

Forest Health

2022 highlights

◀ HAWAII
◀ MARCH 2023

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2022 Summary

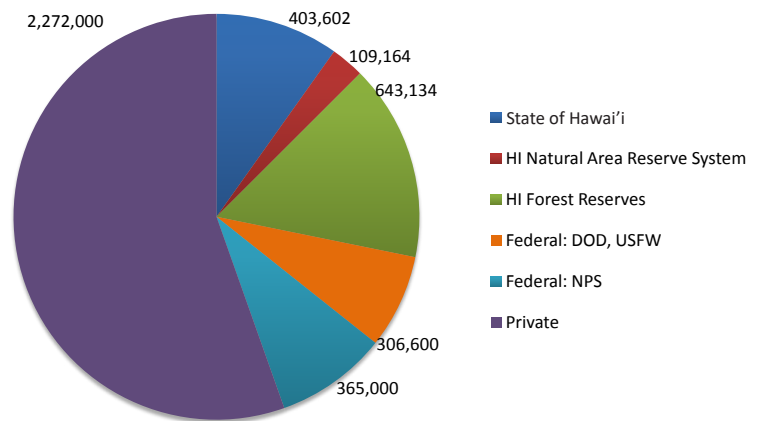
- **Rapid Ōhi'a Death (ROD)** continued spreading on Hawai'i Island, and both *Ceratocystis* species are now established at many sites on Kaua'i. The aggressive *C. lukuohia* has not been found on O'ahu, Maui, Moloka'i, or Lāna'i. Hawai'i island continues to see higher levels of ROD in areas where hoofed animals are damaging forests.
- **Coconut rhinoceros beetle (CRB)** efforts shifted to containing the beetle to O'ahu and preventing spread to other islands. Ongoing detections in forest areas on O'ahu are raising concern for Hawaii's native fan palms (*Pritchardia* spp.) which are susceptible to CRB attack.
- The Hawaii Agriculture Research Center (HARC) in collaboration with the State of Hawai'i Division of Forestry and Wildlife (DOFAW) conducted **disease resistance screening of koa (*Acacia koa*)** and continued establishing seed orchards to provide koa seed for commercial and restoration plantings. DOFAW is working with HARC to scale up koa reforestation efforts, targeting newly acquired lands on O'ahu and Maui for reforestation with koa and other natives.

Forest Resources

This report is for the State of Hawai'i, which includes eight main islands (Kaua'i, O'ahu, Moloka'i, Lāna'i, Kaho'olawe, Maui, Hawai'i, and, Ni'ihau) totaling 4.1 million acres. Approximately 1.4 million acres of the state are considered forested. Non-forested areas include urban and agricultural areas, recent lava flows, and high elevation sites on Mauna Ke'a and Mauna Loa on Hawai'i and Haleakalā on Maui.

DOFAW manages 1,155,900 acres including 643,134 acres in forest reserves and 109,164 acres in the state's Natural Area Reserve System (NARS), which was created to preserve unique native Hawaiian ecosystems. Hawai'i's state forest acreage ranks as the 11th largest in the nation. Federal lands account for 671,600 acres and

Land Ownership in Hawai'i



are managed by the Department of Defense, National Park Service, and US Fish and Wildlife Service. The National Park Service is the largest federal landowner, managing 365,000 acres. Although there are no National Forests in Hawai'i, the Hawai'i Experimental Tropical Forest (HETF) was recently created on the island of Hawai'i as a partnership between USDA Forest Service and DOFAW. The HETF comprises over 51,000 acres and is co-managed by the Forest Service with DOFAW.

The remaining land – 2,272,000 acres – is privately owned. Increasing amounts of private forestlands are being managed in concert with publicly owned lands under public-private partnerships for watershed conservation in order to sustain Hawai'i's water supply. These watershed partnerships manage upland areas comprising a patchwork of federal, state, and private parcels. Eleven island-based watershed partnerships have been established on six islands to protect over 2.2 million acres (including non-forested lava flows and alpine areas). The partnerships actively manage approximately 300,000 acres of priority forest by removing invasive plants and animals.

