

'Ōhi'a lehua



Young 'ōhi'a, pioneer plant on solidified lava crust. Kilauea Caldera, Hawai'i Volcano National Park, Photo Nate Yuen.



Noho Ana 'o Laka, chant by Mea oli Kalena Silva, from "The cultural significance of the 'ōhi'a tree" video, Photo University of Hawai'i News

"The lehua is the first tree that springs up from a recent lava flow. It's for that reason, when we speak in Hawaiian and we speak of people who are skilled, strong, and beloved, they're often referred to as pua lehua, or lehua flowers. They, like the lehua, have a kind of resilience, a strength and a grace about them."

Kalena Silva,
University of Hawai'i Hilo Professor of Hawaiian History

'Ōhi'a lehua *Metrosideros polymorpha*

- Endemic to the six largest islands of Hawai'i
- Most common Hawaiian native tree
- Half of the native trees on Hawai'i Island are 'ōhi'a
- An ultimate adapter growing from sea level to 8,000 feet, from bare rock lava flows to saturated bogs, from short, bushy forms to tall, majestic canopy trees.
- Common in moist and dry forests, often mixed with Koa
- Dominant tree above 1,300 ft
- Colonizer of recent lava flows
- Slow growing
- Flowers are a mass of stamens and range from fiery red to yellow



'Ōhi'a, Volcano National Park, Photo Meghan Minor, Hawai'i Magazine, 2016



'Ōhi'a liko (buds), Kalalau Valley overlook, Kokee, Kaua'i This Kaua'i variety has particularly large, silvery leaf buds. Photo JB Friday, 2013



Native 'ōhi'a (ohia) forest in Kapapala, Ka'u, Hawai'i Island, Photo JB Friday, 2006

'Ōhi'a lehua forests

- About 865,000 acres of 'ōhi'a forests
- Considered primary habitat for many plants, animals, and invertebrates like the 'apapane and the now-extinct mamo
- Protect watersheds for agriculture and drinking water

'Ōhi'a lehua in culture

- Many native Hawaiian traditions refer to the tree and its forests as sacred to Pele, goddess of the volcano, and to Laka, goddess of hula
- In Hawaiian mythology, 'Ōhi'a and Lehua were young lovers. The volcano goddess Pele fell in love with the handsome 'Ōhi'a, but he turned down her advances. In a fit of jealousy, Pele transformed 'Ōhi'a into a tree. Lehua was devastated. Out of pity, other gods turned her into a flower on the 'ōhi'a tree. Or, some say Pele felt remorseful but was unable to reverse the change, so she turned Lehua into a flower herself. When a lehua flower is picked, rain will come representing the separated lovers' tears.
- Wood traditionally used for kapa beaters, poi boards, and weapons
- Leaves were used as a medicinal tea
- Flowers and young growth used for lei and hula altar adornment
- Several Hawaiian words for rain refer to lehua e.g. Ka ua lu lehua o Pana'ewa (lehua-shedding rain of Pana'ewa) and Ka ua Noelehua o Wai'ale'ale (the misty lehua rain of Waialeale).



'Ōhi'a, Photo © Jared Bernard, ecological observer.com

Merrie Monarch Photo, Hawai'i Magazine



Lei Day Celebration Honolulu 2015, lei by First Princess Paige Okamura. Facebook Photo

'Ōhi'a lehua



'Ōhi'a, Kaua'i, Photo JB Friday

'Ōhi'a lehua plays a key role in Hawaiian ecosystems



'Ōhi'a Kohala, Hawai'i Island, Photo Anya Tagawa

This 'ōhi'a forest of Kohala is often shrouded in mist as clouds continually pass through the landscape. Mosses adorn 'ōhi'a branches and trunks and water in great amounts is collected by this pristine 'ōhi'a-dominant forest. The water slowly percolates down and replenishes our aquifer, our source of fresh water.



Fallen 'Ōhi'a with new plants, Hawai'i Island, Photo Anya Tagawa

Even when fallen, 'ōhi'a continues to support and contribute to the health of a forest providing a nursery for seeds and stem sprouts to take root. As it decays, it releases nutrients that nourish surrounding organisms.



