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Forest Health

2017 highlights

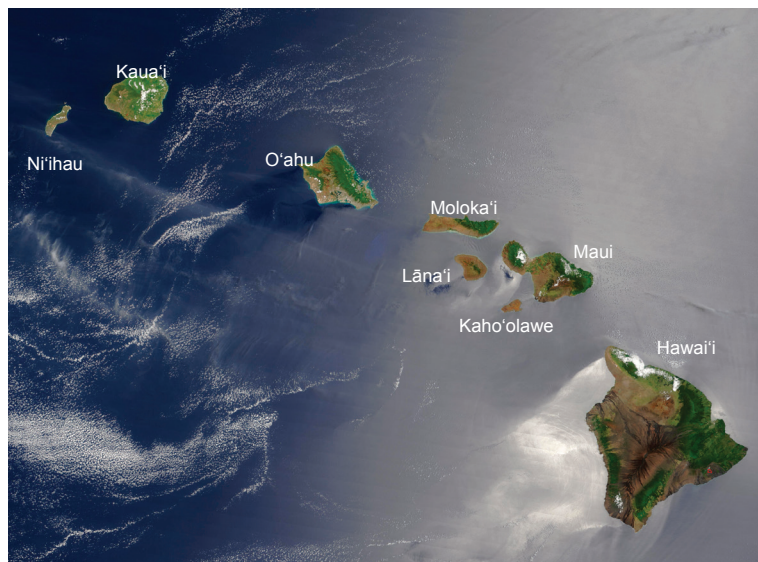
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2017 Summary

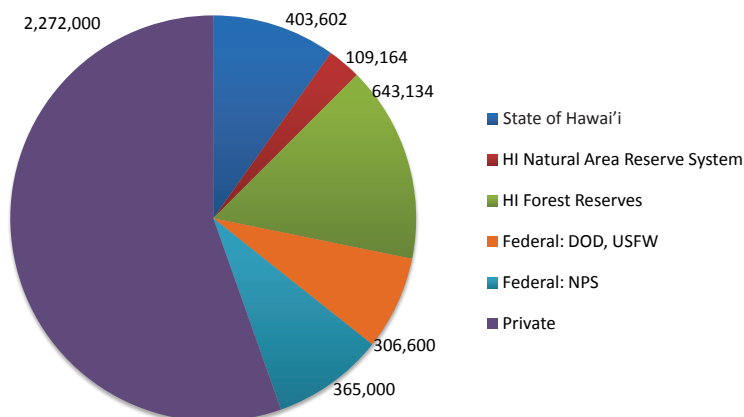
- **Rapid 'Ōhi'a Death (ROD)** continued spreading on Hawai'i Island, and is now present on the northern end of the island (affecting ~135,000 acres), within 50 miles of healthy forest on Maui.
- **Myrtaceae rust** continues to be a concern as it causes severe injury to 'ōhi'a seedlings in nurseries.
- The oldest of the **Koa wilt** resistant seed orchards recently began seed production. Private landowners established the first plantings derived from the orchards in 2017. **Koa seed pests** continue to greatly reduce viable seed production.
- **Coconut rhinoceros beetle (CRB)** eradication efforts continue on O'ahu, and detections in traps continue to decline.

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. Public lands occur on all islands except Ni'ihau and Lāna'i, which are privately owned. 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.



Land Ownership in Hawai'i



The State of Hawai'i Division of Forestry and Wildlife (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 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. Hawaii'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 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.

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.

Starting 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 die-back' previously observed on the Big Island as a cohort effect related to stand age and natural senescence. The phenomenon was coined Rapid 'Ōhi'a Death and researchers and managers began looking for a cause. Wood samples with dark gray discoloration were collected from symptomatic dead trees and were analyzed for presence of pathogens. The fungus *Ceratocystis fimbriata* was isolated from the 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 are currently being taxonomically described and characterized.

In 2017, Rapid 'Ōhi'a Death (ROD) continued its alarming spread on Hawai'i Island, with positive detections in North Kohala on the northern tip of the island. These latest detections put ROD within 50 miles of healthy forest across the channel on Maui Island. Aerial surveys using Digital Mobile Sketch Mapping detected approximately 135,00 acres on Hawai'i Island showing ROD-like symptoms. Within these areas, mortality varies from 1% to 90%. The surveys were carried out statewide, and ground crews have collected samples from mapped areas for laboratory analysis. So far, no samples from other islands have been positive. USDA ARS has developed molecular tools for rapid detection, and samples from the forest are processed in their laboratory to confirm disease presence.

It is still not known how the disease is spreading or where this pathogenic genotype came from. It is suspected that the spread in the environment is facilitated by beetles attacking trees that have been killed by the disease. The boring dust created by beetles is then spread by the wind and may infect trees through wounds. Human activities such as moving 'ōhi'a wood, plants, or soil from an infested area can also spread the disease. The Hawai'i Department of Agriculture has placed quarantine restrictions on such products leaving Hawai'i Island. Researchers are developing techniques to detect spread by boring dust and studying insects associated with boring dust production.

