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# ‘Ōhi‘a Seed Collecting Program to Mitigate Disease Threats

## VOLUNTEERS NEEDED

There are disease threats to ‘Ōhi‘a (*Metrosideros* sp.) that may push ‘Ōhi‘a towards extinction. Maui Nui Botanical Gardens is part of a statewide ‘Ōhi‘a Disease Resistance Program, that collects ‘Ōhi‘a seed to mitigate extinction.

Some seed is sent to Hilo to be grown and tested for disease resistance. Duplicate seeds are kept on Maui, stored at the MNBG Seed Bank. If a wild tree’s seeds are found to be disease resistant, its duplicate seed stored on Maui can be planted on Maui. Those trees can then supply seeds to grow more disease resistant ‘ōhi‘a trees. We welcome hālau, clubs, student groups and individual Maui residents who would like to learn.

Training community members is in two parts.

### Community Training: Part 1

The first part of the training is a 3-hour class taught by Dr. Marian Chau of Kalehua Seed Conservation Consulting. Marian gives an amazingly thorough and fun overview on how to recognize different ‘ōhi‘a species, how to collect seeds and record collections. Participants can view virtually or opt to come to MNBG and view the screen with others, with the addition of hands-on materials.

### Community Training: Part 2

The second part of the training is the day of the field trip where we collect seed and identify the varieties of ‘ōhi‘a. Our first training session field trip resulted in a wonderful day at Haleakalā National Park. Mahalo to Woody Mallinson, HNP Natural Resources Program Manager.

### SIGN-UP FOR TRAINING

To sign up for a training session, please contact the MNBG Seed Storage Technician, Cathy Davenport, by email at [cathy@mnbg.org](mailto:cathy@mnbg.org).

Groups can be scheduled privately and Cathy is willing to come to you.

Pictured: ‘Ōhi‘a Seed Collection Kit



This effort is supported by USDA Forest Service Region 5 Urban and Community Forestry Program. USDA is an equal opportunity provider and employer.



Appendix A.2  
Flyer for Rapid 'Ōhi'a Death (ROD) Project

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<https://laukahi.org/wp-content/uploads/2024/07/Maui-County-ROD-Resistance-Project.pdf>



# Maui County Rapid 'Ōhi'a Death (ROD) Resistance Project



## THE CHALLENGE

'Ōhi'a is a **keystone species** of Hawai'i's native forests and watersheds, but it is threatened by the disease **Rapid 'Ōhi'a Death (ROD)**. We need to collect and preserve seeds of 'ōhi'a for future restoration and develop natural resistance to ROD, especially on the islands of Maui, Moloka'i, and Lāna'i.



'Ōhi'a seeds inside capsules, ready to be collected. Photo by MNBG.



'Ōhi'a seed collection on Maui by MNBG staff. Photo by MNBG.

## OUR SOLUTION

**Hawai'i Agriculture Research Center (HARC)** is leading a project to develop disease-resistant 'ōhi'a seed orchards for Maui County. By identifying trees with resistance to ROD, we can use natural breeding programs to grow more ROD-resistant 'ōhi'a trees for future planting and ecosystem restoration.

This project is made possible by funding from **Maui County Department of Water Supply, USDA Forest Service, and the Hawai'i Tourism Authority.**

## OUR PROJECT PARTNERS

- **Maui Nui Botanical Gardens (MNBG)** - seed collections, collaboration with Maui County conservation partners, germination trials, long-term seed bank storage
- **Kalehua Seed Conservation Consulting** - seed collection strategy, data management, training & community outreach
- **'Ōhi'a Disease Resistance Program ('ŌDRP)** - testing of 'ōhi'a for ROD resistance, training on disease monitoring
- **Laukahi Hawai'i Plant Conservation Network** - web & social media outreach, data sharing & visualization



ROD resistance testing in the 'ŌDRP greenhouse (Hawai'i Island). Photo by 'ŌDRP.



MAUI COUNTY ROD RESISTANCE PROJECT

## KEY ACCOMPLISHMENTS: SEEDS

- 275+ New seed collections from individual, wild ‘ōhi‘a trees since the start of this project (Oct 2020)
- 480+ Total ‘ōhi‘a trees with seed collections in storage at MNBG Seed Bank, available for resistance testing
- 85+ Seed collections germinated for viability estimates at MNBG, to inform resistance testing
- 60+ Seed collections sent to ‘ŌDRP for ROD resistance testing on Hawai‘i Island



‘Ōhi‘a seed collections by MNBG and conservation partners in Maui County. Photos by MNBG.



Dr. Marc Hughes of ‘ŌDRP training members of Kula Community Watershed Alliance how to monitor ‘ōhi‘a trees for diseases (both ROD and ‘ōhi‘a rust) at the recently planted Leeward East Maui Sentinel Plot. Photo by Kalehua Consulting.

## KEY ACCOMPLISHMENTS: PLANTING

- 3 ‘Ōhi‘a Sentinel Plots established on Maui
- 60+ ‘Ōhi‘a saplings planted in ‘Ōhi‘a Sentinel Plots

### What is a Sentinel Plot?

Since resistance testing takes many years, a first step is to establish sentinel plots, using saplings grown from the same seeds being tested for ROD resistance. These trees are carefully monitored for signs of ‘ōhi‘a diseases (including ROD and ‘ōhi‘a rust), serving as an early detection system. Once disease resistance is identified, descendants of resistant mother trees in sentinel plots could serve as the foundation to expand into a seed orchard and ROD-resistance breeding program.

## KEY ACCOMPLISHMENTS: TRAINING & OUTREACH

- 25+ Partner organizations from the conservation community contributing seed collections to MNBG
- 165+ Maui County residents trained in ‘Ōhi‘a Seed Conservation Workshops by Kalehua & MNBG
- 500+ Volunteer hours by > 200 individuals in seed collections, workshops, or outreach events
- 650+ Community members reached at outreach events, such as MNBG Arbor Day and ‘Ōhi‘a Love Festivals, and Hawai‘i Conservation Conference



Workshops/outreach events led by Dr. Marian Chau (Kalehua), Cathy Davenport (MNBG), and Nick Dudley (HARC). Photos by MNBG, left, and Kalehua, right.

Updated June 2024

**Appendix B.1**  
**Seed Ownership, Memorandum of Understanding (MoU) sample**

**Memorandum of Understanding (MoU)**  
**between the Maui Nui Botanical Gardens (MNBG)**  
**and \_\_\_\_\_ (Partner)**

**Purpose**

The purpose of this Memorandum of Understanding (MoU) is to promote effective communication between us. This MoU is not a binding agreement or contract but is intended to explain a plan for seed stored by MNBG, clearly documented for future reference. The seed stored by MNBG is owned by \_\_\_\_\_ (Partner). \_\_\_\_\_ (Partner) chooses the purpose, use and release of their seed stored by MNBG.

**Mutual Interest and Benefit**

MNMG and \_\_\_\_\_ (Partner) have a joint interest in conservation and restoration of native species and their habitats. Native plant communities provide habitat for native fauna. MNMG will facilitate projects important to \_\_\_\_\_ (Partner). MNMG will safeguard \_\_\_\_\_ (Partner) target species, ensuring biodiversity within a variety of habitats on lands important to \_\_\_\_\_ (Partner). Such species may be Naio (*Myoporum sandwicense*) against the Naio thrip and 'Ōhi'a (*Metrosideros* sp.) against Rapid 'Ōhi'a Death (ROD).

**Maui Nui Botanical Gardens**

The MNMG Seed Bank was established to share a role in conservation, restoration and protection of native species and their ecosystems by safeguarding seed and other ex-situ aspects of plant conservation. MNMG is managed as a non-profit. MNMG seed collection and seed processing protocol is in accordance with standards used at Lyon Arboretum. <https://manoa.hawaii.edu/lyon/research/hrpp/>

Coordination of Seed Storage

MNMG oversees activities related to seeds storage (including processing, accessioning, viability testing, drying, packaging, and monitoring collections. MNMG coordinates these collections by providing collection and post-harvest handling protocols, as well as recommendations for re-collection intervals. These services are at no cost to \_\_\_\_\_ (Partner).

Seed Bank Partnership

Maui Nui Botanical Gardens, as a member of the Hawai'i Seed Bank Partnership, protects seed in a secure location for future use. <http://laukahi.org/hawaii-seed-bank-partnership/>

Rapid 'Ōhi'a Death (ROD)

As a precaution to defend against extinction, MNMG preserves 'Ōhi'a (*Metrosideros polymorpha*) seed as a partner in the ROD statewide seed banking initiative led by Laukahi Network. Some of the 'Ōhi'a seed processed by MNMG is stored at Lyon Arboretum for a duplicate place of safe storage, unless otherwise specified by \_\_\_\_\_ (Partner). <http://laukahi.org/ohia/>

Target Species for the MNMG Seed Bank

MNMG priority is to store wild collected seed (seed from a plant not grown by a person). MNMG stores seed from cultivated or outplanted plants if that is helpful to Pūlama Lāna'i projects, yet the best genetic diversity usually occurs in natural populations.