Photo JB Friday

'Ōhi'a growing at sea level, Ononmea, Hawai'i Island



Photo © Jared Bernard, ecological observer.com

Towering 'ōhi'a trees are found in the old growth forest at Kalōpā Native Forest State Park and Recreation Area like this one with a diameter at breast height (DBH) of over 50 inches. 'Ōhi'a trees famously grow at an infinitesimally slow rate of about a tenth of an inch DBH per year, meaning this tree is over 500 years old.

Metrosideros polymorpha may be referred to correctly as a lehua tree, or as an 'ōhi'a lehua, or simply an 'ōhi'a. It is a common misconception that 'ōhi'a refers to the tree and lehua refers only to its flowers. The Hawaiian Dictionary (Pukui and Elbert 1986: 199) defines lehua with these words: "The flower of the 'ōhi'a tree... also the tree itself [emphasis added]." <http://eol.org/pages/2508626/details>

Habitat:

Birds and many other species depend on 'ohi'a for food and nesting sites including many of Hawai'i's federally endangered forest birds. With the majority of Hawaii's endemic birds at risk of extinction, losing the dominant tree from their remaining habitat makes these birds more vulnerable, particularly if the fungus spreads to other islands. Even non-threatened birds, such as the could become endangered following severe habitat loss.

The endangered 'Akepa depends on the 'ōhi'a survive.
Photo Jack Jeffrey, abcbirds.org



'Iwi may become endangered if their habitat continues to disappear.
Photo Robby Kohley, abcbirds.org



Hawaii's federally endangered Hawai'i Creeper.
Photo Jack Jeffrey, abcbirds.org



Rapid 'Ōhi'a Death, Facebook, Photo David Sischo

A success story:

After 20 years of effort, in August 2016 DLNR Snail Extinction Prevention Program reintroduced the nearly extinct, beautiful, tiny Hawaiian tree snail (*Achatinella lila*) to the Ko'olau mountains, O'ahu. Sam Ohu Gon, Nature Conservancy senior scientist and cultural advisor, welcomed the snails back to their home with an oli (chant), and the snails emerged from their shells to crawl on to the rain-soaked 'ōhi'a. In 1997, the last six individuals from this snail population were taken to a laboratory for captive rearing. Now, their progeny are being reintroduced back into the natural home, where they can safely thrive in a predator-proof structure.

Rapid 'Ōhi'a Death



Dead 'ōhi'a in Manukā Natural Area Reserve, May 2016, Photo © Jared Bernard, ecological observer.com

What is Rapid 'Ōhi'a Death?



A formerly pristine 'ōhi'a forest devastated by 'ōhi'a wilt disease, Puna, Hawai'i Island. With the canopy gone, weeds are taking off. Photo JB Friday, 2015

- Rapid 'Ōhi'a Death, or 'ōhi'a wilt, is a fungal infestation that attacks 'ōhi'a trees.
- Individual trees die very quickly. All the leaves turn brown within a few days and fall off in a couple weeks as the tree dies.
- The pathogen is the vascular wilt fungus *Ceratocystis fimbriata* determined through pathogenicity tests conducted by the USDA Agriculture Research Service.
- This is a new strain of the fungus and the first record of any *Ceratocystis* species affecting 'ōhi'a. (A different strain of *Ceratocystis fimbriata* has been present in Hawai'i as a pathogen of sweet potato for decades.)
- It is not yet known whether this widespread occurrence of 'ōhi'a mortality results from an introduction of an exotic strain of the fungus or whether this constitutes a new host of an existing strain.
- *Ceratocystis fimbriata* is transmitted in wood, live plants, and soil.
- There is no known cure, but the current quarantine on 'ōhi'a transport is giving researchers time to look for ways to combat the disease while still confined to one island.
- Rapid 'Ōhi'a Death has the potential to kill 'ōhi'a trees statewide and become a major threat to our native forests and watersheds.

