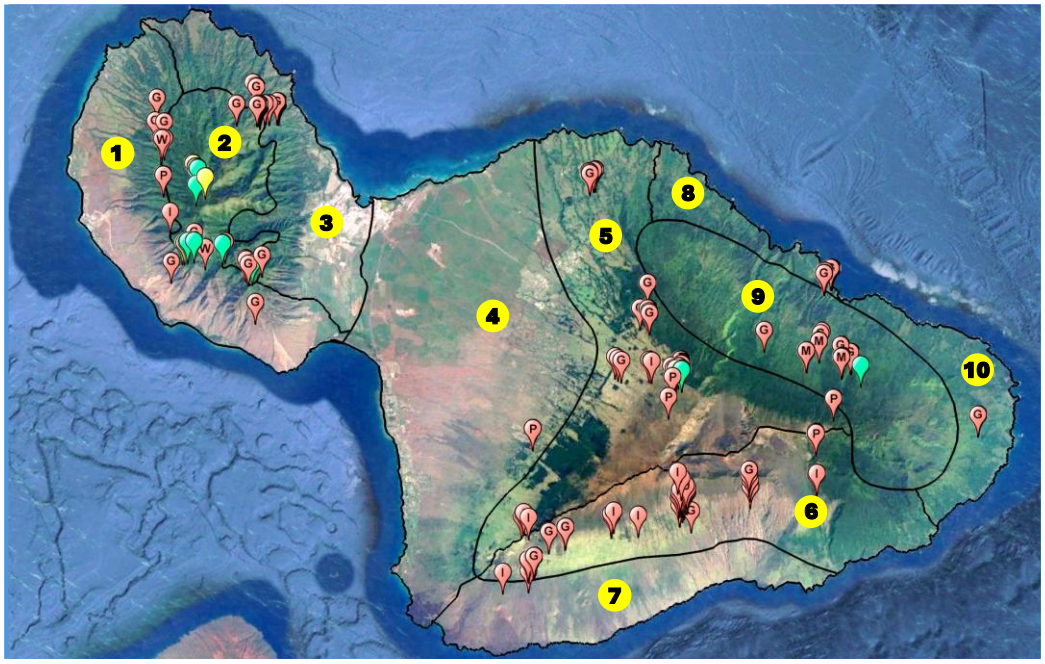
5,000 'ōhi'a seeds with a U.S. quarter coin (24.26 mm diameter, 1.75 mm thickness) for scale. Photograph and info by M. M. Chau.

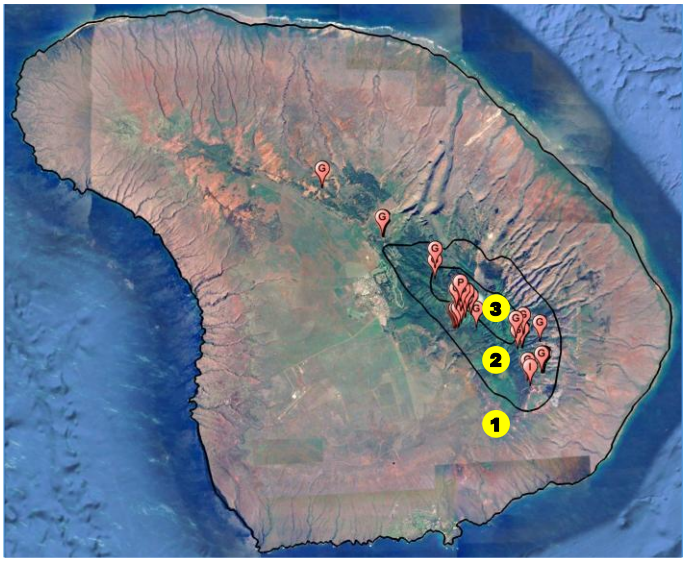
Ripe 'ōhi'a seed before being wind-dispersed from their capsules. Photograph by M. M. Chau.

Unripe, green 'ōhi'a seed capsules. Photograph credit MNBG.

RESULTS

‘Ōhi‘a Seed Accessions. Collected seeds from all seven taxa found within the Maui Nui islands. Collected seeds from all 16 seed zones where the taxa were found: Maui (9 out of 10 zones), Moloka‘i (4 out of 7 zones), Lāna‘i (3 out of 3 zones). Collected 205 accessions from August 12, 2021-August 13, 2024.



