

Disease Activity 2

Insect Activity 3

Additional Information 4

Forest Health

2018 highlights

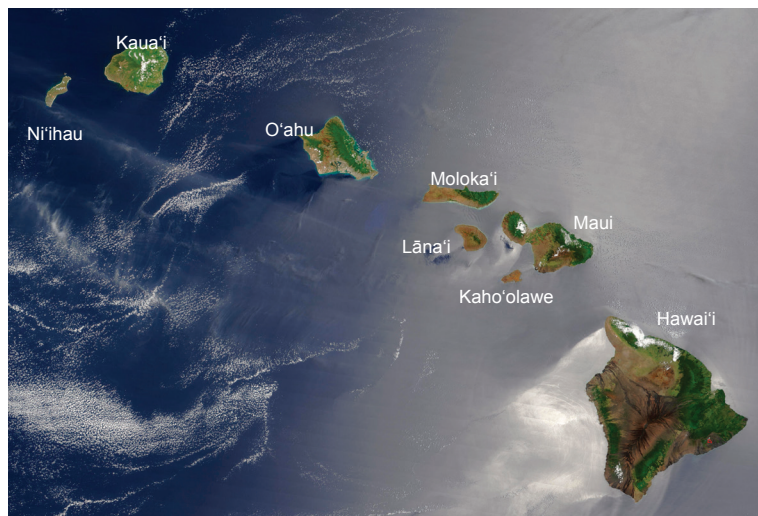
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2017 Summary

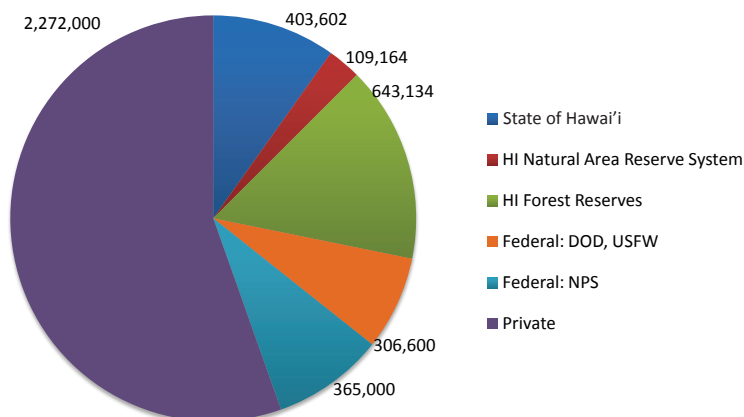
- **Rapid 'Ōhi'a Death (ROD)** continued spreading on Hawai'i Island and is now affecting 'ōhi'a across ~188,000 acres. Fungi associated with ROD were also detected on Kaua'i in 2018.
- **Myoporum thrips** was detected on the island of O'ahu. This pest has killed native naio shrubs and trees on Hawaii island since 2009.
- **Coconut rhinoceros beetle (CRB)** eradication efforts continue on O'ahu, with island-wide trapping, survey and treatment of all known infested sites.
- The Hawaii Agriculture Research Center, in collaboration with Hawai'i Division of Forestry and Wildlife, conducted disease-resistance screening of koa (*Acacia koa*) for **Koa wilt** and continued monitoring outplantings of screened material.
- ***Austropuccinia psidii* rust** has been found to kill 'ōhi'a (previously thought resistant) on O'ahu.

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,



Land Ownership in Hawai'i



and high elevation sites on Mauna Ke'a and Mauna Loa on Hawai'i and Haleakalā on Maui.

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 Hawaii'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 Hawaii'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 dieback' previously observed on Hawaii 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. 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. 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 seen on Hawai'i island (Barnes et al. 2018).

In 2018, Rapid 'Ōhi'a Death (ROD) continued its spread on Hawai'i Island, mostly filling in areas where only scattered mortality occurred. Biannual aerial surveys of the state's 'ōhi'a forests using the US Forest Service Digital Mobile Sketch Mapping tablet-based app detected approximately 188,000 acres on Hawai'i Island showing ROD-like symptoms. Within these areas, mortality varies widely and averaged 4.17%. Ground crews followed up by collecting samples from mapped areas for laboratory analysis.

Both pathogens associated with ROD were also detected on the island of Kaua'i in 2018. DOFAW and its partners responded with surveys to delineate the infestation. *C. huliohia* has been found in approximately 15 trees spread among four remote areas, while *C. lukuohia* was detected in a single location with only a few positive results. Intensified monitoring and management for containment are planned for that island.

Neither pathogens have been detected on Oahu, Maui, Molokai, and Lanai where 'ōhi'a also occurs. Surveys on those islands are ongoing. DOFAW is working closely with Carnegie Institute for Science, the Spatial Data Analysis and Visualization Lab at UH Hilo, and Resource Mapping Hawaii to develop remote sensing tools for detection and monitoring of ROD.

Koa Wilt and Seed and Pod Pests

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.

In 2018 the Hawaii Agriculture Research Center in collaboration with DOFAW completed seed collection (65 mother trees) from the Waianae Mountains on the leeward side of O'ahu. HARC is evaluating these families for disease resistance and locating a site for outplanting screened material. This, along with the Kona side of Hawai'i Island, are the last regions in the state for developing disease resistant material (Kona will be the focus of collections and screening in 2019). Trees outplanted on Kaua'i in 2017 performed well, and HARC is tracking tree form for additional selection.

With disease resistance for much of the state available, the primary hurdle to implementing more 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.

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 6,000 beetles have been detected in traps since 2013. While site-specific eradication has occurred at the original infestation, several infested areas remain.

Myoporum Thrips

Myoporum thrips (*Klambothrips myopori*) was detected on the island of O'ahu in November 2018. This pest has been killing native naio (*Myoporum sandwicense*) on Hawai'i island since 2009 where naio grows in a wide range of ecosystems – from coastal strand to alpine forests on Mauna Ke'a. On O'ahu, natural populations of naio are concentrated in a few coastal locations, including a rare form of the plant, *Myoporum stellatum*, which is only found in southwestern O'ahu.

DOFAW and its partners mobilized in response, utilizing the rapid response plan last updated in 2015: http://dlnr.hawaii.gov/hisc/files/2015/07/EDRR_Plan_Naio_Thrips_Oahu.pdf.

Both natural populations and landscape plantings were quickly surveyed to determine how widespread the insect had spread. Thrips are weak fliers and spread mainly on the wind, although they can be great hitchhikers as well. So far, the pest has not been detected infesting natural populations, and the goal is to treat or remove all known infected plants before the thrips expand to natural areas.



Figure 1. Two year old koa sapling planted on Kaua'i. Photo credit: Nick Dudley, Hawaii Agriculture Research Center



Figure 2. *Myoporum thrips* and its damage to native naio. Photo credit: Ryan Chang, Oahu Invasive Species Committee, UH

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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. Hawai'i'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.

Contacts

Rob Hauff, Forest Health Coordinator, Division of Forestry and Wildlife (DOFAW), Robert.D.Hauff@hawaii.gov
Cynthia King, Entomologist, Division of Forestry and Wildlife (DOFAW), Cynthia.B.King@hawaii.gov

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Meghan Woods, GIS Analyst, Mason, Bruce & Girard, Inc, USDA Forest Service, Region 5



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