Symptoms

- Crowns of infected trees turn yellowish (chlorotic) and then brown within days or weeks. Dead leaves remain on branches for some time.
- Sometimes, leaves of single branches or limbs turn brown before the rest of the crown becomes brown. Within 2 or 3 weeks all branches in the crown show symptoms.
- *Ceratocystis* manifests itself as dark nearly black staining in the sap wood along the out margin of the trunks of affected trees.
- The stain is often radially distributed throughout the wood.
- Fresh-cut wood has a strong fruity odor.
- Insect holes in trees infected with 'ōhi'a wilt from the ambrosia beetle may be related to transmission. We don't know yet whether the insects help spread the disease or whether they just seek out diseased trees. It's thought the fungus is spread by frass, the sawdust created by ambrosia beetles digging into ohia trees.

Beetle hole and beetle frass, Photo JB Friday

Typical wood staining caused by *Ceratocystis*, black streaking in the sapwood of affected trees. Photo JB Friday

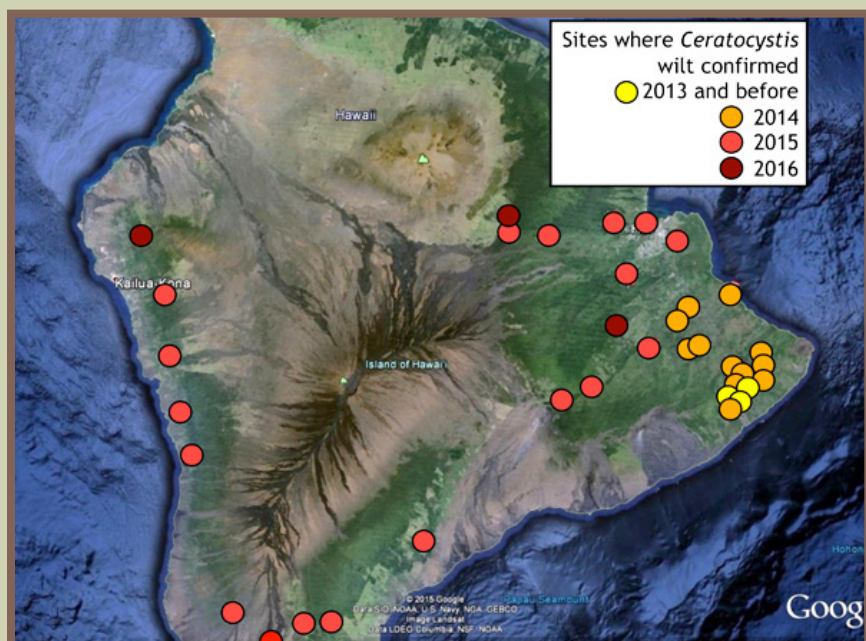


One way the fungus is suspected of being spread is through wind-blown insect frass causing new infections. It is still a question whether insects transmit 'ōhi'a wilt or whether they merely attack diseased trees.



Photo alohaarbtorist.com

"*C. fimbriata* is typically a wound parasite that disrupts water movement, causing necrosis of the inner bark, and discoloration of the sapwood" Ric Lopez, US Forest Service's Institute of Pacific Islands Forestry.



Location of infestations

The latest map of confirmed Rapid 'Ōhi'a Death cases on Hawai'i Island shows that the disease has spread beyond Puna and South Hilo to Volcano, Na'alehu and Kona as far north as Kaloko Mauka. There are still no confirmed cases from North Hilo, Hāmākua or Kohala, and no confirmed cases for other islands.

As scientists and land managers work to understand the disease, we need your eyes in your communities! We have a chance of stamping out the disease where it is still affecting only a few trees, but we need your help in getting these trees identified and tested as quickly as possible.

Please contact researchers (www.rapidohiadeath.org) if you see trees with symptoms of ROD, especially in parts of Hawai'i Island where we don't have confirmed cases or on other islands.

Rapid 'Ōhi'a Death

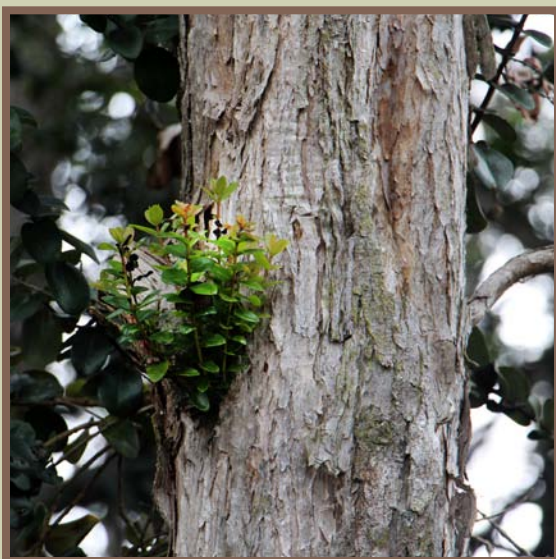


Dead 'ōhi'a in Manukā Natural Area Reserve, May 2016, Photo © Jared Bernard, ecological observer.com