Forest Health Monitoring in Hawai'i

Forest health monitoring occurs throughout the state on private, state, and federal lands. The spread and impact of invasive plants, invertebrate pests, diseases, ungulates, and biological control agents are monitored using ground surveys, transect monitoring, helicopter surveys, road surveys, photo points, and remote sensing techniques.

Monitoring forest health in Hawai'i presents many challenges associated with its climate and geology. Hawai'i's extremely rugged terrain limits ground access to many areas and increases the difficulty of monitoring due to vertical slopes and shadow effects. Watersheds can have as much as half of the total land area in near-vertical slopes. The exceptionally rugged terrain creates extreme temperature and rainfall gradients that result in diverse ecosystems in close proximity. These transitions occur over a very small scale, so monitoring data collected over large scales is not typically representative of widespread conditions. Identifying species and classifying them as diseased or infested is a complex and difficult task. Additionally, a thick layer of clouds present much of the year often limits or prohibits remote sensing and aerial surveys of mountainous areas where much of Hawai'i's forests are located.

DOFAW works with partners to utilize new technologies to collect forest health data at varying scales. UAS surveys for small areas, high resolution cameras mounted on helicopters and fixed wing aircraft, and satellite imagery coupled with computer learning technology, and lidar combined with spectroscopy are examples of different technologies being used in Hawai'i to collect data on pest damage. In addition, the USDA Forest Service Forest Inventory and Analysis program has installed plots throughout Hawai'i's forest and completed the second measurement in 2022.

Rapid 'Ōhi'a Death or *Ceratocystis* Wilt of 'Ōhi'a

Ceratocystis spp.

'Ōhi'a (*Metrosideros polymorpha*) is the most common tree species in Hawai'i's native forests, growing from sea-level to nearly 8,000 feet in dry, mesic, and wet forests. 'Ōhi'a-dominated forests cover 350,000 ha statewide, with 250,000 ha occurring on Hawai'i Island, and 'ōhi'a trees account for 50% of all forest trees in the state. This abundant tree provides habitat to much of the native flora and fauna and also has significant cultural importance. The name 'ōhi'a means 'to gather' in the Hawaiian language, referring to the tree's ability to collect water from the rain and mist, feeding the aquifers that sustain life on this remote archipelago.

Beginning in 2010, residents in the Puna District of Hawai'i island began noticing 'ōhi'a trees on their property suddenly dying, while adjacent trees remained healthy. The symptoms appeared distinct from 'classical 'ōhi'a dieback' previously observed on Hawai'i island as a cohort effect related to stand age and natural senescence. The phenomenon was coined Rapid 'Ōhi'a Death (ROD) and researchers and managers began looking for a cause. Wood samples with dark gray discoloration were collected from symptomatic dead trees and analyzed for presence of pathogens. A fungus closely related to *Ceratocystis fimbriata* was identified from samples using both morphological and molecular characteristics, and Koch's postulates were completed with the pathogen on 'ōhi'a seedlings by USDA Agriculture Research Service (ARS) in 2014 (Keith et al. 2015). Further surveys resulted in identification of two distinct but related species of *Ceratocystis* which were described as *C. huliiohia* and *C. lukuohia* in 2018, the former a slow spreading canker disease and the latter an aggressive wilt disease causing most of the mortality seen on Hawai'i island (Barnes et al. 2018).

In 2022, ROD continued to spread on Hawai'i Island, mostly filling in areas where only scattered mortality occurred. Areas with invasive hoofed animals are experiencing higher incidence of ROD, and researchers are studying interactions between ROD and animals (Perroy et al. 2021). DOFAW and its partners conducted semi-annual aerial surveys of the state's 'ōhi'a forests using the USDA Forest Service Digital Mobile Sketch Mapping tablet-based app to identify new disease outbreaks. On Kaua'i, both *Ceratocystis* species have been detected in multiple areas and managers on that island are responding with containment strategies. In 2021, new detections in high-value native forests warranted rapid response. Only *C. huliiohia* has been detected on O'ahu, while a single detection of *C. huliiohia* on Maui was destroyed and no further detections have been made on the islands making up Maui Nui. Updated information and disease maps can be found on the Rapid 'Ōhi'a Death website at www.rapidohiadeath.org.

