Kaua‘i Rapid ‘Ōhi‘a Death Strategic Plan

Version 1
Developed by the
Kaua‘i Rapid ‘Ōhi‘a Death Working Group
December 2019

Note: Because this is a new and emerging disease, with science and management being carried out concurrently, this is a working document and will be updated by the Kauaʻi Rapid ʻŌhiʻa Death Working Group (KROD) members on a semi-annual basis.

Agencies involved in KROD Strategic plan development:

Department of Land and Natural Resources, Division of Forestry and Wildlife Kauaʻi Branch
Kauaʻi Invasive Species Committee
The Nature Conservancy, Kauaʻi Forest Program
US Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office

KROD Working Group members:

College of Tropical Agriculture and Human Resources, Kauaʻi Extension Office
Department of Land and Natural Resources, Division of Forestry and Wildlife Kauaʻi Branch
Department of Land and Natural Resources, Division of State Parks
Hawaiʻi Department of Agriculture, Kauaʻi Branch
Kauaʻi Invasive Species Committee
National Tropical Botanical Garden
The Nature Conservancy, Kauaʻi Forest Program
US Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office

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I. Executive Summary

The purpose of this plan is to guide management decisions in response to the positive detections of Rapid ʻŌhiʻa Death (ROD) on Kauaʻi in May of 2018. Management strategies are based on the best available science and site-specific information. ʻŌhiʻa trees can be found across the Hawaiian Islands from coastal areas up to 9,000 ft elevation, encompassing approximately 857,00 total acres. These endemic trees vary from tall canopy trees to short and shrubby up at the higher, windy elevations. ʻŌhiʻa is an essential tree in the Hawaiian native forest and is the dominant tree in wet forests on all islands, being a keystone species both ecologically and culturally in Hawaiʻi.

Rapid ʻŌhiʻa Death was first discovered on Hawaii island in 2009-2010 when residents of the Puna district began noticing ʻōhiʻa trees on their properties dying quickly. Seemingly healthy trees were reported to have either a major limb or the entire canopy turn yellow, then brown and within a few weeks appear dead. There are two distinct fungi that are housed under the ROD acronym, *Ceratosystis huliohia* and *Ceratosystis lukuohia* but both types kill ʻōhiʻa trees.

Since the May 2018 detection conservation agencies working in the forest have come together to devise strategies in order to quickly survey, sample and manage trees suspected to have been infected by ROD. This plan outlines the agencies involved, prevention, detections and response strategies for both types of the ROD fungus, ongoing estimated costs and needs as well as a communications and outreach strategy for both sampling on lands and education of residents and visitors to this threat to our native forests.

II. Introductory Statement/Purpose of the Plan

The purpose of this plan is to guide management decisions in response to the recent rapid ʻōhiʻa death (ROD) detections on Kauaʻi. Management strategies are based on the best available science and site-specific information. Site-specific response plans are developed in partnership with appropriate land managers, scientists, and stakeholders. Response strategies are continually evaluated and adjusted as new information and techniques become available. Implementation of the plan is dependent on funding availability and collaboration with partners. The most immediate goals are to determine whether ROD is in the incipient or early stages on Kauaʻi and to prevent the spread of ROD into new and high conservation value areas. This plan can also be adapted to support response to and management of future natural resource incidences.

This disease has coalesced many people around the state, the region and the world, which has stimulated significant scientific research aimed at exploring ʻōhiʻa resistance and resiliency to ROD. We also know that history has shown repeatedly that the natural world can have the ability to heal itself or adapt to enormous threats. It is important that we embrace adaptive management when developing our approach towards understanding and responding to this disease.

III. ROD Overview

ʻŌhiʻa trees can be found across the Hawaiian Islands from coastal areas up to 9,000 ft elevation, encompassing approximately 857,00 total acres. These endemic trees vary from tall canopy trees to short and shrubby up at the higher, windy elevations. ʻŌhiʻa is an essential tree in the Hawaiian native forest and is the dominant tree in wet forests on all islands, being a keystone species both ecologically and culturally in Hawaiʻi.

Rapid ʻŌhiʻa Death was first discovered on Hawaii island in 2009-2010 when residents of the Puna district began noticing ʻōhiʻa trees on their properties dying quickly. Seemingly healthy trees were reported to have either a major limb or the entire canopy turn yellow, then brown and within a few weeks appear dead. It was named Rapid ʻŌhiʻa Death prior to the fungal species being identified because of how quickly the trees seemed to die, within a couple of weeks, in comparison the previous ʻōhiʻa dieback disease.

There are two distinct fungi that are housed under the ROD acronym, *Ceratosystis huliohia* and *Ceratosystis lukuohia*. *Ceratosystis* is a common fungus found worldwide, however, these two species of fungus are new to science. The fungi are distinct in how they affect the tree. *C. lukuohia* affects the entire tree at once, seemingly causing the tree to wither within days. *C. huliohia* is relatively slower moving and affects one limb at a time while the rest of the tree can appear healthy. The fungi are only found in the woody tissue (xylem or sapwood). It does not infect flowers, leaves, or seeds as far as we know, nor is it visible on the exterior of the tree.

Both types of fungi spread in the same manner: 1) by humans moving infected wood or plants, 2) by boring beetles bringing the spores with them from one infected tree to the other or 3) from the frass, or sawdust, pushed out of the tree by the boring beetle as it burrows into the tree. The beetles are drawn to the "smell" of a wounded tree and if they are carrying the *Ceratosystis* spores, they infect the tree as they enter the wound.

Fortunately, spores alone are not carried by the wind. However, they are carried by the frass as the beetle "pushes" it out of the bore hole and then is blown by the wind. Infected sawdust or frass can also be moved on cutting tools that are used on infected trees, by falling into mud and transferred on shoes, tires or animals that carry mud and wound trees.

By just looking at a tree it is not possible to know whether the tree died from the fungus, another pathogen, or even a lightning strike. The only way to tell if a tree is infected is to send a sample to the lab. Since the fungus enters the tree through a wound, the markings of the disease are not visible from the outside surface of the tree. Wounds can be caused either naturally, after a high wind storm, by a browsing animal, spiked boots while hiking, by a weed whacker, or pruning in a yard. The fungus enters the tree and grows in the sapwood, and as it spreads, strangles the tree by cutting off the water supply. The only way to know whether the tree is infected is to cut into the bark and look for tell-tale black staining and then send a sample to the lab. When a tree is sampled, the wood chips and sawdust are sent to a lab on Hawaii island where they tested to determine if the fungus is detected or not detected. It is more difficult to test for *C. huliohia* since the fungus does not "ring" the tree or branch, as with *C. lukuohia*, but moves out from one spot so the sample must be more precise for the fungus to be detected.

IV. History of ROD on Kauaʻi

In May 2018, Rapid ʻŌhiʻa Death (ROD) was confirmed in 14 trees on Kauaʻi's northeast side in Moloaʻa State Forest Reserve, with an additional three trees that later tested positive. Pathologists at the USDA Agricultural Research Service in Hilo confirmed Ceratocystis huliohia as the fungal pathogen causing mortality. DNA testing revealed that the C. huliohia found on Kauaʻi was a genetically distinct population from that found on Hawaiʻi Island where less than five percent of ʻōhiʻa ROD mortality is due to this particular Ceratocystis fungal species.

The discovery of ROD on Kauaʻi triggered a host of rapid response activities by a collaborative team of scientists and forest managers representing state, federal, and private organizations from around Hawaiʻi. Teams conducted aerial drone flights and helicopter surveys using digital mobile sketch mapping and identified 21 additional ʻōhiʻa trees across the island on state and private lands with the ʻōhiʻa trees showing symptoms consistent with the disease.

Throughout the rest of the year, three groups took the lead sampling trees: 1) DOFAW on state lands; 2) TNC on areas encompassed by the KWA Management Plan; and 3) KISC on other private property. By November 2018, 76 samples had been collected and submitted for lab testing. This resulted in the detection of *C. huliohia* on privately-owned land in two additional areas—on the north side of the island at 1,600-feet elevation, on the south side of the island at 1,000-feet elevation.

Then, in December 2018, *Ceratocystis lukuohia* was detected in three trees at 550-feet elevation on DHHL land behind Anahola Mountain on Kauaʻi's east side. Within a day, helicopter surveys using digital mobile sketch mapping (DMSM) was scheduled and within a week, a team from UH Hilo Department of Geography SDAV Lab flew to Kauaʻi to conduct targeted drone surveys. Several dozen suspect trees were identified.