Ceratocystis wilt of 'ōhi'a, Rapid Crown Mortality, Pāhoa, Hawai'i Island, Photo JB Friday, 2015.

Trees within a given stand appear to die in a haphazard pattern; the disease does not appear to radiate out from already infected or dead trees. Within two to three years nearly 100% of trees in a stand succumb to the disease. Other trees in the forest such as kōpiko (*Psychotria spp.*), 'ohe mauka (*Polyscias spp.*), strawberry guava (*Psidium cattleianum*), *Melastoma spp.*, and Koster's curse (*Clidemia hirta*) are not affected by the disease.



Epicormic sprouts on diseased 'ōhi'a, Photo JB Friday

One symptom of Rapid 'Ōhi'a Death is the development of epicormic sprouts, as the fungus *Ceratocystis fimbriata* interrupts distribution of the normal plant hormones that regulate water sprouts.

Timeline:

- 2010: Unusual 'ōhi'a mortality seen in forests and residential areas of Puna and Hilo Districts on Hawai'i Island. Landowners observed previously healthy-looking trees begin to exhibit symptoms and die within a matter of weeks. Later, in 2014, 'ōhi'a trees in these sites diagnosed with the fungus *Ceratocystis fimbriata*.
- 2012: Hundreds of trees recorded as dying
- 2014:
 - Satellite imagery showed about 15,000 acres infected by the disease
 - USDA researchers identify pathogen *Ceratocystis fimbriata* as causing Rapid 'Ōhi'a Death
 - +/-6,000 acres from Kalapana to Hilo affected with stands showing greater than 50% mortality. No reports on other islands.
- 2015:
 - *Ceratocystis fimbriata* found in frass (sawdust) emitted by boring beetles attacking infected trees.
 - USDA moratorium and State Department of Agriculture quarantine on transport of plants and plant parts
- 2016:
 - Lyon Arboretum funds banking 'ōhi'a seeds with a successful gofundme campaign
 - Pua'ena'ena Ceremony at Merrie Monarch 2016 safely returns kinolau, hakina, and lei to the forest with proper protocol and offer thoughts of full recovery to the fire of Ke Ahi O Hi'iaka
 - Aerial surveys of 810,000 acres on Hawai'i Island, with next steps being follow-up flights for the rest of the 'ōhi'a forests and ground-truth for the aerial operations
 - Surveys show ROD spreading to 50,000 acres
 - U.S. Department of the Interior announces additional federal funding to combat ROD

'Ōhi'a Quarantine:

The Hawai'i Department of Agriculture has imposed a quarantine that prohibits movement of all 'ōhi'a plants or plant parts, including flowers, leaves, seeds, stems, twigs, logs, and soil, among the Hawaiian Islands except by permit. Violation of the quarantine is a misdemeanor and carries fines of up to \$10,000. Hearings are underway to make the rule change permanent

PLANT QUARANTINE INTERIM RULE 15-1

- Prohibits the intrastate movement of Ohia (*Metrosideros* – all species in genus) from the Island of Hawaii.
- **EXCEPT** by permit issued by the Hawaii Department of Agriculture.

PLANT QUARANTINE INTERIM RULE 15-1

- OHIA PLANTS
- OHIA PLANT PARTS:
 - ✓FLOWERS
 - ✓LEAVES
 - ✓SEEDS
 - ✓STEMS
 - ✓TWIGS
 - ✓CUTTINGS
 - ✓UNTREATED WOOD
 - ✓LOGS
 - ✓MULCH
 - ✓GREENWASTE
 - ✓SAWDUST
 - ✓FRASS – FROM WOOD BORING INSECTS FEEDING ON OHIA
 - ✓SOIL – JANUARY 1, 2016

Rapid 'Ōhi'a Death



Dead 'ohi'a in Manukā Natural Area Reserve, May 2016, Photo © Jared Bernard, ecological observer.com



Lyon Arboretum Photo

University of Hawai'i Lyon Arboretum Seed Conservation Lab

One of several seed banks in Hawai'i saving endangered Native Hawaiian plants one seed at a time

Selecting plants resistant to rapid 'ohi'a death is another long term strategy.