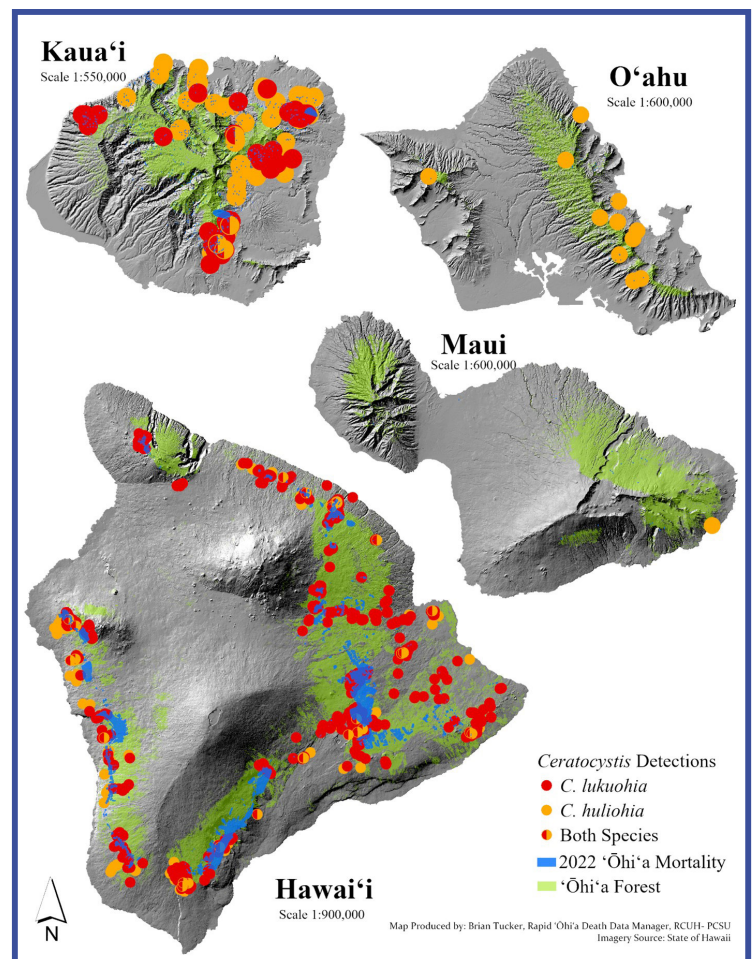


Figure 1. Rapid 'Ōhi'a Death detections and aerially-mapped mortality. Map credit: Brian Tucker, University of Hawaii

DOFAW is working with the Akaka Foundation for Tropical Forests, USDA Forest Service, the University of Hawai'i, and others to develop disease-resistant 'ōhi'a for the restoration of areas impacted by ROD. In 2022, a framework for disease resistance breeding was developed by the project (Luis et al., 2022). The project also worked to refine screening techniques to scale up inoculation trials of 'ōhi'a seedlings collected throughout the state and plans to conduct large-scale screening trials in 2023.

Koa Wilt

Fusarium oxysporum f. sp. *koae*

Over the past decade, DOFAW has worked with HARC in developing disease resistant koa (*Acacia koa*) for both commercial plantations and forest restoration. *F. oxysporum* causes a wilt disease in koa that can cause widespread mortality in planted koa, especially at lower elevations. Screening koa families for disease resistance by ecoregion has been conducted by HARC and seed orchards have been established throughout the state for providing seed to DOFAW and private landowners.

DOFAW is working with HARC to utilize disease resistant koa to reforest recently acquired lands that have been added to the state's forest reserve system. Utilizing available, regionally specific, disease resistant planting stock will ensure healthy koa forests in the future. In 2022, DOFAW and HARC worked together to convert albizia invaded forests to a 5-acre koa and sandalwood seed orchard on the island of O'ahu. This seed orchard will provide seed for future restoration at the site and other locations on the island.

