Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Forest Health
2021 highlights

‹ HAWAIʻI
‹ MARCH 2022

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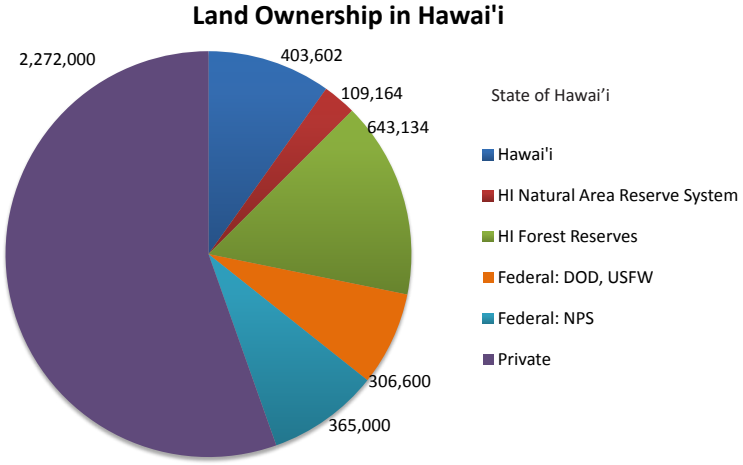
2021 Summary

- **Rapid ʻŌhiʻa Death (ROD)** continued spreading on Hawaiʻi Island, and both *Ceratocystis* species are now established at many sites on Kauaʻi. The aggressive *C. lukuohia* has not been found on Oʻahu, Maui, Molokaʻi, or Lānaʻi. Hawaiʻi island continues to see higher levels of ROD in areas where hoofed animals are injuring trees.
- **Coconut rhinoceros beetle (CRB)** eradication efforts continue on Oʻahu where trapped beetles and area infested are both increasing. Recent detections in forested areas are raising concern for Hawaii's native fan palm loulu (*Pritchardia* spp.), which are susceptible to CRB attack.
- The Hawaii Agriculture Research Center (HARC), in collaboration with the Hawaii 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 Oʻahu and Maui for reforestation with koa and other native species.
- Two new forest pests were detected in 2021 on Oʻahu. **Bronze bug (*Thaumastocoris peregrinus*)**, a pest of eucalypts, was found in native forests, although no damage to native trees has been found. The pest is being monitored to determine host range in Hawaiʻi. The **acacia whitefly (*Tetraleurodes acacia*)** was found infesting street trees and botanical gardens. Neither pest has been detected on other islands.

Forest Resources

This report is for the State of Hawaiʻi, which includes eight main islands (Kauaʻi, Oʻahu, Molokaʻi, Lānaʻi, Kahoʻolawe, Maui, Hawaiʻi, and, Niʻihau) totaling 4.1 million acres. Approximately 1.4 million acres of the state are considered forested.



Forest Health Monitoring in Hawaiʻi

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.

The Hawaii Division of Forestry and Wildlife (DOFAW) is working with partners to utilize new technologies to collect forest health data at varying scales. Unmanned aircraft systems (UAS) surveys for small areas, high resolution cameras mounted on helicopters and fixed-wing aircraft, satellite imagery coupled with computer learning technology, and lidar combined with spectroscopy are examples of different technologies being used in Hawaiʻi to collect data on pest damage. In addition, the US Forest Service Forest Inventory and Analysis program monitors plots through Hawaiʻi's forest.

Rapid ʻŌhiʻa Death or Certatocystis Wilt of ʻŌhiʻa

***Ceratocystis* spp.**

ʻŌhiʻa (*Metrosideros polymorpha*) is the most common tree species in Hawaii's native forests, growing from sea-level to nearly 8,000 feet in dry, mesic, and wet forests. ʻŌhiʻa-dominated forests cover 350,000 ha statewide, with 250,000 ha occurring on Hawaiʻi Island, and ʻōhiʻa trees account for 50% of all forest trees in the state (Fig. 1). This abundant tree provides habitat to much of the native flora and fauna and also has significant cultural importance. The name ʻōhiʻa 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.