MNMG kuleana is coastal areas, as well as wild 'Ōhi'a seed from any environment. MNMG stores native Hawaiian seed from the four islands of Maui Nui (Maui, Moloka'i, Lāna'i and Kaho'olawe).

Permit

MNBG holds a *Natural Area Reserve, Rare Plant, and Native Invertebrate Research Permit* from the Department of Land and Natural Resources. This permit allows MNBG to collect federally listed threatened and endangered species located in Maui County, with permission from the landowner.

(Partner)

(Partner) may choose to facilitate this collaboration by collecting their own seed to be given to MNBG for seed storage. (Partner) and MNBG will periodically assess this collaboration.

**In Closing**

Any revision, modification or termination will be given in writing. Nothing in this MoU shall be construed as giving any type of exclusive arrangements to the exclusion of other groups or organizations. Nothing in this MoU shall create a contract of employment. Neither party shall be authorized to act in the name of or on behalf of the other. This is neither a fiscal nor a funds-obligated document. Nothing in this MoU shall be construed as obligating either party to extend funds or other resources, nor incur any obligation in the present or future.

**Signed**

In the spirit of cooperation, we the undersigned have read and agree with this Memorandum of Understanding.

\_\_\_\_\_ date \_\_\_\_\_

\_\_\_\_\_ date \_\_\_\_\_

\_\_\_\_\_  
Executive Director  
Maui Nui Botanical Gardens  
150 Kanaloa Ave., Kahului, HI 96732  
Tel (808) 249-2798 ext 205  
tamara@mnbg.org

*Partner Representative*  
*Title*  
*Name of Organization*  
*Address*  
*Telephone/Cell*  
*Email address*

## Appendix B.2 Germination Estimate Protocol

### Maui County Rapid 'Ōhi'a Death (ROD) Resistance Program

#### Prepare pots & media

1. Use new or clean 2" or 3" compots (# of pots = # of accessions to test x 2 reps)
2. Fill about ¾ of pots with well drained potting mix (e.g. 1:1 soil & cinders)
3. Top with a layer of sterile sphagnum moss
  - a. Cut/chop up sphagnum to make transplanting easier later
  - b. Saturate sphagnum to prepare pots
4. Make sure the layer is thin (just enough to fully cover the surface), but complete (no potting mix showing through), and press the sphagnum down a bit to make the surface fairly even, to avoid deep (relative to seeds) crevices in the moss

#### Sow 'ōhi'a seeds

1. Count out 2 reps of 100 seeds per accession to be tested
2. Prepare 2 pots per accession, label each pot with:
  - a. MNBG seed bank accession number
  - b. Species/variety code (e.g. MetPolGla)
  - c. Seed zone (e.g. MA-05)
  - d. Date seeds sown
3. Mist/spray sphagnum with water again if not already moist
4. Sow 100 seeds per pot (1 rep per pot)
5. Use insect forceps to place seeds on sphagnum, spread them out so seeds aren't touching each other (do not sprinkle seeds, as they can clump)
6. Mist/spray from above to water the seeds into the sphagnum

#### Run germination test

1. Keep sphagnum and soil consistently moist, using sub-irrigation (placing bottom of pots in trays of standing water) or by placing pots on mist bench
2. Allow germination tests to run for 60 days
3. Check pots regularly to ensure even moisture and watch for any problems

#### Conclude germination test

1. At 60 days, count the total number of seedlings germinated per individual pot
2. Record the % germination for each rep/pot
3. Calculate the average % germination between the two reps/pots per accession

#### Potting the seedlings

1. When seedlings have 4 true leaves, they are ready to up-pot; before this they can be sensitive to being handled
2. Use insect forceps to grasp seedlings by the base of the stem and/or the rooted piece of sphagnum, and transfer seedlings into dibble tubes
3. Also transfer plant tags to dibble rack and add more plant tags as needed

### Appendix B.3 Procedure for Re-Packaging Frozen Seeds for Transport

To mitigate freeze/thaw/freeze destruction (swelling/bursting of seed ovary), while being mailed interisland and then stored in Hilo, the decision was made for Hilo to store the seed in the refrigerator (not the freezer) once the seed arrived.

#### **Most important is to limit moisture entering previously dried seeds.**

Turn on de-humidifier, in addition to air-conditioner.

No need to weigh or count anything. Door to freezer will be opened and closed a lot.

#### **Steps:**

##### **1.**

Pull out one clipped package from freezer. Do one at a time so the other packages stay frozen. Note the accession number on the label (7 digits). Choose an empty origami package. Write this accession# (with pencil only) onto the empty origami package. Open that empty origami on top of a tray, to prepare for receiving 1/8 teaspoon of seed.

##### **2.**

Cut open the closed foil packet. It will need to be resealed, so cut as little as necessary. Some foil packets have been opened many times and are too tiny to reseal. See 'Note b' (above) if this is the case.

Once the foil packet is open, moisture is now entering the packet, and seeds. Remove the origami inside (with seed) and place on a tray separate from the tray with opened, empty origami.

Open up the origami with seed. Measure out 1/8 teaspoon of seed. Place this measured seed onto the empty origami. Stop.

First priority is to do the next step as soon as possible, so that no more moisture gets into the seed that will be refrozen.

##### **3.**

Refold the origami with the remaining (original) seed. Replace that origami package into foil packet. Iron closed the foil packet about ¼ inch from the edge, gently pressing out air as you go (not too hard so that seeds are not harmed). Replace this seed packet back into freezer.

##### **4.**

Second priority is this step, for the seed going into the refrigerator. Fold up the origami with 1/8 teaspoon of seed. Put this origami into the new (open) foil packet. Iron closed (about ¼" edge of) the foil packet. Place this package into the refrigerator.

*Note – Issues that might come up are listed on the 'Notes' page.*

### **Appendix B.3.1 Determine Amount of Seed for Re-Packaging**

Determine the amount of seed to send to the 'Ōhi'a Disease Resistance Program ('ŌDRP) in Hilo for Rapid 'Ōhi'a Death (ROD) disease testing.

#### **The Goal**

#### **According to the 'Ōhi'a Disease Resistance Program ('ŌDRP) workflow chart:**

Grow 80 seedlings to have 40 plants of inoculation size (6mm dia.)

Math: Use 5% germination rate (5 seedlings per 100 seeds).

Mail to Hilo 'ŌDRP, 1,700 seeds (1700 seeds @ 5% germ. rate = 85 seedlings).

#### **Method**

Use weight of 0.0074642 grams per 100 seeds.

Note: This weight determined from averaging 12 accessions collected in Waikamoi, Haleakalā National Park, Maui, on March 02, 2024 (accession numbers 2024006-2024017).

Average weight for 1,700 seeds equals 0.1268914 grams (0.0074642 times 17 = 0.1268914).

Volume used for 1,700 seeds was 1/8 of a teaspoon.

Note: Using volume to measure frozen seeds was quicker than weighing seeds.  
Speed mitigated the thawing of seed.

Calculation: Accession #2024010 was used to determine volume.