Coconut Rhinoceros Beetle

Oryctes rhinoceros

<https://www.crbhawaii.org/coconut-rhinoceros-beetle>

The coconut rhinoceros beetle (CRB) is a pest of coconut trees and other palms and is native to South and Southeast Asia. The adult beetles damage trees by boring into tree crowns where they injure young, growing tissue to feed on sap. The subsequent damage can cause tree death. The beetles breed in moist, decomposing organic matter, especially dead coconut material, leading to a destructive cycle if left unmanaged. Although the beetles can fly up to 2 miles, regularly feeding on coconut palms and returning to the breeding site, spread is primarily through human movement of infested breeding material (e.g., green waste, dead trees, etc.).

The first detection of CRB in Hawai'i occurred on Joint Base Pearl Harbor – Hickam on O'ahu in December 2013 in a USDA trap. The amount and location of the infested mulch made destruction of the breeding population extremely challenging and required developing new tools. Currently infested material is being treated through composting or incineration in air curtain burners.

In cooperation with the United States Navy and the University of Hawai'i, the project which is housed by Hawai'i Department of Agriculture (HDOA) is using pheromone detection traps around the island to delineate the infestation and detect new satellite populations. Crews also survey coconut palms for signs of CRB damage and mulch piles for breeding sites.

Unfortunately, beetles have been trapped throughout most of the island, and HDOA is focusing on control efforts around ports of entry to prevent CRB from establishing on the other islands.

While site-specific eradication has occurred at the original infestation site, several infested areas remain and HDOA is utilizing USDA trained canine teams to detect breeding locations. HDOA is also pursuing regulating the movement of green waste within and between islands in order to stop the spread.

The infestation continued to expand across the entire island in 2022, and there are now populations abutting natural forests. DOFAW and its partners have placed traps in forest areas and have detected beetles in several of these. As the population expands, there is growing concern about impacts to native *Pritchardia* palms which are known to be susceptible to CRB feeding damage. In particular, the endangered *Pritchardia kaalae* which is endemic to the Wai'anae Mountains on O'ahu could be threatened by CRB establishing in natural areas.

Partially funded by a grant from the Genetic Conservation Resistance and Restoration (GCRR) program, DOFAW has begun implementing actions to protect plants in the genus *Pritchardia*, known locally as loulou palms. There are 5 *Pritchardia* species found on O'ahu, two of which are endangered species, and four of which are single island endemics to O'ahu. The



Figure 2. DOFAW staff member climbing a loulou palm during a training class at UH Lyon Arboretum. Photo credit: Hawaii Department of Land and Natural Resources

non-native CRB is a serious threat to all palm tree species. CRB has continued to expand its range on O‘ahu, increasing its distribution in higher elevation areas where the majority of wild loulu populations still occur.

In the first year of this project staff have implemented helicopter surveys to map the distribution of all five loulu species and planned logistics for seed collection missions. Staff attended a tree climbing class, and are preparing to purchase the appropriate climbing gear. Staff have also purchased Goodnature A-24 rat traps and cages which will be placed around and near some key wild loulu populations to help protect seeds from invasive rat predation. A few early seed collection missions found fruit that were too immature for normal propagation in state nurseries, but seeds were taken to the University of Hawai‘i micropropagation lab. Staff plan to begin seed collection trips in the first quarter of the calendar year 2023.



Figure 3. Springer Kaye, BIISC manager, is always on the lookout for invasive species. She found devil weed growing near the Hilo Dragstrip and Motocross Area during a Sunday outing with her children. Photo credit: Big Island Invasive Species Committee



Figure 4. Soon after, it was found growing near the Maku‘u tide pools in Hawaiian Paradise Park. Photo credit: Big Island Invasive Species Committee

Devil Weed

Chromolaena odorata

Since the discovery of devil weed on Hawai‘i in January 2021, the Big Island Invasive Species Committee has worked to remove all plants. Currently, there are eight known locations from Hilo to Kalapana. Several populations were discovered thanks to outreach campaigns. In addition, some were found during weekend excursions by ‘off duty’ staff. With funding from the County of Hawai‘i, [detector dogs](#) will be used to detect new populations. Some areas might be bulldozed where the population is too thick.