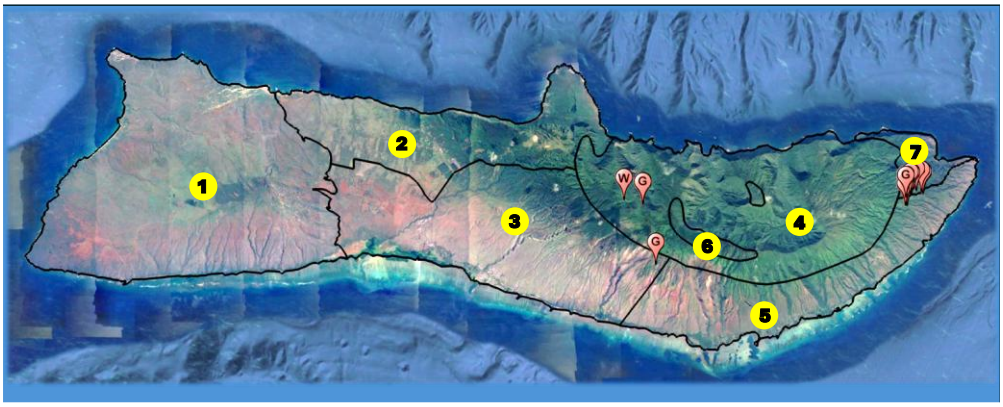


Key:

Red oval flags are accessions (each accession is from one tree).

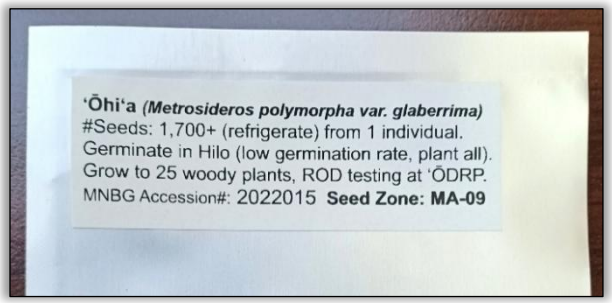
Yellow circles are Seed Zones.

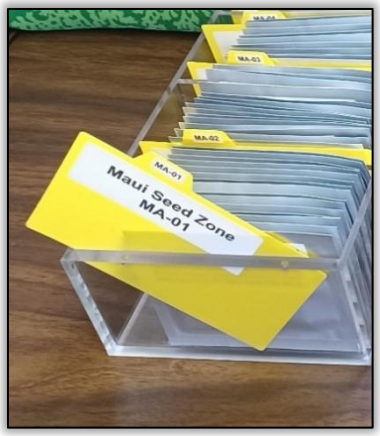
Maps creator credit: M.M. Chau.



Seeds packaged for delivery to the Hilo ʻŌhiʻa Disease Resistance Program (ʻŌDRP).

Re-packaged 316 accessions for delivery to the Hilo ʻŌhiʻa Disease Resistance Program, completing grant deliverable of 300+ accessions. Determine amount of seed (Appendix B.3.1). Packaging small seed (Appendix B.3.2).





Credits, three photo: C. Davenport

Fact Sheet
As of December 31, 2024 (unless otherwise noted)

Seeds Collected – (each accession from one tree)
3 islands – Maui, Molokaʻi, Lānaʻi
16 seed zones – Maui (9 out of 10), Molokaʻi (4 out of 7), Lānaʻi (3 out of 3)
7 taxa – all types found within the Maui Nui islands
205 accessions collected from August 12, 2021-August 13, 2024
316 accessions packaged for delivery to Hilo ʻŌhiʻa Disease Resistance Program

Conservation Workshops
12 workshops
180 attendees (including 76 high school students)

Webinars
3 webinars

Volunteers – as of June 12, 2025
310 individuals (participated 702 times)