Rapid ʻŌhiʻa Death was first observed in 2010 in the Puna District of Hawaiʻi island. Molecular analysis resulted in identification of two distinct but related fungal species of *Ceratocystis* which were described as *C. huliohia* and *C. lukuohia* in 2018, the former a slow spreading canker disease and the latter an aggressive wilt disease causing most of the mortality on Hawaiʻi island (Barnes et al. 2018).

In 2021, ROD continued to spread on Hawaiʻi Island, mostly filling in areas where only scattered mortality occurred previously. 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 ʻōhiʻa forests using the US Forest Service Digital Mobile Sketch Mapping tablet-based app to identify new disease outbreaks. On Kauaʻi, 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. huliohia* has been detected on Oʻahu, while a single detection of *C. huliohia* on Maui was destroyed (Fig 1). No further detections have been made on the islands making up Maui Nui. Updated information and disease maps can be found on the Rapid Ohia Death website at www.rapidohiadeath.org.

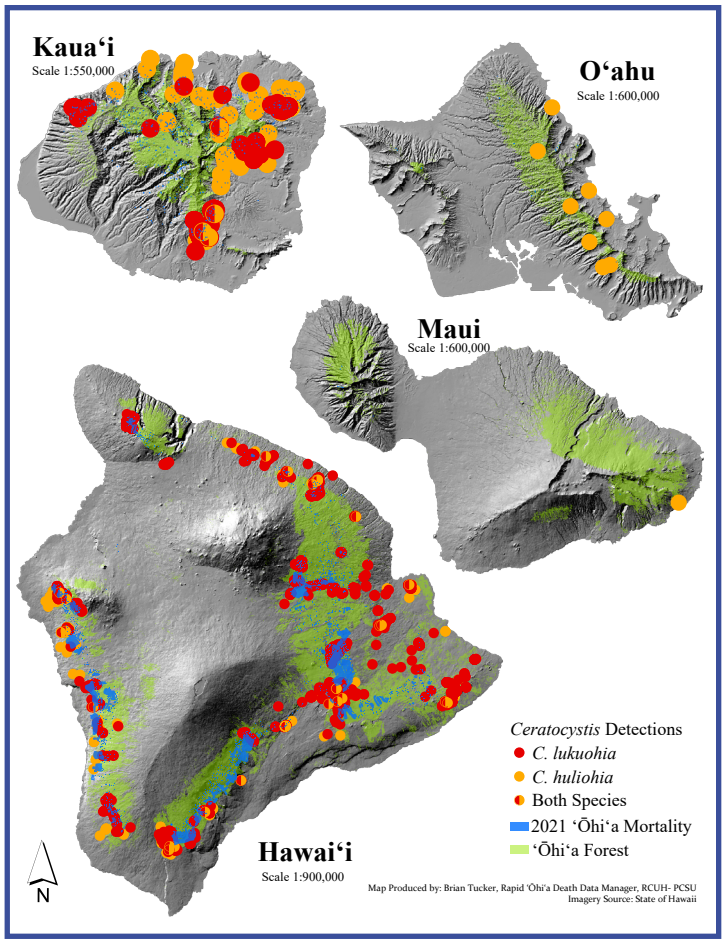


Figure 1. Rapid ʻŌhiʻa Death detections and aerially-mapped mortality. Photo credit: Brian Tucker, University of Hawaii

Also in 2021, the Ohia Disease Resistance Project (ODRP), a project through the Akaka Foundation for Tropical Forests (and partially funded by the U.S. Forest Service), began developing techniques for screening ʻōhiʻa families for disease resistance (Luiz et al. 2022).

Koa Wilt

Fusarium oxysporum* f. sp. *koae

Over the past decade, the Division of Forestry and Wildlife has worked with the Hawaii Agriculture Research Center in developing disease-resistant koa (*Acacia koa*) for both commercial plantations and forest restoration. *Fusarium 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 to provide 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.

Figure 2. The Hawaii Agriculture Research Center is working with DOFAW to restore koa forests using disease-resistant planting stock. Photo credit: DOFAW

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 fumigation, composting, or incineration in air curtain burners. Coconut trees are also being injected with imidacloprid and acephate in infestation areas.

In cooperation with the U.S. Navy and the University of Hawai'i, a project which is housed by Hawaii 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 damage by CRB and mulch piles for breeding sites. No beetles have been detected on other islands in the archipelago, and eradication on O'ahu is still the project goal. While site-specific eradication has occurred at the original infestation, several infested areas remain. 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 spread.