Its volume: 1,875 seeds measured 1/8 teaspoon

Its weight: 0.00970 grams per 100 seeds

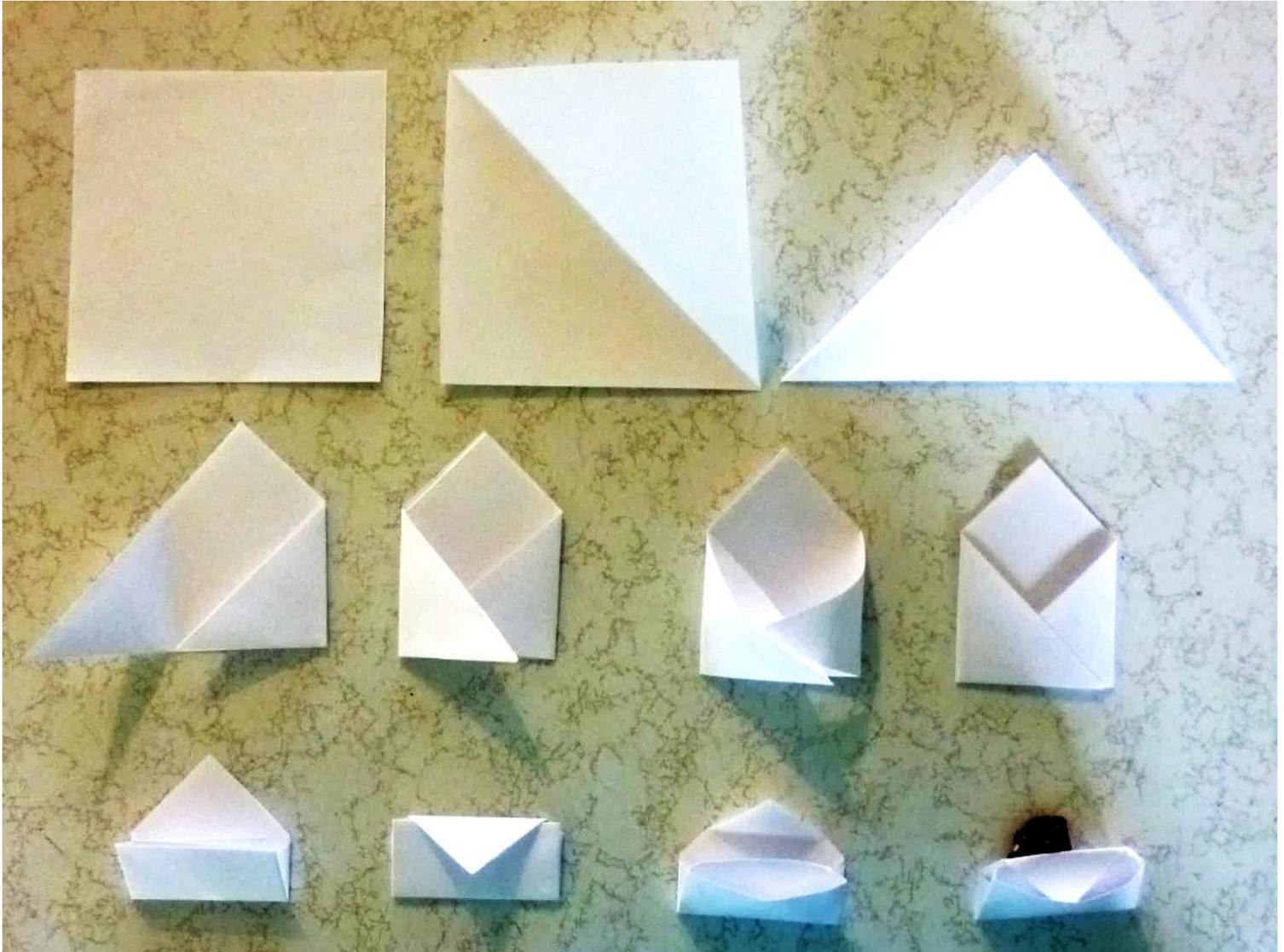
The weight of this seed is larger than the average seed. A larger weight usually results in a larger seed. A larger seed takes up more volume than a smaller seed.

Note: A 1/8 teaspoon measurement with smaller seeds would yield more seeds than the target 1,700 seeds.

**Appendix B.3.2**  
**Packaging Small Seed – Origami**

Origami folding directions.

Best not to use tape, small seeds tend to find it, near impossible to remove the seeds from tape.



**Appendix B.4.1**  
**Timeline – Participant Correspondence**

**Trip Leader to do:**

- 1) Send 1st email:  
Doodle Poll with general fieldtrip info, to find dates volunteers are most available
  
- 2) Send 2nd email: (long before fieldtrip):
  - a) Date of field trip, meeting location, gear to bring, location, elevation, weather, footwear, etc.
  
  - b) Fillable Release Forms
  
  - c) QR Code with link to upload free KoboToolbox\* app.  
Please upload before the day of the fieldtrip to ensure there is internet access for the upload.  
The app can be used off-line after loaded.  
The app is not a requirement, just best for the project.
  
  - d) Let participants know more attachments will be in the next email.
  
- 3) Send 3rd email:
  - a) Reminder of Waiver(s)
  
  - b) Send all other info attachments:  
Waiver and Release form(s); QR Code (with link), Sample Envelope;  
Appendix (with QR Code attached to KoboToolbox Webform);  
Color Photo Identification sheets; Both 'Ohi'a keys (one complex, one simplified);  
Data answers for particular site; Collecting Protocol
  
- 4) Send 4th email: (Closer to date of field trip.)  
Reminder of field trip date, time and location.  
Request a response.

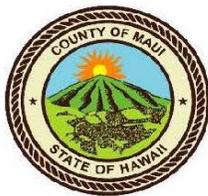
# ‘Ōhi‘a Seed Collection Protocol for Maui ROD Resistance Project



Hawai‘i Agricultural Research Center (HARC)

## Acknowledgments

The Maui ROD Resistance Project is funded by the [Maui County Department of Water Supply](#). This protocol is modified from open-access resources by [Laukahi: the Hawai‘i Plant Conservation Network](#) and [Kalehua Seed Conservation Consulting](#), which also jointly maintain collections data for the [Rapid ‘Ōhi‘a Death Seed Banking Initiative](#). The Seed Bank at [Maui Nui Botanical Gardens](#) (MNBG) accepts ‘ōhi‘a seed collections from Maui, Moloka‘i, and Lāna‘i. We are grateful for the support of all these collaborators, as well as all future contributors of ‘ōhi‘a seeds.



## Introduction

‘Ōhi‘a (*Metrosideros* spp.) are the most ecologically important native trees in Hawai‘i. Now they are seriously threatened by the fungal disease Rapid ‘Ōhi‘a Death (ROD, [rapidohiadeath.org](http://rapidohiadeath.org)). In 2010, the first dying ‘ōhi‘a trees were reported in the Puna district of Hawai‘i Island. ROD has now spread across all districts on the island. In 2015, researchers at USDA identified a *Ceratocystis* species as the cause of the disease. Two new species have been identified and described as *C. lukuohia* and *C. huliiohia*. In 2018, both forms were detected on Kaua‘i, and in 2019 *C. huliiohia* was detected on O‘ahu and Maui, and then eradicated from Maui. HARC’s project “Developing Disease Resistant ‘Ōhi‘a for Watershed Protection on Maui” will use existing banked seeds and new seed collections to test for resistance to ROD, with the goal of establishing seed orchards of ROD resistant genotypes in Maui County. New collections are targeted from under-represented seed zones, initially across the 4 ecoregions of windward and leeward East and West Maui, and later expanding to Moloka‘i and Lāna‘i.

As part of the [2020-2024](#) and [2017-2019](#) ROD Strategic Response Plans, ‘ōhi‘a seed collections are urgently needed statewide. In addition to providing saplings for research on resistance or tolerance to ROD, seeds of ‘ōhi‘a can be secured in long-term seed bank storage to mitigate the potential loss of genetic diversity and provide appropriate plant material for restoration and watershed rehabilitation.

## Ownership of Collections

Landowners retain ownership of seed collections by default; however, conditions for releasing collections of ‘ōhi‘a seeds can be specified in the ‘Ōhi‘a Seed Collection form (see below). Unless you own the land, you need permission from the landowner to collect seeds. [Collectors](#) are responsible for permits, permissions, and any other approval needed to make, transport, and submit seed collections to MNBG.

## Appendix B.4.2 – Seed Collection Protocol

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### Sanitation

The fungus that causes ROD has both sticky spores that stick to tools, gear, and debris from wood-boring insects; and hard coated spores that survive in soil, on live trees, and in harvested ‘ōhi‘a wood. The hard spores may lay dormant for months or even years. ROD is spreading across islands, so following sanitation protocols – even in areas in Maui County where ROD is not known – is critical to prevent spread. Be sure to thoroughly clean tools and shoes using at least 70% isopropyl alcohol, and wash clothes and other gear in hot water and detergent before hiking in a new location. Consider designating separate field gear for each mountain range/location to minimize risk of spread. If you drive into ‘ōhi‘a forest, pressure wash the tires and undercarriage of your vehicle or use a commercial car wash. Visit the [ROD website’s Education & Outreach Materials](#) for the latest recommendations on decontamination, sanitation, and other protocols.

### Preparation

Due to sanitation requirements for ROD and to avoid spreading other invasive species between sites:

**All crew members must clean boots and gear before going to the collection site.**

All crew members should also be prepared with sturdy footwear, field clothes, gloves, backpack, rain gear, sun protection, two liters of drinking water, and food, as appropriate for the collection trip.

Crew leaders should always have the following **supplies** stocked:

- **Sanitation:** boot brushes and full spray bottles of 70% isopropyl alcohol
- **Collection:** plastic storage bags, paper packets, and/or coffee filter cups (see Making Collections)
- **Tagging:** metal tags/markers or red flagging tape, if allowed by landowner
- **Data collection:** printed collection forms, pens, and clipboards, and/or mobile devices (with Kobo webform pre-loaded before leaving cell service) for each collecting crew, permanent markers or pre-written/printed labels, high accuracy GPS device if possible (see Data Collection)
- **Reference materials:** collection protocol, data form guidelines, identification key, seed zone map
- **Tools:** pole pruner with clip-and-hold mechanism, binoculars (see below)

We do not recommend small cutting tools, as most fruit clusters have thin stems that can be pinched off with fingers and a collection bag, if needed. However, when working with tall trees, we recommend a telescoping **pole pruner** (or fruit picker) with a **clip-and-hold mechanism**. Without the mechanism, most seeds will fall out or blow away before the cluster hits the ground. Clip-and-hold grasps the cluster as it cuts, so the collector can bring it down slowly, and a crew member can remove it carefully to minimize seed loss (see photos below). Binoculars can be helpful for scanning the canopy for seeds, as well as scanning the landscape for trees.