In early 2016 Marian Chau of Lyon Arboretum's Seed Conservation Laboratory launched a successful gofundme campaign to support collecting and preserving 'ohi'a seeds from all islands for future forest restoration.

The Seed Conservation Laboratory is:

- collecting seed on Hawai'i Island, especially high risk areas
- collecting seed of 'ohi'a species endemic to O'ahu
- collaborating with partner agencies to obtain 'ohi'a seeds specific to other islands
- working with UH & USDA scientists to optimize their efforts on Hawai'i Island
- providing long term storage of 'ohi'a seeds

Lyon Arboretum currently banks over 12 million seeds from over 500 native species. Its Seed Lab partners with the Lyon Arboretum Micropropagation Lab, the Plant Extinction Prevention Program, the State of Hawai'i Division of Forestry and Wildlife, the Hawai'i Island Native Seed Bank, and other agencies to provide for both long-term storage for conservation, and propagation of plants for restoration efforts



Seed Propagation, Lyon Arboretum Photo

Help spread the word on social media using the hashtag #ohialove.



Kaumana Trail, Hawai'i Island, Photo JB Friday

Brush-like flower clusters are composed of clusters of individual flowers, each with many stamens (male) and one pistil (female). On the flower in the foreground, all stamens have all fallen off, leaving a pistil still attached to a seed capsule for each individual flower. The flower in the background has more recently opened and still has all its stamens. .



Kokee, Kaua'i, Photo Nathanael Friday

Capsules dry and split when the seed is ripe to release the tiny seeds which are blown by the wind. .



Hilo, Photo JB Friday

Newly opened 'ohi'a seed capsules showing the many tiny seeds inside. Cultivated seed capsules.



Lyon Arboretum Photo

Tiny 'ohi'a seeds (1-2 mm) under a microscope.

Other challenges

These vibrant lehua overlook the contrasting lava flow below. The tan coloration on the flow is an invasive grass called Fountain Grass (*Pennisetum setaceum*), a perennial clumping-grass that can dominate barren lava flows. As a pioneer species, 'Ōhi'a is typically one of the first native species to colonize a barren lava flow, but with the introduction of Fountain Grass, 'ohi'a is unable to compete. While Rapid 'Ōhi'a Death is a very big concern, our 'ohi'a also face many other challenges.

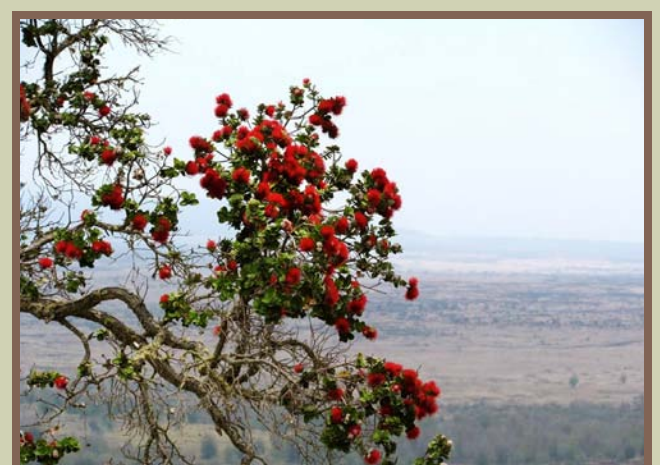


Photo Anya Tagawa

Rapid 'Ōhi'a Death



Dead 'ōhi'a in Manukā Natural Area Reserve, May 2016, Photo © Jared Bernard, ecological observer.com

What we can do:

Currently, there is no effective treatment to protect 'ōhi'a trees from becoming infected with *Ceratocystis* or cure trees that exhibit symptoms of the disease. The pathogen may remain viable for over a year in dead wood and has been found in soils under infected stands in Hawai'i. Contaminated soil may transmit the disease

We can still help! While researchers are working to solve the scientific questions, we can help too.