In January 2019, a week-long, boots-on-the-ground effort with multiple agencies and organizations from around Kauaʻi along with a team of six from Hawaiʻi Island Invasive Species Committee sampled 33 trees of which14 tested positive for *C. lukuohia* and 15 tested positive for *C. huliohia*. At this time there was little visible evidence of beetle activity, although frass from three trees tested positive for ROD. These three trees were felled and tarped in February 2019.

Digital mobile sketch mapping continues to inform further prioritization of suspect trees and on the ground sampling. As of July 2019, sampling areas have been divided amongst agencies and trained staff to determine whether the fungus has spread further on Kauaʻi.

V. Lead Agency Assignments

<u>Department of Land and Natural Resources – Division of Forestry and Wildlife (DLNR-DOFAW)</u> - For all State of Hawaii Lands, including those not owned or managed by DLNR-DOFAW, DOFAW will lead testing and management to positive detections. The Nature Conservancy (TNC) & Kauaʻi Invasive Species Committee (KISC) will support DOFAW as requested. See Resource Catalogue for capacity detailed DOFAW Incident Command Structure.

<u>Kauaʻi Invasive Species Committee (KISC)</u> - For private lands, KISC will lead testing and management responses to positive detections, with landowner permission. The TNC and DLNR-DOFAW to support KISC as requested. See Resource Catalogue for capacity detailed KISC Incident Command Structure.

The Nature Conservancy (TNC) - For areas encompassed by the KWA Management Plan (approximately 25,000 acres), TNC will lead testing and management responses to positive detections. The DLNR-DOFAW and KISC to support TNC as requested. See Resource Catalogue for capacity detailed TNC Incident Command Structure.

VI. Prevention and Outreach Strategies

A. Bio-Sanitation Protocols

All agencies and contractors are expected to follow specific bio-sanitation protocols to prevent the spread of Rapid ʻŌhiʻa Death. Based on each project's scope, partner agencies and contractors are required to craft project-specific bio-sanitation protocols, starting with a basic level of expected bio-sanitation practices (included in attachments).

Additionally, agencies and contractors are expected to educate themselves about Rapid ʻŌhiʻa Death, follow a ROD code of conduct, and be available to periodic accountability of their bio-sanitation practices. If found in violation, contracts may be terminated.

B. Outreach and Education

i. Vision: ʻŌhiʻa will thrive on Kauaʻi

ii. Objectives:
   a. Generate public recognition and appreciation of ʻōhiʻa's ecological and cultural significance.
   b. Prevent spread of ROD (*C. lukuohia and C. huliohia*) through introduction by people through transportation of spores on shoes, clothing, vehicles etc.
   c. Encourage more "eyes on the ground" – reports by people who notice suspect trees to DOFAW or KISC.
   d. Focus communications on research and translate to each audience/s.
   e. Share public questions and sentiment back to researchers and resource managers.
   f. Establish Kauaʻi ROD Team credibility and introduce and lend credibility to statewide and interagency ROD Teams.
   g. Support efforts for ʻōhiʻa to thrive statewide.
   h. Raise awareness and support of decision-makers related to the vision statement.

iii. Messages:
   a. ʻŌhiʻa is important to the native ecosystem, watershed, Hawaiian culture.
   b. Five Things (prioritized for Kauaʻi): Keep your eyes open; avoid injuring ʻōhiʻa; clean your shoes, tools, and gear; wash your vehicle; don't move ʻōhiʻa.

iv. Priority audiences:
   a. Priority 1: motocross, hikers, mountain bikers, hunters, inter-island travelers, heavy equipment operators, large (forest) landowners, Kauaʻi

government, cultural practitioners, other conservation groups, general public, outreach partners, Kōkeʻe cabin leaseholders, media, and Kaua'i visitor industry.
  b. Priority 2: ranchers, landscaping industry, and schools.
  c. Priority 3: forest workers, off-grid naturalists, and grant-makers.

v. Outreach Work Plan (available upon request)

VII. Early Detection Strategies

Goals:
Understand and document the extent of C. huliohia and C. lukuohia infected trees currently on Kauaʻi.
Detect new locations of C. huliohia and C. lukuohia early to prevent their spread.

A. Island Wide Surveys

i. Quarterly to semi-annual aerial surveys as capacity allows.
  a. Lead agency: DOFAW

ii. Techniques - Remote Sensing: DMSM, drone and aerial ortho-imagery, LiDar, hyperspectral infrared imagery, Pictometry, etc.

iii. Ground surveys - Follow up with ground sampling survey of suspect trees
  a. Refer to sampling techniques in XIII Attachment D. Technique Definitions

iv. Refer to section V. Lead Agency Assignments and Resource Catalogue

v. Sanitation surveys

vi. Boot scrubber station sampling techniques

vii. Monitoring – verifying contractors/partners are following proper sanitation protocols/SOP.

B. Monitor ʻŌhiʻa Forested Areas after High Wind Events

i. Monitoring post high wind event in the vicinity with detection.
  a. Identify areas of concern based on wind velocity and direction compared to ʻōhiʻa distribution with Geographic Information System (GIS) mapping technology.
  b. Monitor quarterly for one-year post event.
  c. Lead agency: DOFAW

ii. Techniques
  a. Remote Sensing: DMSM, drone and aerial ortho-imagery, LiDar, hyperspectral infrared, Pictometry, etc.
  b. Ground surveys

iii. Follow up with ground sampling survey of suspect trees.
  a. Refer to sampling techniques (location/section)
  b. Refer to section VI. Lead Agency Assignments and Resource Catalogue

VIII. Rapid Response Strategies for *C. lukuohia* and *C. huliohia* Detections

Goal: Determine extent of localized infestation to maximize successful containment of the disease(s) and prevent spread of disease(s).

A. Objectives:

i. Identify and notify landowner(s) of suspect trees and need for sampling.
   a. Determine if Right of Entry agreements are needed to access and manage suspected infection sites.
   b. Work with landowner to sign their preferred agreement.

ii. If positive results from sampling, develop and implement site-specific communication plan to accurately inform the partners and public regarding the detection and recommend responses.
   a. See site-specific communication plan template
   b. Post infested areas signs to inform forest users, if appropriate.

iii. Define the geographic scope, number of infected ʻōhiʻa trees, and type of Ceratocystis in infestation area.
   a. Using remote sensing techniques map and establish perimeter for boundaries of suspect trees.
   b. Prioritize ground sampling surveys based on gathered remote sensing information.
   c. Assess positive and suspect tree locations to inform potential management decisions.
   d. Continue delimiting aerial and ground sampling surveys while rapid response management plan is being developed.

iv. Review rapid response management options for infested trees to mitigate the spread of the disease to additional ʻōhiʻa trees and forests, while the delimiting sampling survey continues, and the site management plan is being developed.
   a. See Suspect Tree Management Action Checklist
   b. Containment/management options
      1. Fell, stack or cover *C. lukuohia,* seal all cut surfaces to keep spores contained within wood.
      2. Leave standing if felling will injure healthy trees.

v. Formulate medium to long-term management and monitoring plans for each site. Plans include survey, sampling, monitoring and possible containment options.
   a. Continue delimiting aerial and ground sampling surveys and rapid response management actions while management plan is being developed.
   b. Continue to monitor site for insect activity.
      1. Establish permanent plots for monitoring infested area.
      2. Install environmental monitors (spore traps, etc).
   c. Monitor change in mortality rate of positive trees.

IX. Capacity Building

A. Staff Training Needs

Goal 1: Response teams are current on all field and safety training

i. Annual training: Wildlife CPR/first aid, Certified chain sawyer, chainsaw safety.
ii. Specialty training: Survey training, Remote Sensing training, Sampling training, tarp placement training - opportunities to have redundancy in staff to increase capacity and eliminate delays.

B. Adaptive Management Strategies

Goal 2: Increase information gathering to direct management decisions in adaptive management strategies

i. Pathology information to increase knowledge of the difference between *C. huliohia* and *C. lukuohia*.
ii. Correlated wind patterns and new detections; mapping wind events.
iii. After strong wind events: determine management options for monitoring of area during the event to assist with after-storm containment and documentation to inform potential correlation of future detections.
iv. Devise mechanisms and management strategies to preserve the ecosystem: watershed health, endemic habitat, and ecosystem health.
v. Catalogue of effective landscape level control techniques and long-term control techniques: ʻŌhiʻa ROD resistance, insecticide, biocontrol, etc.
vi. Determine potential for replanting or replacement species techniques to maintain watershed function to replace and suppress spread, plant – buffers or wind-breaks to possibly inhibit spread across the landscape.
vii. Support research to improve on the ground management

C. Rapid Response Capacity

Goal 3: Increase technical staff positions

As capacity needs increase for surveying, sampling and response management activities, work to increase staff positions across agencies to meet the demand.