**If any tools are used, sanitize cutting surface by spraying with 70% isopropyl alcohol between each tree.**



## Appendix B.4.2 – Seed Collection Protocol

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≈ 25 capsules



≈ 15 capsules



≈ 12 capsules



≈ 5000 seeds



Immature capsules (too early)



Mature capsules (ready)



Empty capsules (too late)

### Making Collections

Collect seeds only from **mature, ripe capsules** (see above). They can be cracking open, or not, as long as they are brown and dry. Do not collect immature green capsules, as they cannot be ripened off the tree. When possible, carefully remove seeds directly from the tree with the “salt shaker” method ([video example](#)). Whole capsules may be collected if ripe/brown but not open, or if rainy conditions make it hard to remove seeds, by pinching off capsule clusters just below their base. The stems of these clusters are 2-3 mm diameter with low risk of harboring ROD fungus, but using only your fingers (not cutting tools) further minimizes risk.

**If any tools are used, sanitize cutting surface by spraying with 70% isopropyl alcohol between each tree. When collecting capsules in areas where ROD is known or suspected, remove seeds from capsules in the field and discard all other debris on site.**

#### Collection container options:

Loose seeds can go into paper envelopes (if they do not have small openings that let tiny ‘ōhi‘a seeds escape) or folded paper packets (see last page). For initial collecting, it is helpful to use a coffee filter placed into a paper cup (see photo on right), then “salt shaker” the seeds into the filter, fold the filter carefully to keep seeds inside, then, place the folded filter into an envelope or paper packet. Double layering keeps seeds secure, without needing tape in the field.



If capsules must be collected or conditions are wet, plastic zip-lock bags can be used initially, but seeds must be transferred to paper, or capsules need to begin processing, by end of day. Otherwise, they will begin to mold and suffocate. Take as little plant material as possible. Plastic bags can be reused if fully cleaned (with soap and hot water) and dried; rubbing alcohol can remove permanent marker labeling on the outside.

## Appendix B.4.2 – Seed Collection Protocol

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≈ 25 capsules



≈ 15 capsules



≈ 12 capsules



≈ 5000 seeds



Immature capsules (too early)



Mature capsules (ready)



Empty capsules (too late)

### Making Collections

Collect seeds only from **mature, ripe capsules** (see above). They can be cracking open, or not, as long as they are brown and dry. Do not collect immature green capsules, as they cannot be ripened off the tree. When possible, carefully remove seeds directly from the tree with the “salt shaker” method ([video example](#)). Whole capsules may be collected if ripe/brown but not open, or if rainy conditions make it hard to remove seeds, by pinching off capsule clusters just below their base. The stems of these clusters are 2-3 mm diameter with low risk of harboring ROD fungus, but using only your fingers (not cutting tools) further minimizes risk.

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## Appendix B.4.2 – Seed Collection Protocol

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### Data Collection

One option is using the ‘Ōhi‘a Seed Collection Mobile Webform, [available here](#) or by scanning the QR code on the right.



It can be used on or offline to input data, take a GPS coordinate, attach a photo, and submit data to the ROD Seed Banking Initiative. See **Appendix** for instructions before using the mobile form. Although there are several fields, most are optional, and collecting data is quicker once the form becomes familiar. Often one person can collect data while another person collects seeds. However, if you prefer not to use the mobile form, you can still submit written data with the seed collection.

**Identification:** Using the tools listed on page 3 or the attached key, identify the type of ‘ōhi‘a if possible. If uncertain, make sure you attach a **photo voucher** in the app (please do this with every tree as best practice). Assign each individual tree a number. If your organization has a numbering system, you can use that. Otherwise, you can start at 1, 2, 3, and continue sequentially at each location/date. For larger crews, pre-made labels with numbers can be split among smaller collection teams, to avoid duplicate numbering. If we have collector/agency name, location name (which can be brief), date, type of ‘ōhi‘a, and plant number, this information together creates a unique identity for each seed collection. If your organization uses the statewide Geographic Reference Area codes (formerly PopRef codes) for numbering, here is a [link to a GIS map of the areas/codes](#) for reference.

**Geolocation:** Please use the most accurate device available to take **GPS coordinates** for the Maui ROD Resistance Project. However, if you do not have a more accurate device, the Kobo form’s GPS will still be very helpful. If allowable by the landowner, please also tag individual trees collected from (either with metal tags or red flagging tape). This will facilitate return for future seed collection from any resistant individuals.

**This information is required to physically accompany each collection to the seed bank: Collector/Agency Name, Collection Date, Type of ‘Ōhi‘a, Plant Number, Location Name, GPS coordinates.** Write this information on collection bags and/or packets or envelopes. With this, we can use the seeds for conservation and resistance testing, even if we do not have additional digital data.

### Cleaning Collections

If capsules are collected, seeds can be processed by placing the clusters of capsules face down on a clean tray in a dry area, away from sun and wind, for about a week (see photos below). Most of the capsules will open and release seeds. A toothpick can be used to gently remove any seeds stuck inside the capsules, or needle-nose pliers can be used to gently crack capsules (without crushing them into small debris). Remove any stems or large debris by hand. Use a sieve or kitchen strainer to separate seeds from smaller debris (standard mesh sizes #18 or #20, close to 1mm openings, allow all seeds through and capture most debris). A small amount of debris is acceptable for seed bank submission.



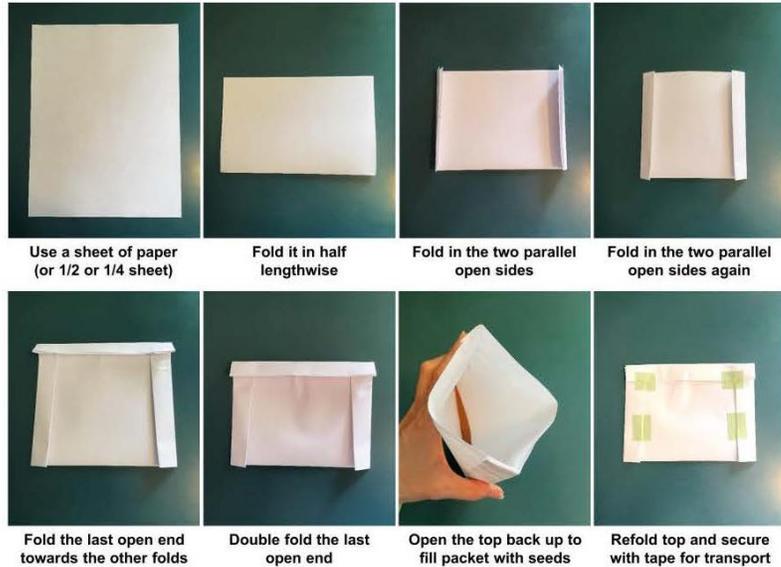
## Appendix B.4.2 – Seed Collection Protocol

(page 6 of 6)

### Transporting Seeds to the Seed Bank

To prepare seeds for transport, transfer clean, dry seeds to well-sealed paper or glassine envelopes (making sure seeds do not escape from corners), or packets made from folded paper (see photo at right). Label each packet as instructed below, seal, and deliver to MNBG.

To successfully conserve the seeds, it is critical that collections be delivered to the seed bank as soon as possible after collection. However, if your seeds are clean and dry in breathable packets, they can be stored in a refrigerator temporarily, if they are protected from moisture.



**The ‘Ōhi‘a Collection Form must accompany each collection. Remember to write the required pieces of information on paper packets/envelopes submitted to the seed bank:**

- Collector and/or Agency Name
- Collection Date
- Type of ‘Ōhi‘a
- Plant Number
- Location
- GPS Coordinates

Before making collections, please contact MNBG Seed Bank to coordinate delivery.



#### Maui Nui Botanical Garden – Seed Bank

150 Kanaloa Ave. Kahului, HI 96732

Tamara Sherrill: [info@mnbg.org](mailto:info@mnbg.org), (808) 249-2798



#### For questions about this protocol and data management, contact:

Dr. Marian Chau, Kalehua Seed Conservation Consulting

[mmchau@hawaii.edu](mailto:mmchau@hawaii.edu)



For more on the statewide ‘ōhi‘a seed collection strategy, collection form, seed zones, collection needs, and types of ‘ōhi‘a, visit [laukahi.org/ohia](http://laukahi.org/ohia)

Photos by Marian Chau, Forest and Kim Starr ([starrenvironmental.com](http://starrenvironmental.com)), Cathy Davenport, and J.B. Friday.