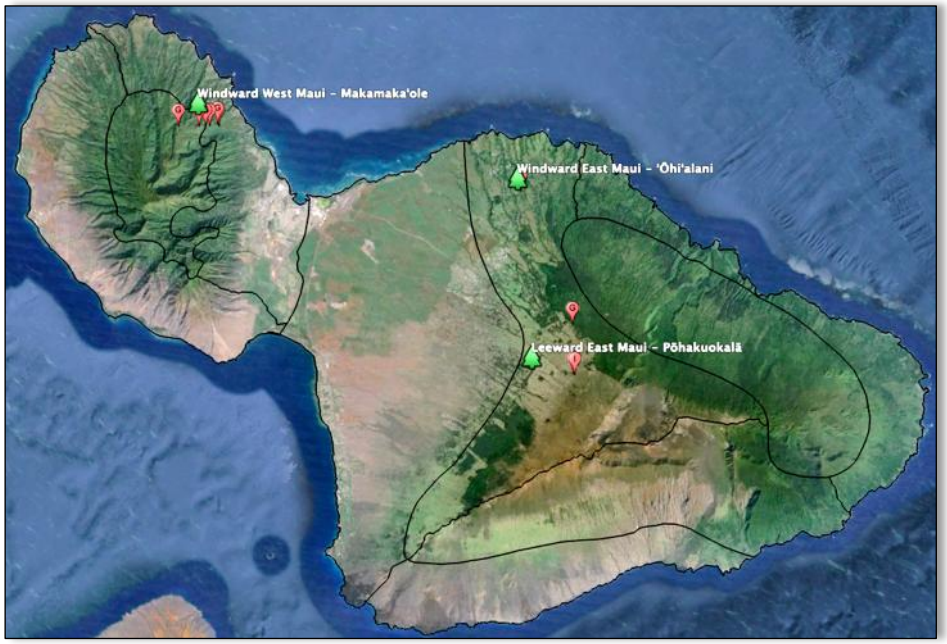
Seed Processing – as of June 12, 2025
27 volunteers (participated 139 times)
435 volunteer hours

Remote Field Trips
29 remote field trips
85 individual collectors (participated 127 times)
599 volunteer hours

Partners
27 for land access and field collection (13 new partners)

Partner Organization's Remote Field Trips
33 remote field trips, by 7 partners (in addition to 29 MNBG remote field trips).
Empowered Partners – Trained by MNBG & Kalehua Conservation Seed Consulting, some partners generously collected seed on their own, while in remote areas, using their personnel and their transportation (including helicopter time).

Sentinel Plots. Plants used for sentinel plots were grown from germination trials with seeds collected nearby. A total of four sentinel plots were established. Two plots established on Haleakalā (East Maui), one windward, one leeward. And two plots were established on Mauna Kahālāwai (West Maui), one windward and one leeward.



<u>New</u> detection of spittle bug insect pest.

(In addition to expected myrtle rust.)

Key:
Green flags are sentinel plots.
Red flags show seed collection areas.

Map credit: M.M. Chau. Photo credits: ʻŌDRP

An unexpected benefit to the community. For better and worst.

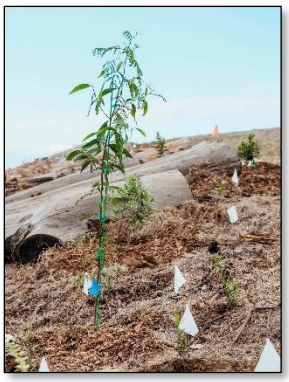
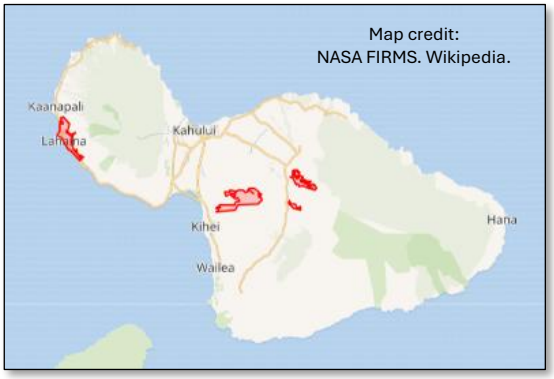


Photo credit: J. Imhoff

Maui endured raging fires, burning in four separate communities, at the same time, across the island, on August 8, 2023. One fire was particularly horrific, with the loss of 102 lives (2 missing), devasting the town of Lāhaina.