Dr. Lisa Keith, Research Plant Pathologist, USDA Agricultural Research Service, Photo Hollyn Johnson, Hawai'i Tribune-Herald

5 THINGS YOU CAN DO TO REDUCE THE SPREAD OF RAPID 'ŌHI'A DEATH

- ### 1 DON'T MOVE 'ŌHI'A WOOD

Don't move 'ōhi'a wood, firewood or posts, especially from an area known to have ROD. If you don't know where the wood is from, don't move it.
- ### 2 DON'T TRANSPORT 'ŌHI'A INTER-ISLAND

Comply with the new quarantine rule to help prevent ROD from spreading. Don't move 'ōhi'a plants, wood, or other 'ōhi'a plant parts interisland without a permit.
- ### 3 CLEAN YOUR TOOLS

Use only proven cleaning methods—other methods have been tested and they don't kill the fungus. Tools used for cutting 'ōhi'a trees (especially infected ones) should be cleaned with 70% rubbing alcohol or 10% bleach (if using bleach be sure to oil afterwards to prevent corrosion).
- ### 4 CLEAN YOUR GEAR

Clean your shoes, gear and clothing. Decontaminate shoes by dipping the soles in 10% bleach, 70% rubbing alcohol, . Other gear can be sprayed with the same proven cleaning solutions. Wash clothing in hot water with detergent.
- ### 5 WASH YOUR VEHICLE

Wash the tires and undercarriage of your vehicles with detergent, especially after traveling from an area with ROD and/or if you have traveled off-road.

With 'ōhi'a wilt rampant in Puna, a Volcano landowner is having visitors dunk their boots in a bleach bath before walking his land. Volcano, Hawai'i Island. Photo JB Friday



Clean your shoes to prevent spread of fungal spores and invasive seeds in our forests. Photo Anya Tagawa



Better yet, get someone else to do it for you! Photo Rapid 'Ōhi'a Death Facebook



Photo Anya Tagawa

HELP PROTECT OUR FORESTS FROM INVASIVE SPECIES AND DISEASE

BEFORE and AFTER Visit:

CLEAN YOUR GEAR

Brush all dirt from shoes and gear. Spray with 70% rubbing alcohol.

CLEAN YOUR VEHICLE

Remove all soil. Wash tires and undercarriage with detergent.

Don't forget to clean inside and outside and under your car.

To avoid beetles being attracted to dead trees and spreading disease through frass that can contain fungus spores and become airborne or get into soil and water, the Department of Agriculture advises landowners to:

- where practical, have infected trees cut down by an arborist, especially in areas adjacent to healthy forests, and
- cover felled trees with tarps until the fungus is no longer viable.

Cutting down dead, ROD-infected trees is risky business

- Be safe!
- Work with an arborist certified by the International Society for Arboriculture - check with the Big Island Invasive Species Committee <http://www.biisc.org/hawaii-island-certified-arborists/>
- Discuss sanitation measures and share our recommended practices.
- Make sure gear, equipment, and vehicles are cleaned of all debris and soil before and after work.
- Chainsaws should be sprayed with 70% isopropyl alcohol to kill *Ceratocystis* fungal spores. Blades should be brushed clean, sprayed with cleaning solution, and run briefly to lubricate the chain.

RAPID 'ŌHI'A DEATH

WHAT SHOULD I DO WITH DEAD INFECTED TREES?

If possible cut tree down, cut into smaller pieces, and securely cover wood with a tarp for 3-6 months to keep boring beetles out (as they may spread the disease). You may also burn the wood after it dries. Do not transport the wood.



Photo Rapid 'Ōhi'a Death Facebook

Rapid 'Ōhi'a Death



Dead 'ōhi'a in Manukā Natural Area Reserve, May 2016, Photo © Jared Bernard, ecological observer.com



Handing out brochures at Merrie Monarch 2016 Photo Anya Tagawa

Learn and Share information

Great turn-out, questions and discussion for the Rapid 'Ōhi'a Death presentation at Kealakekua Library on Hawai'i Island

Keep an eye out for future announcements for community presentations and talk-story sessions.