## Appendix B.4.3 Efficient Data Collection

### Pre-Stamped Seed Collection Envelope

A rubber stamp was created to pre-stamp seed collection envelopes before going into the field. This pre-stamped envelope helped seed collectors remember which information was needed.

Coin Envelope #7 (3-1/2" x 6-1/2")

----- (fold here to keep seeds in) -----

**Date:** Year–Month (in letters)–Day \_\_\_\_\_  
 \_\_\_\_\_ Time: \_\_\_\_\_

**Variety:** (abbreviate genus/species/variety) \_\_\_\_\_

**Met** – \_\_\_\_\_  
 (If hybrid: Met-Pol-Gla X Inc)

**Plant #** or letter(s): \_\_\_\_\_

**Latitude: N.** \_\_\_\_\_  
 (any format)

**Longitude: W.** \_\_\_\_\_  
 (any format)

**Elevation:** (ft. or m.) \_\_\_\_\_

**GeoRefCode & Name:** (if known) \_\_\_\_\_

\_\_\_\_\_

<https://histategis.maps.arcgis.com/apps/webappviewer/index.html?id=de12e4e512824f90b8be>

**Notes on Location:** \_\_\_\_\_

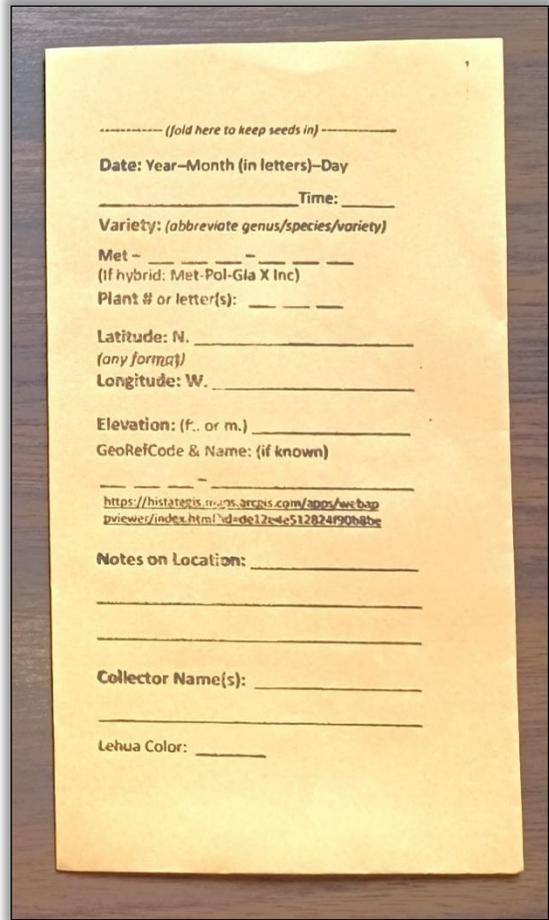
\_\_\_\_\_

\_\_\_\_\_

**Collector Name(s):** \_\_\_\_\_

\_\_\_\_\_

**Lehua Color:** \_\_\_\_\_



Photograph of pre-stamped seed collection envelope.



Photograph of rubber stamp and ink pad.

## Appendix B.4.4 Field Kit Items

**Field Kits** (colorful to find in vegetation):

**Place in this order, into field kit (for participants to easily follow during leader's briefing):**

- 1) Waiver and Release form
- 2) QR Code w/ Link, w/ Sample Envelope copied onto this sheet of paper
- 3) Appendix w/ QR Code attached to KoboToolbox Webform
- 4) 'Ōhi'a Color Photo identification keys
- 5) Both `Ōhi`a keys (one complex, one simplified) stapled together
- 6) Data Answers for Particular Site
- 7) Protocol information
- 8) Extra KoboToolbox\* webforms (5 per folder)
- 9) Copy of last email correspondence (so participants can review and confirm instructions).

In medium sized plastic bag:

- 10) Pens, colorful to find in vegetation (two each)
- 11) Cup to collect seeds to buffer wind
- 12) Coffee filters for seed (no plastic, or seed will rot) (6 each)
- 13) Coin Envelopes (6 each)
- 14) Additional medium sized plastic bags (2 each)

**Leader must bring:**

- 15) Permits
- 16) Fruit Pickers (two)
- 17) Orange bags with ROD cleaning kits (rubbing alcohol in spray bottle, boot brushes)
- 18) GPS units (two)
- 19) Extra batteries for GPS units (lithium)
- 20) Gallon zip lock bags to hold packets of seeds
- 21) Phone numbers of participants
- 22) List of participants w/ those who have Waiver forms completed
- 23) Extra blank Waivers
- 24) Field kits for each participant
- 25) Extra coffee filters, coin envelopes, pens, plastic bags

\* The webform KoboToolbox was helpful, but newer technology could replace it, as the GPS capture was irregular. Pen and paper was preferred.

Minimalist tools to collect 'ōhi'a seed.



Photo credit: M.M. Chau

**Appendix B.4.5**  
**Hawaiian Protocol – Chant**

Have respect (ha'aha'a).

Chant (oli) to request entry to an area, permission for an activity.

Have gratitude (mahalo).

The chant below was offered for the activities of this project by Lonoa Hōnua a me Hālau 'Ōhi'a.

**E Ulu Kini**

**E ulu e, e ulu e!**

**E ulu kini o Hawai'i** (*name of 'āina*)

**'O Kāne me Kanaloa**

**Ulu a'e kēia 'Ōhi'a** (*name of plant*)

**E ulu kini, e ulu e**

**E ulu e, hū! hā!**

*Mahalo e Lonoa Hōnua a me Hālau 'Ōhi'a.*

The Hawaiian language, poetic in subtleties, a word may have many meanings.

The translation below is from definitions of the words found in The Hawaiian Dictionary, written by Mary Kawena Pukui & Samuel H. Elbert, University of Hawai'i Press, 1986.

**Grow, Increase the Multitudes**

**Enter and inspire!**

**Grow, increase the multitudes of this land** (*name of the land*)

**Honor the gods giving life, light, fresh water, the depths of the sea, and transformation**

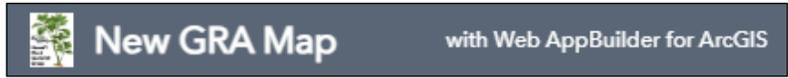
**Increase, flourish, and spread these 'Ōhi'a**

**Increase the multitudes, inspire to grow**

**Inspire, Rise swell! The stalks, the breath!**

*With gratitude and admiration to Lonoa Hōnua a me Hālau 'Ōhi'a.*

## Appendix B.4.6 Geographic Reference Areas



<https://histategis.maps.arcgis.com/apps/webappviewer/index.html?id=de12e4e512824f90b8be4fa68ce9e9c1>



**New GRA Map**
with Web AppBuilder for ArcGIS

+  
-  
🏠  
🔄

lao Valley IAO
✕

Zoom to
\*\*\*

📏 -156.433 20.789 Degrees
Earthstar Geographics **esri**

Geographic Reference Areas
Options ▾ Filter by map extent 🔍 Zoom to ☑ Clear selection 🔄 Refresh

POPREF	POPREFNAME	ISLAND	Acres	SQM	GlobalID
IAO	lao Valley	Maui	14,325.05	57,971,438.70	1a5f9e75-712d-4cb9-b5cb-713d51f26e2a

Appendix B.4.7  
Botanical Key

‘Ōhi‘a (*Metrosideros* sp.) types on Maui

**Quick Key for common varieties:** (Look at the undersides of older leaves.)

Leaf undersides smooth/not hairy, edges flat = *M. polymorpha* var. *glaberrima*

Leaf undersides hairy, edges flat = *M. polymorpha* var. *incana* (unless hairs are rubbed off easily)  
If so, then it's a hybrid *M. polymorpha* var. *glaberrima* x *incana*

Leaf with wooly hair, edges revolute (rolled under) = *M. polymorpha* var. *polymorpha*

**Complete Key:** (Look at the undersides of older leaves.)

1. Plant is found in a forest, **not** an upper elevation bog ..... 2

1. Plant is found in an upper elevation bog ..... 6

2. Leaf undersides are hairy ..... 3

2. Leaf undersides are smooth/not hairy ..... 4

3. Leaf edges are flat ..... *M. polymorpha* var. *incana* (common)

3. Leaf edges are revolute (rolled under) ..... *M. polymorpha* var. *polymorpha* (common)

4. Leaves have acute tips (<90 degrees) and long red petioles ... *M. waialeale* var. *fauriei*

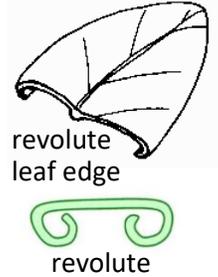
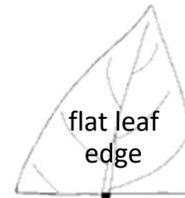
4. Not as above ..... 5

5. Leaves are large and broadly ovate .... *M. polymorpha* var. *macrophylla*

5. Not as above ..... *M. polymorpha* var. *glaberrima* (common)

6. Leaves are small (10-15mm long), leaf undersides are hairy, leaf edges are revolute (rolled under),  
leaves lack petioles, and plant is found in bog near summit of West Maui ... *M. polymorpha* var. *pseudorugosa*

6. Leaf edges are slightly rolled under, leaves have petioles, leaf undersides may be hairy or smooth/  
not hairy, and plant is found in a bog at upper elevations of East or West Maui ... *M. polymorpha* var. *pumila*



Common varieties:

*Metrosideros polymorpha* var. *glaberrima* is found on all main Hawaiian islands. New leaves can be hairy, but hairs fall off and older leaves are glabrous (no hair, smooth). The margins of the leaves are flat and new leaves are often very colorful (liko).