Two of the four fires were in upcountry Maui (Olinda and Kula). One fire was in central Maui (Pūlehu). Then in Lāhaina, on Mauna Kahālāwai (West Maui).



From the upcountry area, MNBG had already grown 122 ʻōhiʻa in germination trials, from seed collected nearby. With permission from the seed owner, these plants were donated for fire restoration to two self-organized upcountry organizations, a Conservation Initiative and a Watershed Alliance.

MNBG did not have plants germinated from seeds in the Lāhaina area. However, Heather did. Growing up in Lāhaina, Heather had learned from her great uncle how to collect ʻōhiʻa seed in the forest above Lāhaina. He taught her how to germinate the seed, a seed not easy to germinate. A slow growing tree, she had many in pots, some quite large, and hundreds of seedlings. Her great uncle had just recently passed away, before the fire, and these plants were precious. As the fire neared, Heather, friends and family saved the plants they could.

Shortly thereafter, Heather attended an ʻŌhiʻa Workshop at MNBG. She told us her story. We were humbled, and agreed to care for her plants in the MNBG nursery. She mostly wanted her plants to help the Lāhaina community. MNBG embarked on an outreach to Lāhaina area residents (see appendix C.1), to see who would like an ʻōhia from Lāhaina, telling them Heatherʻs story. MNBG would care for the plants, up until August 8, 2025, (for over a year, when the MNBG nursery would run out of room). They shared heart-felt stories (Appendix C.2).
A total of 65 Lāhaina ʻōhiʻa were returned back home.

PARTNERSHIPS

Land Access & Field Collection
Auwahi Wind
Department of Hawaiian Homelands
DLNR-DOFAW-NARS – Maui & Molokaʻi
DLNR-DOFAW-NEPM-SEPP – Maui
East Maui Watershed Partnership*
Haleakalā National Park
Haleakalā Ranch
Hāna Ranch
Kupu Hawaiʻi
Leeward Haleakalā Watershed Restoration Partnership*
Maui Forest Bird Recovery Project
Maui Nui Seabird Recovery Partnership
Maui Plant Extinction Prevention Program
Mauna Kahālāwai Watershed Partnership
MNBG Volunteers
Molokaʻi Land Trust
ʻŌhiʻalani
Private Landowners (2)
Pūlama Lānaʻi*
Puʻu Kukui Watershed Preserve*
Puʻu o Hōkū Ranch
Skyline Conservation Initiative*
Snail Extinction Prevention Program
The Nature Conservancy – Maui* & Molokaʻi
Uhiwai o Haleakalā
Ulupalakua Ranch
**Organizations that hosted ʻŌhiʻa Seed Consesrvation Workshops for their staff*.

Outreach & Education
ROD Outreach Working Group
Laukahi Hawaiʻi Plant Conservation Network
Kula Community Watershed Alliance
Kamehameha Schools Maui
ʻŌhiʻa Legacy Initiative

Volunteers
Hundreds of individual volunteers for field work, training, seed processing and outreach

Plant Propagation
Aileen Yeh Nursery
Maui Native Nursery
Kupu Hawaiʻi

Funding & In-Kind Research Support
Maui County Department of Water Supply
USDA Forest Service Urban & Community Forestry Grants Program
Akaka Foundation for Tropical Forests

Acknowledgements.


Photo credit: C. Davenport

Most impressive are the upcoming generations in Hawai‘i who are entering the fields of restoration and conservation. Their knowledge, determination and alacrity have been a joy to work with. They have my admiration and deep gratitude. I thank those who have taught them. I thank their bosses for allowing them a wide reign to assist with endeavors, such as this project.

MNBG is grateful to USFS for believing in our abilities, and offering financial support. MNBG was very lucky to have been assigned Miranda Hutten as our USFS contact. Miranda skillfully and patiently offered wise suggestions, especially when we needed to adapt to changes.

Marian M. Chau led us. I believe she is capable of any skill needed. I don’t know what she can’t do. She brought to us a stunning history of experience. She led us graciously, keeping us on track with the big picture, while she created detailed exquisite maps, downloaded enormous amounts of data and kept organized the difficult work of intricate spreadsheets.