Photo Megan Lamson Rapid 'Ōhi'a Death Facebook

To request a presentation for your community:

contact the ROD outreach specialist Corie Yanger at cmryanger@hawaii.edu.

'Ōhi'a Picking Guidelines!

How to safely pick 'ōhi'a on Hawai'i Island

- Avoid areas confirmed to have Rapid 'Ōhi'a Death.
- Always, everywhere, follow decontamination protocol:
 - remove soil from tools (loppers, pruners, etc.), gear and shoes,
 - then sanitize by spraying (saturate) with 70% rubbing alcohol.
 - Follow this process after leaving and before entering any new area and between cutting from different trees
- Wash vehicles with detergent before traveling from one place to another, especially tires and undercarriage, and especially before and after traveling off-road. It is critical to remove all soil.
- Pick ONLY the first four inches of 'ōhi'a stem tips (includes flowers and liko)
- Do Not move any part of an 'ōhi'a plant off Hawai'i Island, except by Hawai'i Department of Agriculture permit

You need a permit from DOFAW to pick on State land.

When you apply for a Foliage Picking Permit at the Hilo office you will receive:

- Permit and amended special conditions
- ROD brochure
- Free 16oz bottle of alcohol and a standard-sized boot brush to keep



Photo Anya Tagawa

Substitute Materials

When you can, substitute different plant materials, like this wreath from a 2015 Alternate Material Christmas Wreath Workshop

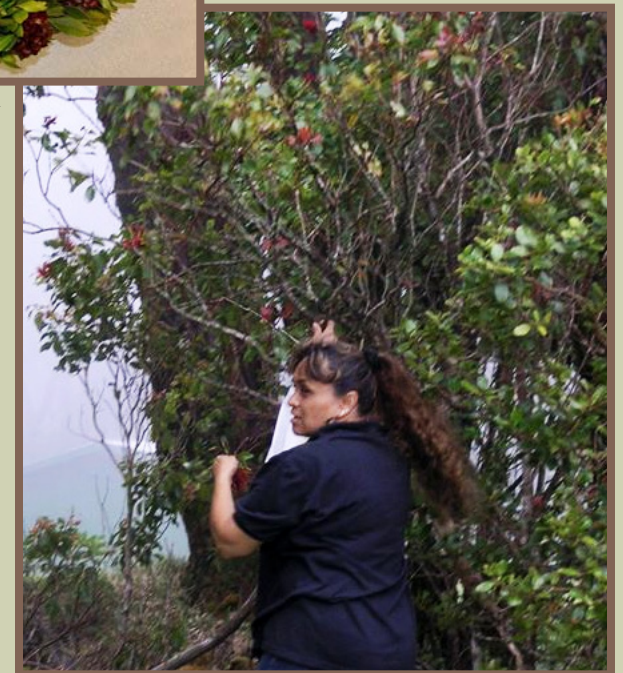


Photo Rapid 'Ōhi'a Death Facebook



Merrie Monarch 2016 Photo Anya Tagawa

Mahalo nui loa

to all the wonderful folks supporting efforts and doing their part protecting Hawaii's unique 'Ōhi'a lehua!

Individuals and organizations including Hawai'i Department of Land and Natural Resources, Hawai'i Department of Agriculture, University of Hawai'i, USDA Agriculture Research Service, Hakalau Forest National Wildlife Refuge, and Hawai'i Volcanoes National Park are working on research on and educating the public about Rapid 'Ōhi'a Death, how to comply with containment regulations, and have instituted biosecurity measures for staff and researchers to prevent increased spread. Everyone can help.

Contact researchers (www.rapidohiadeath.org) for information or if you see trees with symptoms of ROD, especially on Hawai'i Island where we don't have confirmed cases or on other islands.

'Ōhi'a lehua



Orange and red flowers on adjacent 'ōhi'a, Kukaiaua, Hawai'i Island, Photo JB Friday

He ali'i ka 'āina, he kauā ke kanaka
The land is chief and the people are its servants

Respect the land and care for it



Merrie Monarch Photo, Hawai'i Public Radio



For up-to-date information check
facebook.com/RapidOhiaDeath/ or rapidohiadeath.org