*Metrosideros polymorpha* var. *incana* is found on O‘ahu, Moloka‘i, Maui, Lāna‘i and Hawai‘i Island. More common in low elevations, it has flat leaf margins and short hairs on the underside of the leaves. Hybrids with *Metrosideros polymorpha* var. *glaberrima* are common. These have hair that can be easily scraped off the undersides of the leaves.

*Metrosideros polymorpha* var. *polymorpha* is found on O‘ahu, Moloka‘i, Maui, Lāna‘i and Hawai‘i. The margins of the leaves are rolled (revolute), and the undersides have light-colored woolly hair.

Less common varieties:

*Metrosideros waialeale* var. *faurei* is found at upper elevations only on Maui, Moloka‘i and Lāna‘i. New leaf buds are large and pointed. The long, pointed leaves are glabrous (no hair) and the margins are flat. Petioles are usually reddish color.

*Metrosideros polymorpha* var. *macrophylla* is a cryptic taxon reported from Maui and Hawai‘i Island. Like *Metrosideros polymorpha* var. *glaberrima*, variety *macrophylla* has flat leaf margins and no hair on the undersides of the older leaves. However, the broad leaf shape and relatively large capsules and other plant parts distinguish this variety.

Uncommon varieties (only found in bogs):

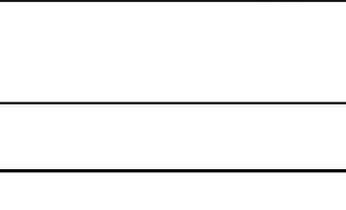
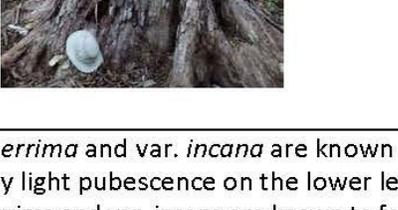
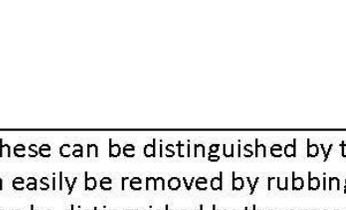
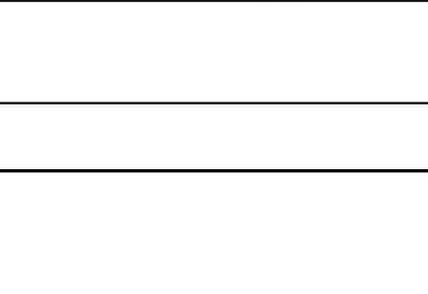
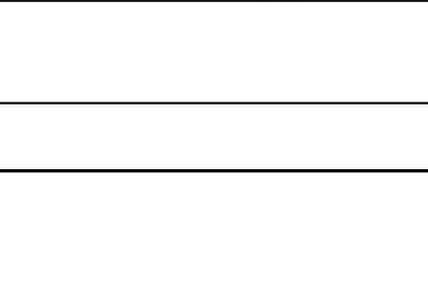
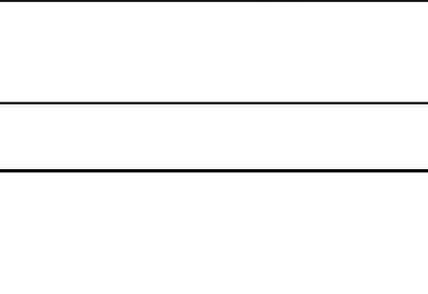
*Metrosideros polymorpha* var. *pumila* is found in upper-elevation bogs on Kaua‘i, O‘ahu, Maui and Moloka‘i. The margins of the leaves are slightly rolled under and the undersides can be glabrous (no hair), or hairy. Plants on Moloka‘i have been observed to be glabrous. This ‘Ōhi‘a is a shrub or small tree and the leaves have a distinct petiole.

*Metrosideros polymorpha* var. *pseudorugosa* is found only in summit areas of West Maui. It is a shrub or small tree and has very small leaves (10-15mm). The margins of the leaves are rolled (revolute) and the undersides are hairy.

**Appendix B.4.8**  
**Botanical Photographic Key**

(page 1 of 4)

[https://laukahi.org/wp-content/uploads/2021/06/Metrosideros-Key\\_Maui\\_20180105.pdf](https://laukahi.org/wp-content/uploads/2021/06/Metrosideros-Key_Maui_20180105.pdf)

Character	<i>M.pol. glaberrima</i> Photos: Joel Lau, Marian Chau & Adam Williams	<i>Met. pol. incana</i> Photos: Scott Heinzman, Marian Chau & Hank Oppenheimer
Stature	shrubs to tall trees 	shrubs to tall trees 
Leaf shape	ovate or obovate to elliptic 	ovate to suborbicular 
Lower leaf surface	glabrous 	appressed pubescent 
Petiole length	petiolate 	sessile to petiolate 
Leaf apex (tip)	rounded to acute 	rounded or retuse 
Leaf base	rounded or cordate to cuneate 	rounded to cuneate 
Leaf margin	flat, rarely revolute 	flat 
Inflorescence	pubescent (Rock described it as glabrous) 	pubescent 
Bark characteristics	bark rough or separating in thin strips 	bark rough 
Elevation	middle to high 	low to middle 
Island distribution	Kaua'i, O'ahu, Moloka'i, Lana'i, Maui, Hawai'i 	O'ahu, Moloka'i, Lana'i, Maui, Hawai'i, Kaua'i 
Other characteristics	NOTE: var. <i>glaberrima</i> and var. <i>incana</i> are known to form hybrids. These can be distinguished by the presence of very light pubescence on the lower leaf surface that can easily be removed by rubbing. NOTE: var. <i>glaberrima</i> and var. <i>incana</i> are known to form hybrids. These can be distinguished by the presence of very light pubescence on the lower leaf surface that can easily be removed by rubbing.	

Appendix B.4.8 – Botanical Photographic Key

(page 2 of 4)

Character	<i>M. polymorpha macrophylla</i> Photos: Forest & Kim Starr and Hank Oppenheimer	
<b>Stature</b>	small to tall trees	 <p style="text-align: right;">Forest &amp; Kim Starr</p>
<b>Leaf shape</b>	broadly ovate, large	 <p style="text-align: right;">Forest &amp; Kim Starr</p>
<b>Lower leaf surface</b>	glabrous	
<b>Petiole length</b>	petiolate	
<b>Leaf apex (tip)</b>	rounded to obtuse	
<b>Leaf base</b>	rounded or truncate	
<b>Leaf margin</b>	flat	
<b>Inflorescence</b>	pubescent	 <p style="text-align: right;">Hank Oppenheimer</p>
<b>Bark characteristics</b>	bark separating in thin strips	
<b>Elevation</b>	middle	
<b>Island distribution</b>	Hawai'i, Maui	
<b>Other characteristics</b>	very similar to var. glaberrima except for leaf size and bark	

Appendix B.4.8 – Botanical Photographic Key

(page 3 of 4)

Character	<i>M. polymorpha polymorpha</i>	Photos: Joel Lau	<i>M. pol. pseudorugosa</i>	Photos: Hank Oppenheimer
Stature	shrubs to small trees		prostrate shrubs	
Leaf shape	ovate to suborbicular		small, broadly ovate to suborbicular	
Lower leaf surface	densely woolly or appressed pubescent		densely woolly	
Petiole length	sessile		?	
Leaf apex (tip)	rounded to retuse		rounded	
Leaf base	cordate		rounded to cordate	
Leaf margin	revolute to rolled		revolute	
Inflorescence	pubescent		?	
Bark characteristics	bark rough		unknown	
Elevation	middle to high		high elevation bogs	
Island distribution	O'ahu, Moloka'i, Lana'i, Maui, Hawai'i		West Maui	
Other characteristics	growing in higher elevation bogs on West Maui			

**Appendix B.4.8 – Botanical Photographic Key**

(page 4 of 4)