X. Ongoing Costs Estimations

Ongoing implementation of the plan is dependent on funding availability and collaborators' rapid response capacity. These cost estimates are intended to give a range of possible costs, and to illustrate the numerous expenses involved in managing for ROD, especially in areas that are helicopter access only, a common occurrence on Kauaʻi due to rugged terrain.

A. Kauaʻi Estimated Response Costs:

Table is pending and will be updated in subsequent versions to show response and management costs based on location and number of trees that require sampling.
*Lab costs per sample are not included in this estimate but may be charged per tree in the future.

Number of Suspect Trees	500	1000	2000
Non-sampling Personnel Costs			
Sampling Costs			
Surveying Costs			

B. Estimated Cost "per tree"

In Table 1 below there is an example of estimated cost for sampling of a suspect tree or felling of a known ROD infected tree. These costs are estimates and are intended to give a range of possible costs, and to illustrate the high cost involved in managing for ROD, especially in areas that must be accessed only by helicopter, which is common on Kauaʻi with its rugged terrain. For example, sampling a tree in a remote area (helicopter access only) may cost >$3000 for field time alone. Felling a tree in a remote area may cost upwards of $5-6000 if multiple flights are needed to transport necessary crew.

Table 1: Estimated Cost "per tree" for Sampling/Felling*:

Item	***Number needed***	***Cost/hour***	***# Hours***	***Total Cost***
Helicopter time	1-2	$900	2	$2,050-$4,100
Crew Lead (Forester etc)	1	$25-$35	10	$250-$350
Technicians (sampling)	2	$15-$20	10	$300-$400
Technicians (felling)	5	$15-$20	10	$750-$1,000
Drone operator (sampling)	1	$30-$35	10	$300-$350

**Assumes isolated suspect trees and full field day to access and sample each tree, which is representative of many suspect trees on Kauaʻi. Time estimate includes transport to and from site, field time plus time for full bio-sanitation efforts. Not included are additional costs for vehicle, fuel, equipment, remote sensing surveys to identify suspect trees, prep time for field day (mapping, landowner contact, coordination etc.).*

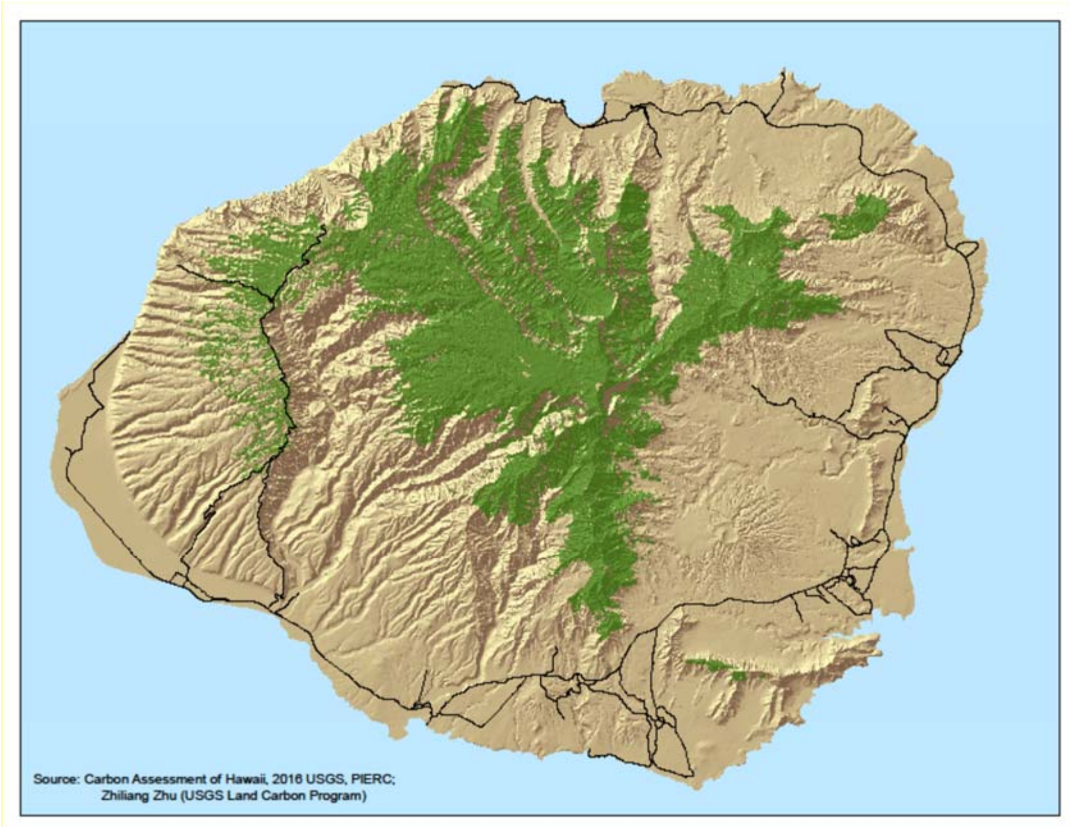
XI. Resources and Additional Information:

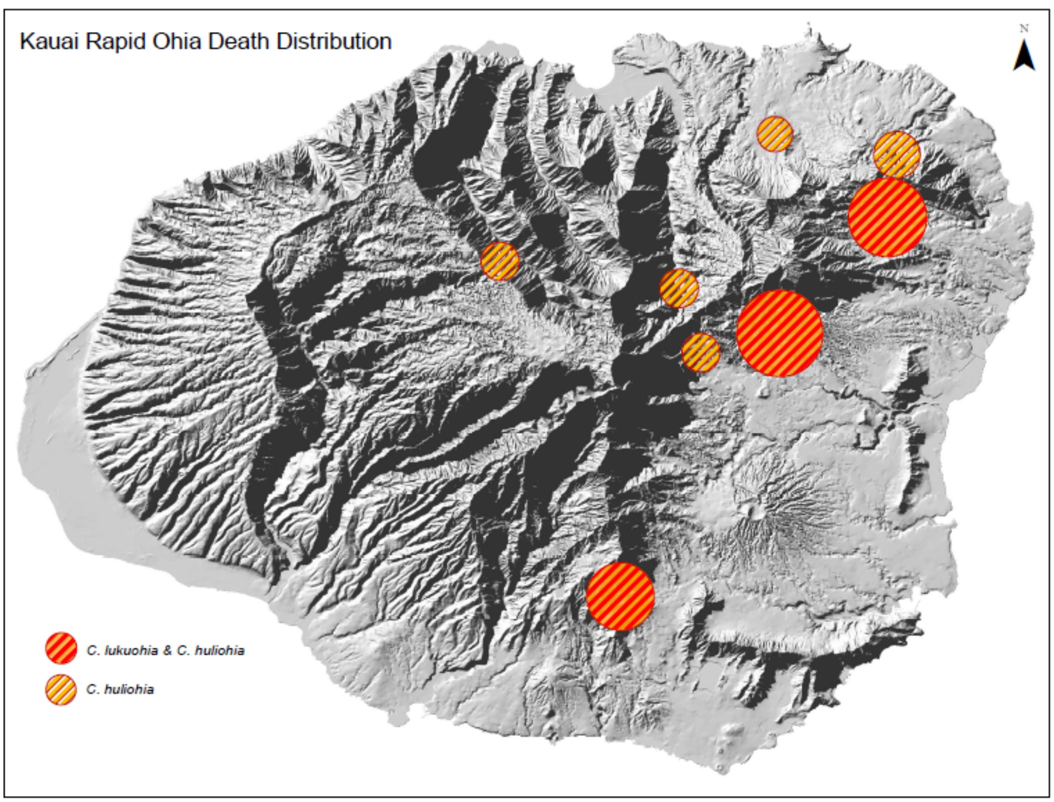
A. Research

The latest research and information can be found at The College of Tropical Agriculture and Human Resources at University of Hawaiʻi at Manoa website on Rapid ʻŌhiʻa Death under Research for Publications and References.