Tamara Sherrill wore many hats. For this USFS project, she completed progress reports, financial reports, negotiated changes, updated timelines, and adjusted personnel. As she was doing that, impressively, she kept the MNBG non-profit organization one of the best ever. A place inviting, full of events and classes, always closely aligned with Hawaiian plants and culture.

My ‘comrades-in-arms‘ for many of the seed collecting trips, especially interisland, were Jennifer Higashino and Emmely Cabacungan. Both had connections and excellent reputations with other islands. Both upheld great work ethics; adapted calmly to unexpected and/or difficult situations; were skilled in remote areas, with 4WD; and were fun. We spent days round-the-clock as co-workers, and sharing living quarters. They were the perfect team, and I am grateful our paths met.

Humbled by the kōkua of our partners and volunteers, respectfully, I cannot name in this small space, the hundreds of people that gave of their time and effort. I know, that they know, how greatly they have been appreciated, and how valued their work. Still, I must thank you again, pau’ole, without end.

I have learned that, if people don’t care, it’s not going to happen. And if they care, more than you thought, will happen.

E mālama pono,
Cathy Davenport
Seed Storage Technician
Maui Nui Botanical Gardens

References

Abbott, Isabella A. (1992). La‘au Hawai‘i Traditional Hawaiian Uses of Plants. Copyright 1992 Bishop Museum. Library of Congress Catalog Card No. 91-073874. ISBN-0-930897-62-5.

Chau, Marian M. et al (2019). Seed freeze sensitivity and ex situ longevity of 295 species in the native Hawaiian flora. American Journal of Botany, 106, pg 1261. Citations: 47
https://bsapubs.onlinelibrary.wiley.com/doi/full/10.1002/ajb2.1351
https://doi.org/10.1002/ajb2.1351

Chau, Marian M. (2020). Rapid response to a tree seed conservation challenge in Hawaii through crowdsourcing, citizen science, and community engagement. Journal of Sustainable Forestry.
DOI:10.1080/10549811.2020.1791186.
Marian M. Chau http://orcid.org/0000-0002-4114-3804
Journal of Sustainable Forestry 2022-08-09 | Journal article
DOI: 10.1080/10549811.2020.1791186 URL: https://doi.org/10.1080/10549811.2020.1791186
Contact: Marian M. Chau; mmchau@hawaii.edu; Kalehua Seed Conservation Consulting, Aiea, 96701

CPC (2019). Best Plant Conservation Practices to Support Species Survival in the Wild. Center for Plant Conservation**.** https://saveplants.org/wp-content/uploads/2020/12/CPC-Best-Practices-5.22.2019.pdf

CPC (2025). Best Plant Conservation Practices. Center for Plant Conservation. Website.
https://saveplants.org/best-practices/why-conserve-rare-plants/

Laukahi (2025). Laukahi Hawai‘i Plant Conservation Network: https://laukahi.org/
Best Practices: https://laukahi.org/wp-content/uploads/2021/06/HawaiiSeedBankPartnership.pdf
‘Ōhi‘a Seed Protocol: https://laukahi.org/wp-content/uploads/2021/06/HawaiiSeedBankPartnership.pdf
Seed Zone Maps: https://laukahi.org/seed-zone-maps/

Loope, L. (2016). Guidance document for Rapid ‘Ōhi‘a Death. U.S. Forest Service. https://www.fs.fed.us/psw/publications/hughes/psw_2016_hughes006_loope.pdf
https://www.fs.usda.gov/psw/publications/hughes/psw_2016_hughes006_loope.pdf
Background for the 2017—2019 ROD Strategic Response Plan by Lloyd Loope December 2016

Luiz, Blaine C. et al (2022) A framework for establishing a Rapid ‘Ōhi‘a Death resistance program
Springer Nature. https://link.springer.com/article/10.1007/s11056-021-09896-5
Research Gate.
https://www.researchgate.net/publication/358105090_A_framework_for_establishing_a_rapid_'Ohi'a_death_resistance_program#:~:text=638,ecosystem%20composition%2C%20structure%2C%20and%20function
New Forests. https://doi.org/10.1007/s11056-021-09896-5.
New Forests (2023) 54:637–660. January 2022 New Forests 54(S2):1-24. License CC BY 4.0