<b>Character</b>	<i>Met. pol. pumila</i> Photos: Adam Williams, M. Chau	<i>Met. waialeale faurei</i> Photos: H. Oppenheimer, M. Chau
<b>Stature</b>	shrubs 	shrubs to small trees 
<b>Leaf shape</b>	broadly ovate to orbicular 	Ovate to lanceolate or broadly ovate. Buds narrow, pointed, spatulate scales. Narrow bracts (3mm long x 1mm wide) 
<b>Lower leaf surface</b>	glabrous or lower surface wooly or appressed tomentum 	glabrous 
<b>Petiole length</b>	petiolate	petiolate and slender
<b>Leaf apex (tip)</b>	rounded to obtuse	acute
<b>Leaf base</b>	obtuse to cordate	Cuneate to rounded
<b>Leaf margin</b>	slightly revolute 	flat 
<b>Inflorescence</b>	pubescent 	glabrous or appressed short-pubescent 
<b>Bark characteristics</b>	separating in thin flakes	Fissured, flaky.
<b>Elevation</b>	middle to high	High (600-1300m)
<b>Island distribution</b>	Kaua'i, Moloka'i, Maui, O'ahu	Maui, Moloka'i, Lana'i
<b>Other characteristics</b>	growing in middle to higher elevation bogs on Kaua'i, Moloka'i, O'ahu, and Maui	Narrow bracts that fall off early (caducous)

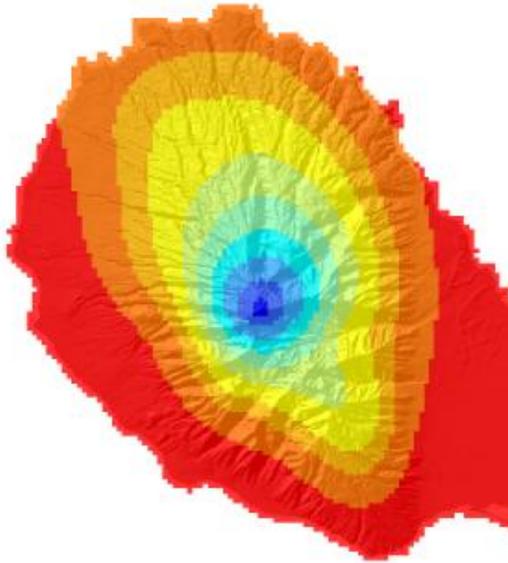
## Appendix B.4.9 Rainfall Zones

### Mean Annual Rainfall Hawaiian Islands of Maui, Moloka'i and Lāna'i.

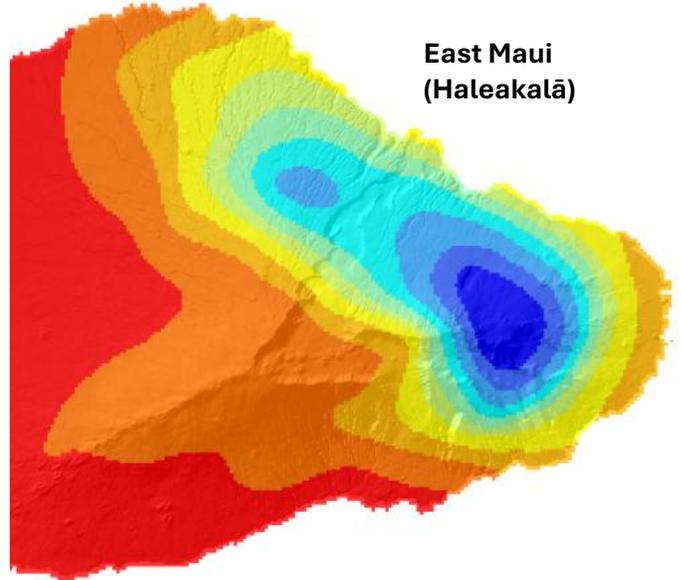
2013 Rainfall Atlas of Hawai'i, Department of Geography, University of Hawai'i at Mānoa

(Islands not to scale.)

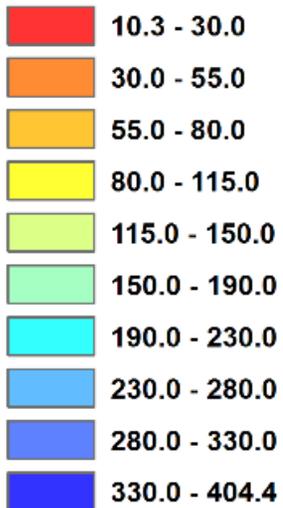
West Maui (Mauna Kahālāwai)



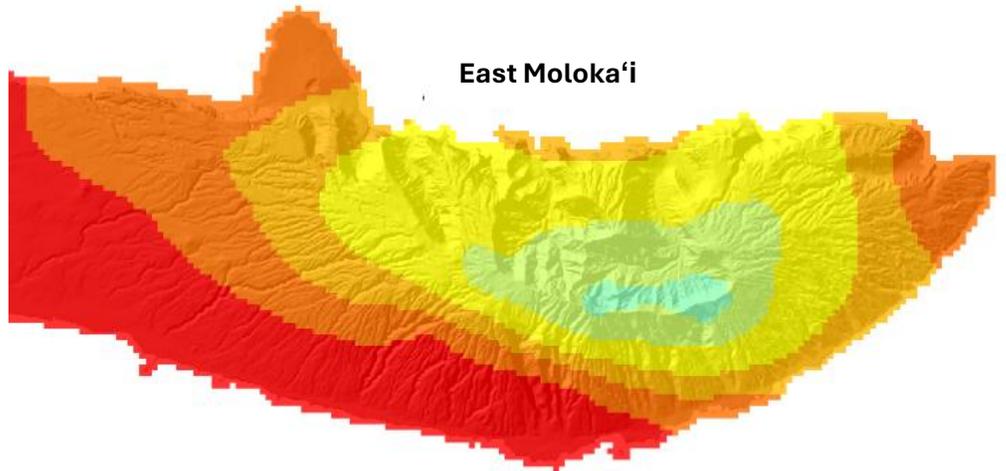
East Maui  
(Haleakalā)



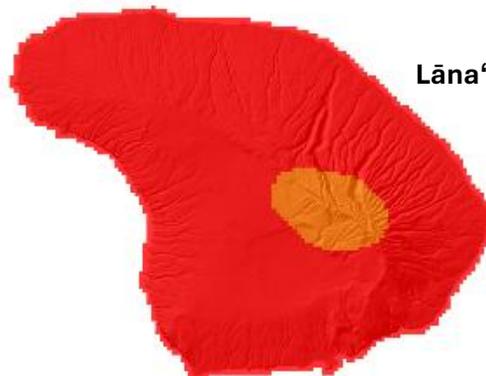
### Annual Rainfall (inches)



East Moloka'i



Lāna'i



Appendix C.1  
Lāhaina ‘Ōhi‘a Tree Reservation Form

## Lāhainā ‘Ōhi‘a Tree Reservation Form

**B** *I* U ↻ ✕

Maui Nui Botanical Gardens has ‘ōhi‘a lehua (*Metrosideros* sp.) plants from Lāhainā, which were placed into MNBG's care and grown out for the last year, available to give to residents of Lāhainā who were affected by the fires.

One year ago, Heather and her friends and family scrambled to put many of her ‘ōhi‘a plants into a truck as they fled the fires. The plants were brought up to Kula for temporary safekeeping. Heather came to an ‘ōhi‘a class at MNBG and told us her story. MNBG has been honored to take care of the plants ever since. Heather would like the plants to go back to Lāhainā, given to families for restoration of their homes. As a young girl, Heather was taught by her great-uncle how to collect ‘ōhi‘a seed in the forest around Lāhainā. He taught her how to germinate the seed and then grow the seedlings into healthy plants, which takes a lot of time and care. The trees are now ready to put into Lāhainā hands.

**How: If you don't have a place to care for a potted plant, then MNBG can hold the plant for you for up to one year** - until August 8, 2025. If you want us to hold trees for you, please fill out this form so we can label them. You may pick them up any time from Tuesday-Saturday, 8 am - 4 pm, in the next 12 months. Please note we may be closed on State holidays. Responses are time stamped, so trees are first come.

**Donations to:** Residents of zip code 96761, or those displaced from that zip code.

**How many plants:** Up to 3 plants per Lāhainā property or family.

**Color and size:** We don't know the lehua color because these are wild sourced seedlings. We will keep the plants in pots large enough to let them grow healthy. As of 8/8/24 they are one gallon size.

**Where to pick up your trees:** Maui Nui Botanical Gardens, 150 Kanaloa Ave., Kahului

**Questions:** (808) 249-2798

**When:** Beginning Tuesday, 8/13/24. Ongoing until all plants are spoken for.

**Appendix C.2**  
**Lāhaina Responses**  
*(page 1 of 2)*

Heather and her Great Uncle collected wild 'Ōhi'a seed from the Lāhaina area for years. He taught her how to grow the seed, a difficult seed to germinate. Heather, friends and family saved 150+ pots of 'Ohi'a trees and seedlings from the Lāhaina Fire. Heather donated the trees to the Lāhaina area people to raise their spirits.