The infestation continued to expand into agriculture lands in central O'ahu in 2020, and there are now populations abutting natural forests. DOFAW and its partners have put traps in forest areas and have detected beetles in several traps. 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 Waianae Mountains on O'ahu, could be threatened by CRB establishing in natural areas.

Mule's Foot Fern (*Angiopteris evicta*) and Australian Tree Fern (*Cyathea cooperi*)

DOFAW also began work on their 2021 Landscape Scale Restoration grant, which is focused on stopping the spread of invasive tree ferns (*Angiopteris evecta* and *Cyathea cooperi*) to preserve Hawaii's remaining native forests. These ferns quickly overtake the forest by shading out native understory, leaving bare ground prone to runoff and erosion. These species are encroaching on some of the last remaining native forest in Hawai'i, which are home to endemic and rare species and the source of the islands' fresh water supply.

Targeted areas across 21,000 acres include the Ko'olau Mountains, North Shore Moloka'i, and West Maui. The project is an extensive partnership network including the Hawaii Association of Watershed Partnerships (HAWP) partner lands, both public and private.

In 2021, the team developed a control regimen across various sites in the Ko'olau Mountains that were identified as particularly well-suited for aerial spray based on weed population data created from both ground observations and aerial imagery. Mapping of the invasive fern populations on the north shore of Moloka'i through remote sensing technology and helicopter aerial observations were mostly completed across almost 23,000 acres. Based on what was learned from the process, the partnership produced instructional videos on mapping and detection for mule's foot fern (*Angiopteris evecta*). DOFAW has launched a pilot program to equip a group of volunteers with sufficient training to control mule's foot fern in remote areas of state-managed forest reserves on O'ahu. Spray operations for O'ahu are anticipated to begin in 2022.

Multiple invasive plant species at Hawai'i Volcanoes National Park

This project provided funding to reduce invasive plant infestations on over 50 ha within the Small Tracts of the 'Ōla'a Rainforest Unit of Hawai'i Volcanoes National Park (HAVO) (Figs. 3 and 4).

U.S. Forest Service funding enabled the re-establishment of cyclic treatments of invasive plants in order to preserve the integrity of this high-val-

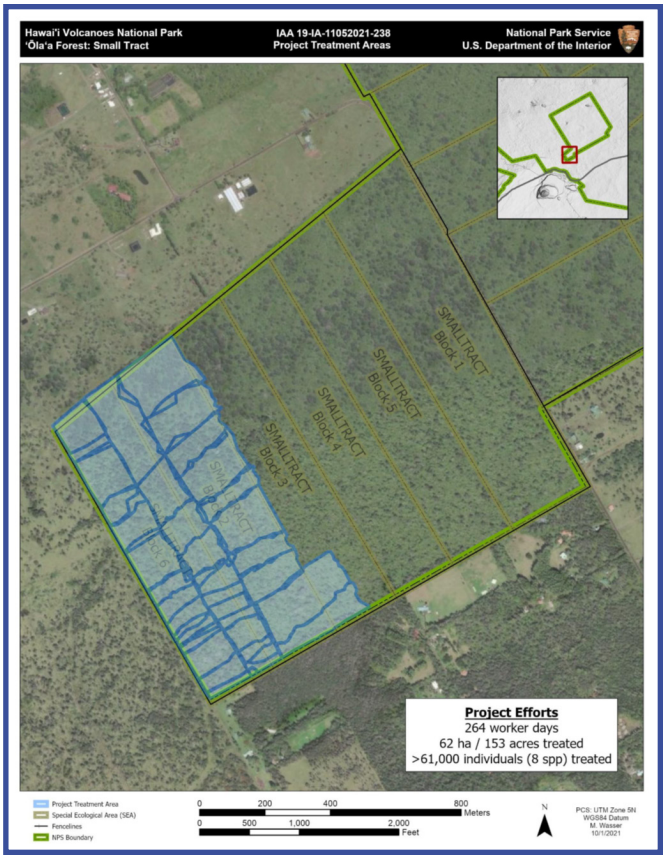


Figure 3. Map showing project treatment areas (in blue) and treatments completed for Ōla'a Rainforest Unit of Hawai'i Volcanoes National Park. Map credit: National Park Service

ue rainforest. Six widespread invasive plant species were targeted in the unit: Kahili ginger (*Hedychhium gardnerianum*); faya tree (*Morella faya*); banana poka (*Passiflora tarminiana*); strawberry guava (*Psidium cattleianum*); Florida blackberry (*Rubus argutus*); and yellow raspberry (*Rubus ellipticus*). Two localized species were also targeted: Australian tree fern (*Cyathea cooperii*) and night jasmine (*Cestrum nocturnum*).