Myrtaceae Rust

Austropuccinia psidii

A rust disease on 'ōhi'a lehua (*Metrosideros polymorpha*) seedlings was first detected in a nursery on O'ahu in 2005. The disease was eventually identified as *Austropuccinia psidii*, commonly known as "guava rust" in Florida and as "eucalyptus rust" in Brazil. It is considered to be a serious threat to several hosts in the Myrtaceae family in numerous tropical and subtropical countries. The disease is referred to locally as "'ōhi'a rust" because of the importance of this native tree, but it infects many species in Myrtaceae present in Hawai'i. The disease is present on all major islands and can cause severe injury to 'ōhi'a seedlings growing in nurseries.



Figure 1. Mature stand of 'ōhi'a (*Metrosideros polymorpha*) on Hawai'i Island heavily impacted by the vascular wilt pathogen *Ceratocystis fimbriata*. Photo credit: UH Hilo, Spatial Data Analysis and Visualization (SDAV) Lab

Multiple strains of *Austropuccinia psidii* have been found to be associated with different hosts in Brazil (Graca et al. 2011). Fortunately, only a single strain of *Austropuccinia psidii* is known to occur in Hawai'i, and this strain has not caused excessive injury to 'ōhi'a trees. A study conducted in Brazil found 'ōhi'a families to be more susceptible to several of the strains isolated in Brazil (da Silva et al. 2014). This information is being used by quarantine officials at state and federal levels to protect Hawai'i from accidental introduction of additional, more harmful strains of the disease.

In 2016 and 2017 large areas (>1000 acres) of dead and defoliated 'ōhi'a were documented. *A. psidii* was found on epicormic sprouts on some of the affected 'ōhi'a trees, and it was determined to be the most likely cause of the mortality incident. It is not known whether a climatic anomaly caused the outbreak or whether a new genotype of *A. psidii* was responsible. Host range testing of isolates collected from the affected areas were consistent with earlier testing by Dr. Uchida's lab at the University of Hawai'i, indicating it was likely the same strain. Genetic analysis of samples is also being conducted through partners on the mainland to confirm that it is still the same strain that is spreading across the world, most recently detected in New Zealand.

Koa Seed and Pod Pests

Fusarium oxysporum f.sp. *koae*

Koa is a valuable tree species economically, ecologically, and culturally in Hawai'i. Koa wilt disease, caused by *Fusarium oxysporum* f. sp. *koae*, is a vascular wilt that causes high rates of mortality in plantings and threatens native forests. Landowners are reluctant to plant koa in many areas due to the threat of disease. The Hawai'i Agriculture Research Center (HARC), in collaboration with the USDA Forest Service and the State of Hawai'i DLNR-DOFAW, has made significant progress exploiting genetic resistance to combat the disease. The primary outcome from this 14+ year partnership is a network of koa wilt resistant seed orchards designed to produce locally adapted, disease resistant koa seed for restoration, reforestation and genetic conservation. HARC now maintains a network of wilt resistant seed orchards to provide improved seed. Each orchard contains selected families, each from within a specific region of the state, to conserve the integrity of that region's genetic diversity. The oldest orchards recently began seed production, and private landowners established the first plantings derived from the orchards in 2017.

With this management tool in place, the primary hurdle to implementing moer broadscale reforestation is the ability to reliably collect and distribute sufficient quantities of improved seed. Koa, like most *Acacia* species, is an intermittent seed producer resulting in large variations of seed yields from year to year. Furthermore, koa seed is heavily predated by several insect pests (*Araecrus levipennis*, *Stator limbator*, and *Cryptophlebia illepida*), often resulting in losses exceeding 75%. Current ongoing work is targeted at developing management tools to prevent insect-caused seed loss.



Figure 2. Koa haole seed weevil (*Araecrus levipennis*), one of several seed pests affecting koa reforestation efforts in Hawaii. Photo credit: US Forest Service

Coconut Rhinoceros Beetle

Oryctes rhinoceros

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 U.S. Navy and the University of Hawai'i, the project 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. No beetles have been detected on other islands in the archipelago, and eradication on O'ahu is still the project goal. Over 4,000 beetles have been detected in traps since 2013. Detections in traps have been declining annually since the eradication efforts began.

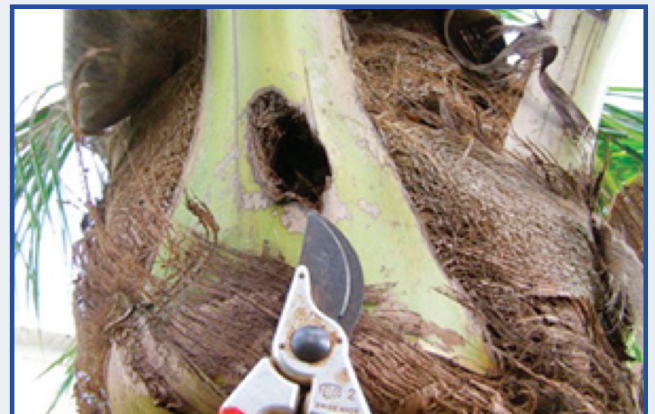


Figure 3. Adult coconut rhinoceros beetle create holes in palm frond stems. Photo credit: Ernie Nelson, Greenscapes Inc.

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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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