XII. Attachments:

A. Maps of Existing 'Ōhi'a Zones and ROD Locations





B. List of ROD Boot Scrubber and Trail Signage Locations

i. Kōkeʻe/Alakaʻi
   a. Kukui Trail
   b. Cliff/Canyon Trail - Puʻu Hinahina Lookout
   c. Cliff/Canyon Trail - MM14, top of Halemanu Valley
   d. Nuʻalolo Trail
   e. Awaʻwapuhi Trail
   f. Pihea Trail
   g. Berry Flats Trail
   h. Alakaʻi Swamp Trail
   i. Kawaikōi Stream Trail
   j. Poʻomau Ridge Trail
   k. Kohua Ridge Trail

ii. Wailua
   a. Nonou East - Wailua Houselots
   b. Nonou West - Wailua Homesteads
   c. Nonou – Kuamoʻo
   d. Moalepe Trail
   e. Powerline Trail
   f. Kuilau Trail

iii. Makauwahi Cave Reserve (3)

iv. NTBG (1)

v. Kīpū Adventures (3)

C. ROD Sampling Start-up Kit

<u>Dedicated ROD Response Kit Request</u>

1 storage container...$20.00

1 Stihl Chainsaw (18" blade)...$300.00

1 Set of Chaps..$120.00

1 Woodcutter Safety Helmet...$50.00

1 battery powered drill..$70.00

Drill bits..$5.00

1 Hachet..$20.00

1 Hand Saw..$15.00

1 20X20 Tarp..$90.00

1 20X30 Tarps..$140.00

1 large bottle rubbing alcohol 70%.. $10.00

1 32 Oz spray bottle...$10.00

1 box of nitrile/latex gloves..$16.00

! pair Leather work gloves..$12.00

1 Safety Glasses..$10.00

! box heavy duty trash bags..$20.00

1 box ZipLoc bags..$5.00

1 Box Sharpie Pens..$10.00

D. Techniques Definitions

i. Surveying Methods:

a. **Digital Mobile Sketch Mapping (DMSM)** – US Forest Service technique using tablet hardware, software, and back end data support processes (ArcGIS Desktop Tools) that allows trained aerial surveyors, in light aircraft, and ground observers to record forest disturbances. This greatly enhances the quality and quantity of forest health data while improving safety by integrating with programs such as operational remote sensing (ORS) which uses satellite imagery to monitor disturbances.

b. **Drone**: Formally known as unmanned aerial vehicles (UAVs) or unmanned aircraft systems (UASes). Drones can be remotely controlled or fly autonomously through software-controlled flight plans in their embedded systems, working in conjunction with onboard sensors and GPS. There are numerous types of drones. For our use, they primarily fall into these two categories:

- ***Multi-rotor***: If you want to get a small camera in the air for a short period of time, then it is hard to argue with a multi-rotor. They are the easiest and cheapest option for getting an 'eye in the sky', and because they give you such great control over position and framing, they are perfect for aerial photography work. The downside of multi-rotors is their limited endurance and speed, making them unsuitable for large scale aerial mapping, long endurance monitoring and long-distance inspection such as pipelines, roads and power lines. Although the technology is improving all the time, multi-rotors are fundamentally very inefficient and require a lot of energy just to fight gravity and keep them in the air. With current battery technology they are limited to around 20-30 minutes when carrying a lightweight camera payload. Heavy-lift multi-rotors are capable of carrying more weight, but in exchange for much shorter flight times. Due to the need for fast and high-precision throttle changes to keep them stabilized, it isn't practical to use a gas engine to power multi-rotors, so they are restricted to electric motors. So until a new power source comes along, we can only expect very small gains in flight time.
- ***Fixed-wing drones*** (as opposed to 'rotary wing', i.e. helicopters): These use a wing like a normal airplane to provide the lift rather than vertical lift rotors. Because of this they only need to use energy to move forward, not hold themselves up in the air, so are much more efficient. For this reason, they are able to cover longer distances, map much larger areas, and loiter for long times monitoring their point of interest. In addition to the greater efficiency, it is also possible to use gas engines as their power source, and with the greater energy density of fuel many fixed-wing UAVs can stay aloft for 16 hours or more. The main downside of a fixed-wing aircraft is obviously their inability to hover in one spot, which rules them out for any general aerial photography work. This also makes launching and landing them a lot trickier, as depending on their size you can need a runway or catapult launcher to get

them into the air, and either a runway, parachute or net to recover them safely again at the end. Only the smallest fixed-wing drones are suitable for hand launch and ‘belly landing’ in an open field.

c. **Hyperspectral remote sensing**: also known as imaging spectroscopy, is a relatively new technology that is currently being investigated by researchers and scientists with regard to the detection and identification of minerals, terrestrial vegetation, and man-made materials and backgrounds. Hyperspectral imaging, like other spectral imaging, collects and processes information from across the electromagnetic spectrum. The goal of hyperspectral imaging is to obtain the spectrum for each pixel in the image of a scene, with the purpose of finding objects, identifying materials, or detecting processes.

d. **Infrared:** Infrared remote sensing makes use of infrared sensors to detect infrared radiation emitted from the Earth's surface. The **middle-wave infrared (MWIR)** and **long-wave infrared (LWIR)** are within the thermal infrared region. These radiations are emitted from warm objects such as the Earth's surface. They are used in satellite remote sensing for measurements of the earth's land and sea surface temperature. Thermal infrared remote sensing is also often used for detection of forest fires.

e. **LiDAR:** which stands for Light Detection and Ranging, is a surveying method that measures distance to a target by illuminating the target with laser light and measuring the reflected light with a sensor. Differences in laser return times and wavelengths can then be used to make digital 3-D representations of the target.

f. **Pictometry:** Developed by Pictometry International Corp. and merged with EagleView Technologies, provide geo-referenced aerial images from both an oblique view giving natural perspective and an orthogonal, top-down view.

ii. Sampling

Media follows (5 pages).

COLLECTING SAMPLES FROM OHIA TREES SUSPECTED OF BEING INFECTED WITH *CERATOCYSTIS* (RAPID OHIA DEATH)

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Background: Two newly introduced species of the plant pathogen, *Ceratocystis,* referred to as species A and species B, are known to cause the disease known as Rapid Ohia Death in ohia trees on Hawaii Island. For both species, the fungus is known to grow within the sapwood, but not on the surface of the trees (i.e. bark surface).

Sanitation: Precautionary measures should be taken to prevent the transmission of the fungus to new hosts via contaminated cutting implements, gloves, hands, etc., by spraying with 70% isopropanol (rubbing alcohol) or 70% ethanol or 10% bleach (freshly mixed solution). Sawdust created when cutting into diseased trees contains a high number of viable spores; efforts should be made to contain and/or decontaminate any sawdust. Sawdust can be caught on tarps spread on the ground around the tree and collected for disposal; wetting the tarp slightly helps to catch sawdust. Felling trees on no wind/slightly wet days will help minimize airborne movement of infectious sawdust. Chainsaws must be thoroughly cleaned, including removing the bar and chain, to remove residual sawdust and disinfect surfaces between samples. It is important to prevent cross-contamination of samples by disinfecting tools, gloves, etc. before starting and after finishing collection of each sample. Testing methods include both culture-based techniques and molecular methods (DNA testing). Only culture-based techniques will determine viability of the fungus; DNA tests might additionally reveal the presence of fungus that is no longer alive due to heating, other treatments, or the length of time a tree has been dead.