Timestamp	Reserve how many trees?	Where are you hoping to plant this tree? Please add any other comments.
8/7/2024 16:19:46	Three 'ōhi'a	My yard and another yard In Launiupoko
8/8/2024 9:11:55	Three 'ōhi'a	In our yard on A'a Street (Lāhaina)
8/8/2024 10:44:13	Two 'ōhi'a	Replacing some of the invasive grass on my small hillside overlooking Lāhaina town
8/8/2024 11:15:19	Three 'ōhi'a	95 Kahili Pl, Lahaina, HI 96761 - thank you
8/8/2024 19:14:13	Three 'ōhi'a	We still haven't begun building so we would like you to hold them for us please. Mahalo piha. It will be planted all three Lahaina homes that were burned. My two Aunty's and Uncle's and my Dad's home. If there are any left, my other two Aunties also lost their home. Mahalo piha!
8/8/2024 21:54:05	Three 'ōhi'a	Wahikuli
8/9/2024 19:47:05	Three 'ōhi'a	In the front yard of our new home
8/11/2024 5:40:44	Two 'ōhi'a	At our property 1558 Malo st. Lāhaina hi 96761
8/13/2024 11:38:01	Three 'ōhi'a	Our beloved Lahaina property when the time comes , Mahalo MNBG
8/13/2024 12:33:05	Three 'ōhi'a	at my new home in Kahului
8/13/2024 13:00:11	Three 'ōhi'a	Keep potted for as long as safe and then plant in my future yard; otherwise, donate to another Lāhaina 'Ohana who can!
8/13/2024 13:47:33	One 'ōhi'a	In my yard
8/13/2024 15:38:46	Three 'ōhi'a	Lāhaina
8/13/2024 16:02:59	Three 'ōhi'a	Yes, when the time is right to move back to Lāhaina
8/13/2024 16:25:32	Three 'ōhi'a	One at a farm in Launiupoko, one at a farm in Hāli'imaile, and one at my new home in Kahului. Aloha
8/13/2024 16:52:35	Three 'ōhi'a	At my home in Lāhaina
8/13/2024 17:53:55	Three 'ōhi'a	My backyard
8/13/2024 17:55:42	Three 'ōhi'a	Front yard
8/13/2024 17:58:13	Three 'ōhi'a	My home
8/13/2024 18:38:05	Three 'ōhi'a	On my property
8/13/2024 18:39:41	Two 'ōhi'a	1 - my home 646D Luakini St 2 - My church, Waiola/Wainee Graveyard
8/13/2024 18:44:33	Three 'ōhi'a	I'm hoping to gift this for friends who lost homes, but were renters. Mahalo for holding them.
8/13/2024 19:30:47	Three 'ōhi'a	Lāhaina Intermediate School. I am a teacher and am creating native gardens. Mahalo nui loa.
8/13/2024 19:32:24	Three 'ōhi'a	In my backyard
8/13/2024 19:36:45	Three 'ōhi'a	Residence - backyard
8/13/2024 19:43:13	Three 'ōhi'a	On our 'āina where we lost our house
8/13/2024 20:48:24	Three 'ōhi'a	one at property at baby beach other two nearby neighbors
8/13/2024 20:48:25	Three 'ōhi'a	at my lot in Lāhaina as we rebuild our home
8/13/2024 21:09:08	Three 'ōhi'a	My new landlord who graciously opened up her home to my family and I and whose favorite tree is 'ōhi'a!
8/13/2024 21:39:20	Three 'ōhi'a	On my property in Wahikuli
8/13/2024 22:54:46	Three 'ōhi'a	My home in Lāhaina
8/14/2024 0:02:57	Three 'ōhi'a	1628 A'a Street, Lāhaina, HI 96761
8/14/2024 0:28:40	Three 'ōhi'a	My home in Lāhaina. We are currently displaced and would ask if you guys could hold them for a about 8 months. If that is not possible we can figure out an alternative plan. Mahalo
8/14/2024 1:04:41	Three 'ōhi'a	On my Property!!
8/14/2024 4:27:45	Two 'ōhi'a	I'm hoping to plant the trees on our property on Komo Mai St. This is such an incredible gift as we had a small 'ōhi'a growing that didn't survive the fire. Mahalo!!
8/14/2024 5:45:14	Three 'ōhi'a	Ka'anapali

## Appendix C.2 – Lāhaina Responses

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8/14/2024 6:13:06	Three 'ōhi'a	Our new home or apartment when we get one
8/14/2024 7:47:59	Three 'ōhi'a	At my grandmas house or at our empty lot as we rebuild
8/14/2024 8:04:42	Three 'ōhi'a	On our family property in Honokohau. will pick up on Thursday or Friday
8/14/2024 9:51:44	Three 'ōhi'a	Lāhaina & Happy Valley
8/14/2024 12:36:31	Three 'ōhi'a	At our home, down Mala
8/14/2024 13:59:05	Three 'ōhi'a	On my property 525 Hui Road A, Lāhaina HI 96761
8/14/2024 14:09:17	Three 'ōhi'a	On our family property in Lahaina, where we loss our beloved uncle.
8/14/2024 17:05:25	Three 'ōhi'a	Backyard
8/14/2024 17:30:52	Three 'ōhi'a	In home then Lāna'i
8/15/2024 1:38:30	Two 'ōhi'a	570 Luakini St., Lāhaina, HI 96761 (My home)
8/15/2024 9:30:38	Two 'ōhi'a	I'm hoping to plant one tree at my hale, the other one close to my home office at Lāhainaluna.
8/15/2024 16:58:59	Three 'ōhi'a	At our family home in Lāhaina after rebuild
8/15/2024 22:19:42	Three 'ōhi'a	Back on the lot where my home burned down in Wahikuli.
8/16/2024 11:36:23	Three 'ōhi'a	Out in Punalau on 'Ōhana property
8/16/2024 20:02:47	Three 'ōhi'a	Lāhaina
8/17/2024 8:04:43	Three 'ōhi'a	on our family property in Honokohau
8/17/2024 10:45:41	Two 'ōhi'a	In my yard since all my trees burned except for 2 mango trees
8/17/2024 12:40:10	Three 'ōhi'a	At my home in Leiali'i Lāhaina
8/17/2024 15:36:01	Three 'ōhi'a	We are breaking ground on our lot. We would plant it back in the Wahikuli neighborhood
8/17/2024 15:36:43	Two 'ōhi'a	At my Hale
8/17/2024 21:27:15	One 'ōhi'a	To provide shade for my tutu lady at her place of rest at Waiola Church. If not there, then to provide shade for my tutu man at his resting place in Kīpahulu.
8/17/2024 23:18:02	Three 'ōhi'a	My property and my mom's. Both properties burned in Lāhaina
8/18/2024 9:36:20	Three 'ōhi'a	Back home in Labuan when we rebuild. 1387 Ainakea Rd
8/18/2024 13:39:58	Three 'ōhi'a	back home in Lāhaina
8/19/2024 8:04:23	Three 'ōhi'a	Lāhaina when we return.
8/29/2024 19:49:57	Two 'ōhi'a	Hopefully back on my property on a front st, Lāhaina near Malu Ulu Olele park.

**Appendix D.1**  
**Pua 'Āhihi Mele**

Source: Pamai Tenn Collection - Maddy Lam composed this song for Kahauanu Lake, as a gift to Maiki Aiu. This was first danced by April Peeples Chock and presented as a ho'okupu to Maiki. She loved the mele and it became the signature song of her halau. This mele compares a sweetheart to the beautiful 'āhihi blossom. The 'āhihi, a low spreading shrub-like bush with a twisted trunk (*Metrosiderous*) is a form of lehua. Lanihuli is the peak west of the Nu'uauu pali gap where the 'āhihi grows profusely. [https://www.huapala.org/Pua/Pua\\_Ahihi.html](https://www.huapala.org/Pua/Pua_Ahihi.html)

Lanihuli (2,760 feet elevation, 841 meters) in the Ko'olau (windward) Range.

**PUA 'ĀHIHI**

Me 'oe ka 'ano'i e ka 'āhihi Ka lei milika'a a ka'u aloha	With you is my desire, o 'āhihi The lei caressed over and over by my love
He aloha makamae kai hiki mai He 'ala honehone i ka pu'uwai	It is a precious love, that comes to me A fragrance teasing the heart
He waiwai 'oe i ka'u 'ike Ua kehakeha i luna a'o Lanihuli	You are of great value in my sight High above Lanihuli
Huli mai nō 'oe 'olu kāua I mehana ho'i au a'i ko poli	Turn to me, let us comfort one another Let me be warmed by your bosom
Ha'ina ka puana no ku'u lei Ka pua 'āhihi a'o Lanihuli	The story is told for my lei The 'āhihi blossom of Lanihuli