During 2020 and 2021, HAVO NRM Vegetation Management staff spent 2,112 worker hours treating over 61,000 individuals of eight invasive plant species across 62 hectares (153 acres).

Kahili ginger was by far the most commonly-treated species, accounting for nearly 95% of individuals treated (~58,000 individuals). Strawberry guava and yellow raspberry were the most common woody species treated.

Figure 4. Aerial photo showing the back section of Small Tract (left foreground) where U.S. Forest Service-supported treatment was completed, and adjacent ranch lands. Photo credit: National Park Service

Tectococcus ovatus biocontrol for *Psidium cattleyanum*

A new system was created for aerially deploying *Tectococcus ovatus* biocontrol for *Psidium cattleyanum*.

Six sites were selected within small unmanned aircraft systems (sUAS)-accessible native Hawai'ian forests on public land currently undergoing invasion by strawberry guava across the Hilo, Ka'ū, and Puna districts of Hawai'i Island.

The purpose of the project is to convert existing sUAS platforms into a dedicated system capable of deploying multiple *Tectococcus ovatus* containers effectively: The prototype system will be ready for flight tests in the next three to six months. Improvements have been made in utilizing sUAS flights over previously-inoculated areas to determine the best methods for monitoring the biocontrol agent. The project will continue to test and refine the deployment system and develop standard operating procedures for the process. Inoculation trials at two separate sites should commence in 2022.

Multiple invasive plants on Maui

Approximately 5,256 acres of invasive grasses and shrubs (1 hour - 10,000 hour fuels) were treated with herbicide and maintained with the help of USFS SPF Invasive Plants funding and USFS-NRCS Joint Chiefs' Funding. The initial 583 acres of treated invasive vegetation helped protect the larger area (encompassing approximately 8,500 acs) in large part by preventing numerous wildland fires that originated near these treatment units from growing and spreading throughout the landscape (Fig. 5). Weather conditions in the area where these treatment units are located is dry and windy, causing fuels to become very receptive to wildland fire ignitions and spread. The project utilized two UTV 50 gallon slip-on units that allow crews to treat more than one area at a time (Fig. 6).

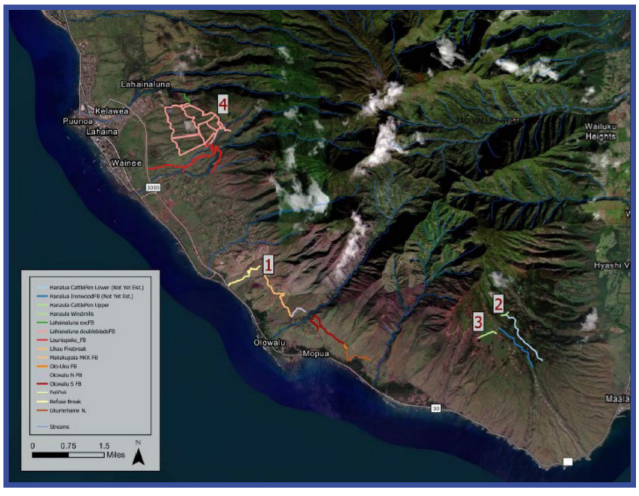


Figure 5. Map of West Maui Firebreak Project area. Map credit: DOFAW

Figure 6. Fifty-gallon sprayer tanks used for invasive species and firebreak treatments (x2). Photo credit: DOFAW

Acknowledgements
This report relied on information from a long list of collaborators including: Sheri Smith (USFS FHP R5), Phil Cannon (USFS FHP R5), Flint Hughes (US Forest Service, IPIF), J.B. Friday (UH), Aileen Yeh, Nick Dudley, and Tyler Jones (HARC), and Janis Matsunaga (Hawaii Department of Agriculture).

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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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