Range of 'typical' staining/discoloration observed in ohia infected with either *Ceratocystis* species:

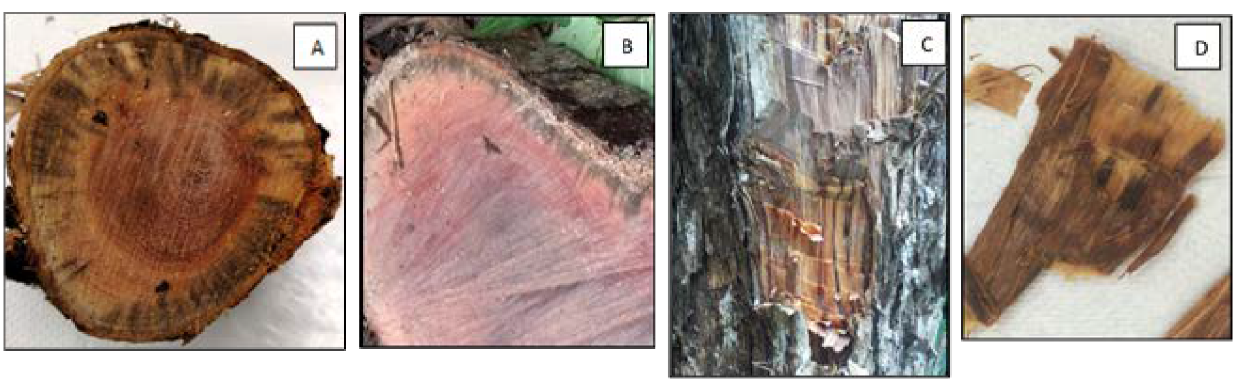

Figure 1. Typcial symptoms of ohia wood associated with *Ceratocystis* species A: an outward radiating pattern (starburst) of discoloration from stem cross-sections ("cookies") (A,B) and vertical streaks under the bark (C,D). Streaks are usually brown to black in color.

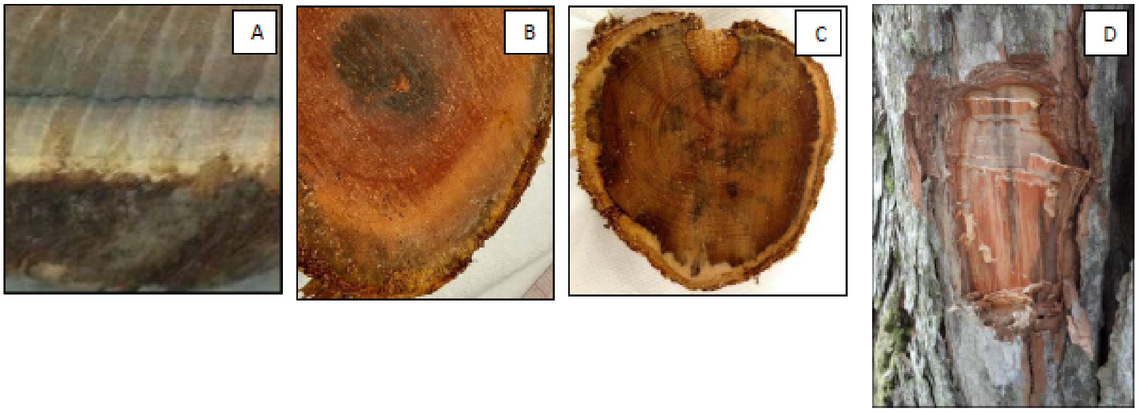

Figure 2. Typical symptoms of ohia wood associated with *Ceratocystis* species B: thin black lines of discoloration along the outer edge of cross-sections ("cookies") underneath the bark layer (A,B,C) and vertical streaks under the bark (D). Streaks are usually brown to grey-black in color.

Possible collection methods:

FOR SUSPECT TREES IN NEW LOCATIONS, ESPECIALLY HEALTHY FORESTS, WE RECOMMEND THAT INITIAL SAMPLES ARE COLLECTED BY THE DRILLING AND/OR SLASHING WITH A HATCHET OR AXE TECHNIQUES. THE USE OF A CHAINSAW CAN DISPERSE LARGE AMOUNTS OF INFECTIOUS SAWDUST. CONTAINMENT AND DECONTAMINATION ARE EXTREMELY DIFFICULT!

1. Drilling. *Pros*: Drilling is quick to perform and easy to make composite samples from many points on the same tree. Drilling makes a good first test. *Cons*: The sampling is blind. It is very unlikely that discoloration will be detected in shavings. Sampling is limited to places the collector can reach.
    a. Method notes:
        i. Use a 5/16" drill bit in a cordless drill. Use a portable propane torch (e.g. Bernzomatic) to flame sterilize drill bit between trees. Sterilizing bits with heat rather than alcohol destroys the DNA of the fungus and prevents cross-contamination, whereas alcohol will kill the fungus but may not destroy the DNA.
        ii. Drill at least 2" deep into at least 4 places (N-E-S-W) around breast height from a single tree, or from a suspect branch. Collect shavings into a plastic bag for testing.
        iii. Brush any residual wood shavings from the drill bit before sterilizing by flame or bleach/alcohol method. If working in an area where fire risk precludes use of the torch, keep a stock of clean, wrapped drill bits (to prevent cross contamination) on hand and change between samples. Clean hands and/or change gloves between samples.

2. Slashing by hatchet or axe. *Pros*: Slashing offers some ability to look for staining or discoloration, which is usually apparent as "streaking" (Figures 1c & 2d). Slashing disperses far less inoculum than felling the tree and cutting sections with a chainsaw would. *Cons*: As with drilling, a limited amount of the tree can be accessed by this method. Slashing leaves open wounds that could attract wood-boring insects. If an infection started in the crown of the tree, it might be missed by drilling or slashing at breast height.
   See YouTube video for demonstration: https://www.youtube.com/watch?v=DKlRoisstD0
   a. Method notes:
      i. Slash multiple places on the trunk to look for streaking underneath the bark. It may be necessary to cut a deep wound at least half an inch to detect the streaking. Collect wood pieces (not bark) and place in a plastic bag.
      ii. Disinfect hatchet or axe with 70% alcohol or a freshly-mixed 10% bleach solution between samples. Clean hands and/or change gloves between samples.

3. Beetle boring dust (frass). *Pros*: Collecting beetle boring dust or frass is the least invasive method and is quick to perform and easy to make composite samples from many points on the same tree. Like drilling, collecting beetle boring dust or frass is a good first test. *Cons*: The sampling is blind. It is very unlikely that discoloration will be detected in beetle boring dust. Boring dust and frass is not found on all trees nor at all stages of infection.
   a. Method notes:
      i. Collect insect boring dust or frass (Figure 3) in a plastic bag or a clean capped vial or conical tube for testing.
      ii. If insect boring dust/frass is held up in the bark, peel back or loosen bark and frass should pour out.
      iii. Clean hands and/or change gloves between samples.

Figure 3. Bark and ambrosia beetle boring dust (frass) (within red circles) that collects in trunk bark cracks and branch crotches.

4. Felling the tree and taking cross sectional samples ("cookies"). *Pros*: Felling the tree offers the greatest ability to assess staining or discoloration associated with either species of *Ceratocystis*

(Figures 1 & 2). Many cookies can be cut along the length of the tree to detect localized infections. *Cons*: Felling trees is dangerous and should only be attempted by trained and experienced personnel. Felling is very labor intensive. Sawdust from chain-sawing infected trees has been shown to contain live *Ceratocystis* spores and can become broadly dispersed in the felling location. Felling trees in a dense stand can injure neighboring, healthy trees and create the possibility of more infections.

a. Method notes:
    i. Fallers should wear safety equipment, including chainsaw chaps, boots, and eye and ear protection. Take all the usual precautions in felling trees: make sure the area is clear and all other personnel are out of the range of the falling tree. Make sure to have two escape routes to leave as the tree comes down. Do not fell trees with large dead branches in the crown ("widowmakers").
    ii. Make attempts to contain and/or decontaminate sawdust by sampling on calm, wet days and collecting and removing sawdust with tarps.
    iii. Once the tree is on the ground, cut thin cookies, under 1" thick, and place in plastic bags. Look for signs of staining in the sapwood (xylem) (Figures 1 & 2). Take one sample every 4 to 6 feet along the stem. If multiple cookies from the same tree are simultaneously submitted, mark the samples to indicate their relationship to each other "Tree 1, cookie A", "Tree 1, cookie B." If possible, provide a map of cookie location on the tree.
    iv. Sawdust can also be submitted as a sample. Do not mix the sawdust with dirt or other non-ohia particles.
    v. Thoroughly clean chain saw by taking off the bar and chain, removing all loose sawdust, and disinfecting with 70% alcohol or 10% bleach between trees. Clean hands and/or change gloves between samples.

Disinfecting Tools: Brush or wipe tools free of wood particles. Spray cleaned tool surface with 70% alcohol (isopropanol or ethanol) or a freshly made 10% bleach solution and allow to soak at least 5 minutes; rinse with clean water or allow to air-dry before use. A portable propane torch can also be used to heat particle-free, metallic surfaces (hatchet blades and drill bits) to kill infectious propagules and allow to air dry until cool to touch. Always disinfect tools between the sampling of multiple trees.