Devil Weed (*Chromolaena odorata*) is a [noxious weed](#) native to North, Central, and South America. It is one of the world’s [worst 100 invasive species](#) and has scored [high risk](#) on the Hawaii-Pacific Weed Risk Assessment. Devil weed was found on the Big Island for the first time in 2021, growing at the dragstrip and motocross area of Hilo, and just beginning to spread into nearby agricultural fields. This is no surprise, considering it was previously found growing on a motocross track on O‘ahu. The small, sticky seeds were likely transported by accident from O‘ahu, potentially on clothing, equipment, gear, or off-road recreational vehicles.

Tree Ferns

Angiopteris evecta

DOFAW is utilizing funding from LSR (Landscape Scale Restoration), Joint Chiefs, and Forest Health Protection grants to support ongoing work across the islands to mitigate invasive plants, improve watershed function, and reduce wildfire fuels. Management activities include locating and removing invasive ferns across landscapes with some of the most difficult topographies, such as the north shore sea cliffs of Molokai, and supporting knowledge exchange across the various island programs that target these ferns. DOFAW has published instructional videos on fern control, and also created innovative apps that allow tracking of volunteers who are independently assisting with fern control.



Figure 5. Invasive ferns have been identified and removed from the sea cliffs on the north shore of Molokai . Photo credit: Emma



Figure 6. Working sUAS attachment and protocols for deployment of multiple *Tectococcus ovatus* bolas.
Photo credit: Ryan Perroy, University of Hawaii, Hilo

Strawberry Guava

Psidium cattleianum

The University of Hawaii, utilizing funding from the Biological Control of Invasive Forest Pests special grants program, continued work on their system for aerially deploying *Tectococcus ovatus* (TO) biocontrol for strawberry guava (*Psidium cattleianum*). In 2022, permits for six research sites across the Hilo, Kau, and Puna districts of Hawai'i island were granted by the Hawai'i DLNR. The program also converted existing sUAS platforms into a dedicated system capable of deploying multiple TO bolas effectively and developed standard operating procedures and other documentation, which was reviewed by the FAA. Additionally, they began testing and refining the TO deployment system via flight tests and stress tests, and coordinated with Big Island Invasive Species Council field crews to conduct inoculation trials at two of the six newly permitted research sites. Lastly, they conducted multiple sUAS imaging flights over previously TO-inoculated areas to determine best methods for detecting and monitoring TO infection and spread using high-resolution imagery.

Albizia

Falcataria moluccana

In April 2022, the Kauai Invasive Species Committee (KISC) and DOFAW held the first stakeholder information gathering meeting to initiate the facilitation of the island-wide strategic management plan to address albizia trees on Kauai Island. 51 individuals registered for the meeting with representation from private landowners and managers, non-profit organizations, private businesses, and state, federal, and county agencies. A strategic planning input survey has been developed and distributed to stakeholders island-wide. KISC is currently compiling input and identifying information gaps. From August to October, KISC will reconvene with individuals and small groups of stakeholders to clearly define priorities, objectives, and implementation tasks for individual sections of the plan.

Pesticide Treatments

Approximately 225 acres of firebreaks were treated with herbicide and maintained, including several acres of previously treated grasses and shrubs. Two recently purchased UTV 50-gallon slip-on units were put into operation in 2022. They plan to use a fire-retardant product (Phos-Chek FORTIFY product – Perimeter Solutions) to treat critical firebreak sections. Treatment sections will continue to be scouted, treated, and monitored throughout 2023. This should increase the holding capacity for some critical sections of firebreak while decreasing the frequency of maintenance site visits and treatments.

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Data Sources

The data sources used for this report include the Division of Forestry and Wildlife, US Forest Service Region 5, Hawai'i Department of Agriculture, University of Hawai'i College of Tropical Agriculture and Human Resources, Hawai'i Agriculture Research Center and other partner organizations.

Hawaii's Watershed Partnerships, the National Park Service, The Nature Conservancy of Hawaii, and DOFAW's Natural Area Partnership System also conduct monitoring of invasive plants and ungulates to improve the effectiveness of their management activities, but those data are not the focus of this report. The USDA Forest Service's Forest Health Forest Inventory and Analysis Program was recently introduced to Hawai'i, but results from the survey are not yet available.

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