MISC (2025). ‘Ōhi‘a seeds from resilient trees may hold the key to stopping Rapid ‘Ōhi‘a Death. Maui Invasive Species Committee interview with Ryan Belcher, Operations Specialist, ‘Ōhi‘a Disease Resistance Program. Published in Maui Now on July 7, 2025. https://mauinow.com/2025/07/07/misc-%CA%BBohi%CA%BBa-seeds-from-resilient-trees-may-hold-the-key-to-stopping-rapid-%CA%BBohi%CA%BBa-death/

OHA (2023). Island Community Report: Lāna‘i. Office of Hawaiian Affairs. Executive Summary.
https://www.oha.org/wp-content/uploads/2023-Lanai-Executive-Summary.pdf

OHA (2024). Island Community Report: Moloka‘i. Office of Hawaiian Affairs. https://www.oha.org/wp-content/uploads/2024-Molokai-Island-Community-Report.pdf

Pukui, Mary K. (1983). ʻŌlelo Nōeau – Hawaiian Proverbs & Poetical Sayings. Bernice P. Bishop Museum Special Publication No. 71, Bishop Museum Press, Honolulu, HI

Pukui, Mary K. & Elbert, Samuel H. (1986). Hawaiian Dictionary. University of Hawaii Press, Honolulu, HI.

SOH (2020). 2020-2024 Rapid ʻŌhiʻa Death Strategic Response Plan. State of Hawaiʻi. PUB1.14.20. Contact Rob Hauff, State of Hawaiʻi, DLNR Division of Forestry & Wildlife. https://gms.ctahr.hawaii.edu/gs/handler/getmedia.ashx?moid=66598&dt=3&g=12

SOH (2024). Latest Population Estimate Data. State of Hawaiʻi – Department of Business, Economic Development & Tourism. (Released June 26, 2025). https://census.hawaii.gov/home/population-estimate/

SOH (2025). ʻŌhiʻa Lehua. State of Hawaiʻi – Department of Land and Natural Resources. Division of Forestry and Wildlife: Forestry Program. https://dlnr.hawaii.gov/forestry/plants/ohia-lehua/

Wagner, Warren L., et al (1999). Manual of the flowering plants of Hawaiʻi. Revised Edition Volume 1, pgs 964-965. Bishop Museum, Honolulu, HI

WPR (2025). Demographics. World Population Review. https://worldpopulationreview.com/us-cities/hawaii/lanai-city

Webinars

Seed collection and storage in the Maui County ROD Resistance Project
Chau, Marian M. et al (2023). Hawaiʻi Conservation Conference 2023.
Symposium: Advances in Managing Rapid ʻŌhiʻa Death and Protecting Hawaiʻi's Native Forests

Seed collection and storage in the Maui County ROD Resistance Project
Chau, Marian M. et al (2025). National Native Seed Conference 2025. Feb 24-27, 2025.
Advances in Managing Rapid ʻŌhiʻa Death and Protecting Hawaiʻi's Native Forests

Engaging community with wild seed collection to protect genetic diversity and develop disease resistance for ʻŌhiʻa, a keystone native Hawaiian tree.
Sherrill, T. et al (2025). The Region 5 US Forest Service Urban and Community Forestry program. March 6, 2025.

Figures

Figure 1. Mokiao-Lee, Ambyr. ʻŌhiʻa Distribution by Moisture Zone. From powerpoint: Importance of ʻŌhiʻa and Rapid ʻŌhiʻa Death (ROD) by Ambyr Mokiao-Lee, Statewide ROD Outreach Coordinator, U.H. Mānoa, Hawaiʻi

Figure 2. Luiz, Blaine C. et al (2022) A framework for establishing a Rapid ʻŌhiʻa Death resistance program
Springer Nature. Distribution of diseases, figure from page 643. New forests. https://doi.org/10.1007/s11056-021-09896-5. New Forests (2023) 54:637–660. January 2022 New Forests 54(S2):1-24. DOI:10.1007/s11056-021-09896-5 License CC BY 4.0

Websites

Kalehua Seed Conservation Consulting: https://www.kalehuaconsulting.com/

LIST OF
APPENDICES