Photo Record: Take pictures of the individual tree prior to sampling and pictures of the tree slash sites and/or cookies to record any internal discoloration. Discoloration may darken once exposed to air and discoloration often becomes less obvious upon storage. Photographs of both the entire tree and affected leaves and branches are useful.

Labeling: Label any bags with a specific name for the site. GPS points are ideal if available, otherwise street addresses help. Include the collector's name, the date of collection and the location. Complete the sample submission form.

Delivery: Drop off samples to your local Hawaii Department of Agriculture Plant Quarantine Branch office or, if in Hilo, the USDA ARS office located at 64 Nowelo St. It is important that samples arrive in the lab as quickly as possible after collection, ideally within 48 hours, although slightly longer storage periods are okay if refrigerated.

Hawai'i Department of Agriculture Plant Quarantine Branch Locations

Oahu Plant Quarantine Branch 1849 Auiki Street Honolulu, HI 96818 (808) 832-0566	**Maui or Molokai** Plant Quarantine Branch 635 Mua Street Kahului, HI 96732 (808) 873-3962
Kauai Plant Quarantine Branch 4398A Pua Loke Street Lihue, HI 96766 (808) 241-7135	**Hawai'i Island** Plant Quarantine Branch 16-E Lanikaula Street Hilo, HI 96720 (808) 974-4141

For more information, please contact:

J.B. Friday, Ph.D.
Extension Forester
College of Tropical Agriculture and Human Resources
University of Hawaii at Manoa
Komohana Research and Extension Center
875 Komohana St.
Hilo, HI 96720
Phone: 808-969-8254
jbfriday@hawaii.edu

or

Lisa Keith, Ph.D.
Research Plant Pathologist
USDA ARS
DKI-PBARC
64 Nowelo St.
Hilo, HI 96720
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Mention of trademark, proprietary product, or vendor does not constitute a guarantee or warranty of the product by the U.S. Dept. of Agriculture and does not imply its approval to the exclusion of other products or vendors that also may be suitable.

E. Resource Catalogue (from Anders Lyons)

Kauaʻi ROD Response Plan Interagency Resource Catalogue

ao April 17, 2019

This document compiles, in one place, resources and contact information that can be utilized in a response to the detection of Rapid ʻŌhiʻa Death on the island of Kauaʻi. The agencies and resources can be mixed and matched to create the most effective response possible based on on-the-ground facts. To finalize the plan, fill out ICS form 202 *Incident Objectives,* ICS form 203 *Organizational Assignment List* and ICS Form 204 *Assignment List* at the time of a response, based on real-time information.

Accompanying this resource catalogue, in completed draft form, are ICS form 201 *Incident Briefing*, ICS form 215A *Incident Action Plan Safety Analysis, &* ICS form 206 *Medical Response Plan.* They are meant to provide a quick and effective way to define the parameters of the response and to compile a complete Incident Action Plan (IAP), with as little effort as possible. Combined, the completed ICS forms 201, 202, 203, 204, 206 and 215A will constitute the Maui Rapid ʻŌhiʻa Death IAP.

Agencies listed here have agreed to provide the identified personnel and resources to respond to a Rapid ʻŌhiʻa Death detection.

I. Command Staff Resource List

INCIDENT COMMANDERS (ONE ONLY)

- Sheri S. Mann DOFAW 808-274-3436(o) sheri.s.mann@hawaii.gov
- Tiffani Keanini KISC 808-821-1490(o) 808-634-2526(m) tkeanini@hawaii.edu

LIAISON OFFICERS

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- Ray Kahaunaele KISC 808-821-1490(o) 808-634-0750(m) rk30@hawaii.edu

PUBLIC OUTREACH/INFORMATION OFFICERS

- Dan Dennison## DLNR 808-587-0407(o) 808-295-8749(m) dlnr.comms@hawaii.gov
- Janelle Saneishi HDOA 808-241-7132(o) hdoa.info@hawaii.gov
- Kim Rogers KISC 808-821-1490(o) 808-634-1303 (m) kimsr@hawaii.edu
- Yuki Reiss DOFAW 808-241-3769(o) kyreiss@hawaii.edu
- Melissa Fisher TNC 808-587-6258(o) 808-635-4462(m) melissa_fisher@tnc.org
- JB Friday## CTAHR 808-969-8254(o) jbfriday@hawaii.edu

- Corie Yanger ## CTAHR 808-969-8268(o) cmyanger@hawaii.edu
- Ambyr Mokiao-Lee ## CTAHR 808-989-7222(o) ambyr@hawaii.edu
- Rob Hauff ## DOFAW 808-587-4174(o) robert.d.hauff@hawaii.gov

= Statewide ROD Communications Team

II. General Staff Resources List

PLANNING SECTION CHIEF

- Mapuana O'Sullivan DOFAW 808-241-3766 (o) 808-346-2338(m) mapuana.r.osullivan@hawaii.gov
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- Kim Rogers KISC 808-821-1490(o) 808-634-1303 (m) kimsr@hawaii.edu
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GIS

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- Alicia Hedlesky KISC 808-821-1490(o) hedlesky@hawaii.edu
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- Mapuana O'Sullivan DOFAW 808-241-3766 (o) 808-346-2338(m) mapuana.r.osullivan@hawaii.gov

Experienced Statewide Advisors

Resource Advisors

- Bill Stormont DOFAW 808-974-4221(o) 808-319-8792(m) william.t.stormont@hawaii.gov
- Bill Buckley BIISC 808-933-3340(o) 808-208-1585(m) buckleyw@Hawaii.edu
- Rob Hauff DOFAW 808-587-4174(o) robert.d.hauff@hawaii.gov

Pathology/Testing Advisors

- Lisa Keith USDA-ARS 808-959-4357(o) lisa.keith@ars.usda.gov
- Marc Hughes CTAHR/USDA-ARS 808-932-2107(o) mhughes7@hawaii.edu

Communications Advisors

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- Corie Yanger CTAHR 808-969-8268(o) cmyanger@hawaii.edu
- Ambyr Mokiao-Lee CTAHR 808-989-7222(o) ambyr@hawaii.edu

Resource Advisors (habitat info, site access logistics, trails, hazards, etc)

- Ray Kahaunaele KISC 808-821-1490(o) 808-634-0750(m) rk30@hawaii.edu
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- Kawika Smith DOFAW/Trails 808-274-3433 dan.k.smith@hawaii.gov
- Adam Williams DOFAW/Botany 808-639-3827 adam.w.williams@hawaii.gov
- Sheila Berry TNC 808-587-6257(o) sheila.berry@tnc.org

Drone Operators

- TNC 2 operators
    - Lucas Behnke
    - Marcela Brimhall
- DOFAW – Hiring 1 operator in 2019
- KISC
    - Alicia Hedlesky

OPERATIONS SECTION

Available Crews - *assure all samplers have updated sampling protocol.*

- TNC 3 samplers
- TNC 3 chainsaw operators
- USFWS field personnel available upon request under certain circumstances.
- HDOA 1 rappelling certified staff
- HDOA 1 pest control technician
- KISC 8 trained ROD testers
- KISC 5 rappelling certified staff
- KISC 6 field crew
- KISC 6 chainsaw operators
- KISC 2 dedicated ROD chainsaw
- KISC 3 ROD testing kit
- DOFAW 4 samplers
- DOFAW 1 trained rappellers
- DOFAW 6 field crew
- DOFAW 6 chainsaw operators
- DOFAW 4 ROD testing kits

Sample Mailing Support receive & transport samples for testing. Establishing quarantine areas.

- Laura Iishi HDOA 808-241-7135(o) hdoa.pqkauai@hawaii.gov
- Clide Ragasa HDOA 808-241-7135(o) hdoa.pqkauai@hawaii.gov

Entomology & Spread Reduction Strategies

- Roshan Manandhar CTAHR 808-274-3474(o) 808-358-8681(m) roshanm@hawaii.edu
- Rob Hauff DOFAW 808-587-4174(o) robert.d.hauff@hawaii.gov

Vehicles

- USFWS – 1 truck.
- KISC 2 - 4x4 trucks.
- DOFAW – 4 4x4 trucks; 1 F350 with 3,000 gal slip on unit

Baseyards (equipment and vehicle storage)

- KISC baseyard. 1 spot covered vehicle storage. ½ container for storage. (Approval by T. Keanini)
- DOFAW baseyard.

Helicopter Landing Zones

- KISC and USFWS has access to a helicopter landing zone at CTHAR, Kauaʻi Ag Research Station (approval by Michelle Clark, Tiffani Keanini)
- All LZ's on DOFAW managed lands are accessible. Map available from Sheri S. Mann
- KISC, DOFAW & TNC – may be able to help getting LZ use approval from private landowners

Radios

- Mapu to describe DOFAW's radio assets: make, model, stations we use & how many
- TNC VHF radios (Vertx, HYT, Motorola) and repeater system at Waiʻaleʻale with 100 radii in line-of-sight. Also 2 satellite phones for emergencies.

FINANCE/ADMINISTRATION SECTION

- Melissa Fisher TNC 808-587-6258(o) 808-635-4462(m) melissa_fisher@tnc.org
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- Rob Hauff DOFAW 808-587-4174(o) robert.d.hauff@hawaii.gov

LOGISTICS SECTION

Facility Managers

- Latham Keaweamahi DOFAW(baseyard ops) 808-639-3644 latham.w.keaweamahi@hawaii.gov
- Ray Kahaunaele KISC 808-821-1490(o) 808-634-0750(m) rk30@hawaii.edu

Other Logistics Support

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- Michelle Clark USFWS 808-822-4315(o) 808-457-7276(m) michelle_clark@fws.gov
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Helicopter Managers

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- Mapuana O'Sullivan DOFAW 808-346-2338(m) mapuana.r.osullivan@hawaii.gov

Ambulance Services

- 911

Hospitals and Clinics

- Kauaʻi Veterans Memorial Hospital 4643 Canyon Drive, Waimea, HI 96796 808-338-9431(o) 808-338-9420(f)
- Mahelona Medical Center 4800 Kawaihau Rd. Kapaa, HI 96746 808-822-4961(o) 808-823-4100(f)
- Wilcox Medical Center 3-3420 Kuhio Hwy, Lihue, HI 96766 808-245-1100(o)
- Kaiser Permanente 75 Maui Lani Pkwy. Wailuku, HI (808) 243-6000
- Queens Medical 1301 Punchbowl St. Honolulu, HI (808) 538-9011 - Helipad
- Straub Clinic 888 S. King Street Honolulu, HI (808) 522-3781 – Burn Center

CONTACT INFORMATION BY AGENCY

DOFAW: Division of Forestry and Wildlife (State of Hawaii Department of Land and Natural Resources)
KISC: Kauaʻi Invasive Species Committee
USFWS: United States Fish and Wildlife Service
C of K: County of Kauaʻi
TNC: The Nature Conservancy
HDOA: Hawaii Department of Agriculture – Plant Quarantine Maui
BIISC: Big Island Invasive Species Committee
USDA-ARS: Unites States Department of Agriculture – Agricultural Research Services
CTAHR: College of Tropical Agriculture and Human Resources (University of Hawaii)

** = Primary agency contact for ROD issues.

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- Sheri S. Mann ** 808-274-3436(o) 808-729-0719(m) sheri.s.mann@hawaii.gov
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USFWS

- Aaron Nadig 808-792-9466
- Michelle Clark** 808-822-4315(o) 808-457-7276(m) michelle_clark@fws.gov

C of K

-

TNC

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HDOA

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- Clide Ragasa(Inspector) 808-241-7135(o) hdoa.pqkauai@hawaii.gov
- Craig Kaneshige (Weeds) 808-241-7132(o) craig.k.kaneshige@hawaii.gov
- Eric John Garcia (Pest) 808-241-7132 eric.j.garcia@hawaii.gov
- Janelle Saneishi (Communications) 808-241-7132(o) hdoa.info@hawaii.gov

BIISC (Hilo)

- Springer Kaye 808-933-3340(o) skaye@hawaii.edu
- Bill Buckley** 808-933-3340(o) 808-208-1585(m) buckleyw@Hawaii.edu

USDA-ARS (Hilo)

- Lisa Keith** 808-959-4357(o) lisa.keith@ars.usda.gov

CTAHR (Oahu & Hilo)

- Roshan Manandhar (Kauaʻi)**808-274-3474(o) 808-358-8681(m) roshanm@hawaii.edu
- Russel Messing (Kauaʻi)
- JB Friday**(Communications)808-969-8254(o) jbfriday@hawaii.edu
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- Marc Hughes 808-932-2107(o) mhughes7@hawaii.edu
- Ambyr Mokiao-Lee 808-989-7222(o) ambyr@hawaii.edu

F. Landowner Detection Communication Checklist

Landowner
Detection Communication Checklist

Date and purpose of site visit (could be multiple):
Date of lab results:
Landowner:
Location:
Contact name:
Contact info:
POC agency:
POC name:

Results:

☐ No detection for ROD.

☐ Positive detection for ROD.
- ☐ *Ceratocystis huliohia*
- ☐ *Ceratocystis lukuohia*

Next steps:

☐ No action by POC agency.
☐ Ask property owner/manager to keep an eye on trees, maybe take a picture once a month. If see "browning of canopy," call back.
☐ POC agency return visit to determine the extent of ROD on the property and give recommendations to contain the spread of the disease.

- ☐ Re-sample trees.
- ☐ Sample more trees.
- ☐ Check for frass on sampled trees.

☐ ROE/MOU needed?
- ☐ Yes.
- ☐ No.

Landowner Detection Communication Checklist, continued

Management recommendations:

☐ Landowner continues to survey. Call POC agency with reports of any changes in tree health.
☐ Leave trees standing.
☐ Fell trees.
    ☐ Tarp
    ☐ No tarp
    ☐ Burn trees.
    ☐ Bury trees.

☐ POC agency returns at designated time to re-survey/re-sample.
    ☐ One month
    ☐ Two months
    ☐ Three months
    ☐ Six months
    ☐ One year

Outreach:

Public announcement recommendations:
    ☐ Press release:
        ☐ Yes
            If yes, quote?
                ☐ Yes
                ☐ No
        ☐ No
    ☐ Public signage
        ☐ Yes
        ☐ No

Provide outreach materials to landowner:
    ☐ Brochure(s)
    ☐ Link to videos
    ☐ Bio-sanitation protocol flyer
    ☐ Brochure(s)
    ☐ Link to video

G. Press Release Checklist

Press Release Checklist

Is a press release necessary?

☐ No

If no, are other forms of announcement (social media, public presentations, etc.) okay?

☐ Yes

☐ No

☐ Yes

If yes:

☐ Determine lead press release agency/author:

☐ DLNR

☐ KISC

☐ Joint:

☐ Other:

☐ Determine press release's distributor.

☐ DLNR

☐ KISC

☐ Other:

☐ Determine key points:

☐ Determine how to publicly identify location.

☐ Determine how to publicly identify landowner.

☐ Determine who should be quoted.

☐ Science team

☐ Rapid Response team

☐ Landowner

Determine who spokespeople are:

☐ DOFAW

☐ KISC

☐ TNC

☐ Other

☐ Determine who gets approvals before releasing:

☐ Science team

☐ Rapid Response team

☐ Landowner

☐ Other

Press Release Checklist, continued

☐ Determine who gets a "courtesy" review before releasing:

- ☐ Science team
- ☐ Rapid Response team
- ☐ Landowner
- ☐ Key government officials:
  - -county
  - -state
  - -federal
- ☐ County officials:
  - -director of parks/recs
  - -office of economic development
  - -other
- ☐ Key ROD supporters
- ☐ Key stakeholders: conservation partners:
  - -ROD Outreach group
  - -DOFAW branch managers
  - -Invasive species committees
  - -HDOA
  - -Hawaii state parks
  - -Forest service
  - -USGS
  - -USFWS
  - -KRCP
  - -NTBG
  - -TNC
  - -KWA
  - -KCA
  - -Hui O Laka
  - -Cultural practitioners
  - -Kauaʻi ROD Listserv
  - -HTA

Develop talking points?

- ☐ Yes
  - ☐ Internal
  - ☐ Public
- ☐ No

Update the Kauaʻi ROD map graphic?

- ☐ Yes (How?)
- ☐ No

Decide whether to conduct public meeting and when.

- ☐ Yes
- ☐ No

H. Volunteer Bio-Sanitation Code

Volunteer Bio-Sanitation Code

1. Rapid ʻŌhiʻa Death Education and Training: May include any combination of the following:

☐ *Watch "Saving ʻŌhiʻa" documentary;*
☐ *Watch five-minute bio-sanitation video; and/or*
☐ *Participate in three-hour bio-sanitation workshop.*

2. Code of Conduct: All those working on behalf of agencies and contractors are expected to sign a pledge to protect ʻōhiʻa that includes:

☐ Protect ʻōhiʻa from wounds. Avoid unnecessary cutting or injuring ʻōhiʻa and stepping on tree roots.
☐ Clean shoes, gear, and tools before and after use. Brush off all soil and spray with 70% rubbing alcohol.
☐ Wash all vehicles, including the tires and undercarriage, where appropriate, to remove dirt. Follow by spraying with 70% rubbing alcohol.
☐ Do not move ʻōhiʻa.
☐ Report any ʻōhiʻa with ROD-like symptoms.

3. Oversight and Accountability: Agencies and contractors are expected to make themselves available for periodic oversights that, depending on the project, may include:

☐ Self-monitored checklist;
☐ Counter-signed checklist;
☐ Random and periodic monitoring.

I. Suspect Tree Management Action Checklist

Felling factors to consider:

Accessibility: How frequently or easily can the tree be accessed?

Fellability: How difficult/technical is the tree, and can it be felled without damaging surrounding healthy trees?

Status: Has the tree been sampled? Is it displaying symptoms and close to other ROD positive sampled trees?

J. General Kauaʻi Bio-Sanitation Protocols

General Kauaʻi Bio-Sanitation Protocols

The described procedures below provide guidelines to limit transmission of the fungal pathogen *Ceratocystis* through field activities. *Ceratocystis* has been determined to be the pathogen causing Rapid ʻŌhiʻa Death. Humans can inadvertently spread ROD, but there are steps we can take to limit our role in spreading the fungus to new areas. Remember that following these protocols will reduce the introduction and spread of other diseases or pathogens on Kauaʻi.

Roles and Responsibility

Supervisor: Ensure all field leaders and coordinators understand and abide by the protocol.

Field Supervisors/Leaders: Ensure all staff are trained and instructed to follow this recommended protocol. Ensure necessary supplies and time to carry out sanitation procedures are provided daily/weekly. Training is available from DOFAW.

Staff: All staff, regardless of position or frequency in the field, are required to follow this protocol. This includes contractors, researchers, interns and/or volunteers.

Sanitation Schedule

Sanitation procedures are to be conducted before and after operations for each work site and prior to moving to a new location. At a minimum, complete sanitation is to be conducted at the end of each workweek and prior to every trip to an uninfected area. Ad hoc sanitation may be required based on interaction with suspect ʻōhiʻa trees in otherwise healthy forest or when transferring ("hopping") between distinct ʻōhiʻa forest work sites.

Decontamination Protocol

1) **Sanitation of Outerwear: Soap and Water**
   Hand/machine wash all outerwear (rain jacket, rain pants, backpacks, vests, hats, etc.) with soap and water. Rinse with clean water and hang dry in the sun. All other clothing should be laundered with detergent in hot water (daily) and dried in a dryer, if possible. (Temperatures in excess of 140 degrees Fahrenheit will kill the fungal spores.)

2) **Sanitation of Tools: Disinfectant**
   Wash equipment to remove visible dirt, plant material, sawdust, and other contaminants. Spray entire surface thoroughly with 70% rubbing alcohol.

General Kauaʻi Bio-Sanitation Protocols, continued

3) Sanitation of Boots: Disinfectant

Thoroughly scrub/wash all visible dirt, plant material, etc. from boot surfaces. Be sure to pay special attention to the sole grooves and any crevices that may trap soil. Spray with 70% rubbing alcohol. Pay special attention to cleaning and disinfecting spiked boots and tabis.

4) Sanitation of Vehicle

Using a high-pressure washer, spray down vehicles with soap and water, paying particular attention to removing dirt and organic material from the undercarriage, truck bed, bumpers, mud flaps, and wheel-wells. Clean all dirt and organic material from interior of vehicle—using a vacuum, if available. Wash floor mats with soap and water then spray floor mats with 70% rubbing alcohol. Changing and bagging or using totes to store dirty clothes or boots can help alleviate vehicle decontamination.

5) Dedicated On-Island Gear

Dedicated gear is a separate set of gear that is devoted to preventing cross-contamination of sites. Dedicated gear should be cleaned following the decontamination protocol listed above and stored separately from regular work gear.

Dedicated Gear includes but is not limited to: Footwear (e.g. leather and rubber boots), rain gear, backpack, and safety chaps.

K. Kaua'i Island Conservation Partners Sanitation Protocol

RAPID 'ŌHI'A DEATH

UPDATED
February 2019

Kaua'i Island Conservation Partners Sanitation Protocol

The described procedures below provide guidelines to limit transmission of the fungal pathogen *Ceratocystis* through field activities. *Ceratocystis* has been determined to be the pathogen causing Rapid 'Ōhi'a Death. Humans can be a vector of transmission and there are steps we can take to limit our role in unintentionally spreading the fungus to new areas.

Roles and Responsibility

Supervisor: Ensure all field leaders and coordinators understand and abide by the protocol.

Field Supervisors/Leaders: Ensure all staff are trained and instructed to follow this recommended protocol. Ensure necessary supplies and time to carry out sanitation procedures are provided daily/weekly. Training is available from DOFAW.

Staff: All staff, regardless of position or frequency in the field, are required to follow this protocol. This includes contractors, researchers, interns and/or volunteers.

Sanitation Schedule

Sanitation procedures are to be conducted before operations begin and at the close of operation for each work site, prior to moving to a new location. At a minimum, complete sanitation is to be conducted at the end of each work week, and prior to every trip to an uninfected area. Ad hoc sanitation may be required based on interaction with suspect 'ōhi'a trees in otherwise healthy forest or when transferring ("hopping") between distinct 'ōhi'a forest work sites.

Decontamination Protocol

Sanitation of Outerwear: Soap and Water

Hand/machine wash all outerwear (rain jacket, rain pants, backpacks, vests, hats, etc.) with soap and water. Rinse with clean water and hang dry. All other clothing should be laundered with detergent in hot water, if possible (DAILY).

Sanitation of Tools: Disinfectant

Wash equipment to remove visible dirt, plant material, sawdust, and other contaminants. Spray entire surface thoroughly with 70% rubbing alcohol .

Sanitation of Boots: Disinfectant

Thoroughly scrub/wash all visible dirt, plant material, etc. from boot surfaces. Be sure to pay special attention to the sole grooves and any crevices that may trap soil. Spray with 70% rubbing alcohol. Pay special attention to cleaning and disinfecting spiked boots and tabis.

Continued on next page.

RAPID ʻŌHIʻA DEATH

UPDATED
February 2019
Recommended Staff Protocol Continued

Protocol Continued.

Sanitation of Vehicle

Wash vehicles with detergent, paying particular attention to removing dirt and organic material from the undercarriage, truck bed, bumpers, mud flaps, and wheel-wells. Clean all dirt and organic material from interior of vehicle. Wash floor mats with soap and water then spray floor mats with 70% rubbing alcohol. Changing and bagging or using totes to store dirty clothes or boots can help alleviate vehicle decontamination.

Dedicated On-Island Gear

Dedicated gear is a separate set of gear that is devoted to prevent cross-contamination of sites. Dedicated gear should be cleaned following the decontamination protocol listed above and stored separately from regular work gear.

Dedicated Gear includes but is not limited to: Footwear (e.g. leather and rubber boots), rain gear, backpack, and safety chaps.

INTER-ISLAND DECONTAMINATION PROTOCOL

Rapid ʻŌhiʻa Death is currently confirmed on both Hawaiʻi Island and Kauaʻi.

Dedicated Inter-Island Gear (Work trips from Kauaʻi Island to other islands)

Maintain a dedicated set of clean gear to be used for work trips to other islands. Store gear separately from regular work gear. If dedicated gear or borrowing gear from an on-island agency is not an option, it is recommended that work trips to other islands be carefully considered.

DO NOT MOVE TOOLS INTER-ISLAND: This includes chainsaws, machetes, pruners, clippers and any other equipment or machinery that could have come into contact with infected ʻōhiʻa wood.

To learn current ROD confirmation locations, how to identify the symptoms of ROD infected trees, and keep current with the latest decontamination recommendations please visit rapidohiadeath.org

ʻŌHIʻA FOR OUR FUTURE
rapidohiadeath.org

L. Kaua'i ROD Outreach Overview