

< HAWAII
< APRIL 2011

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Forest Health

2010 highlights

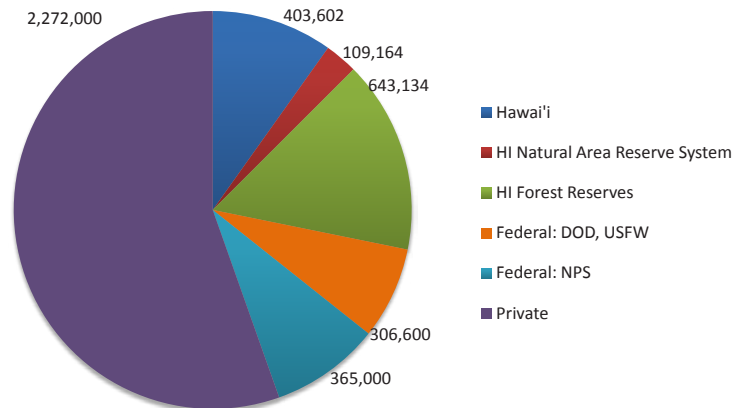
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Forest Resource Summary

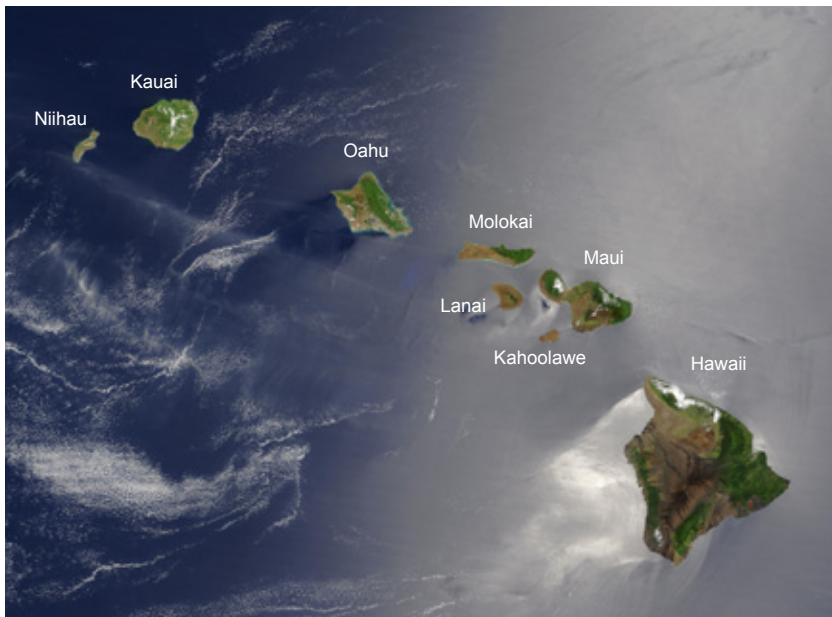
The State of Hawai'i includes eight main islands (Kaua'i, O'ahu, Moloka'i, Lāna'i, Kaho'olawe, Maui, Hawai'i, and Ni'ihau) totaling 4.1 million acres. Public lands occur on all islands except Ni'ihau and Lāna'i, which are privately owned. Approximately 1.4 million acres of the state are considered forested.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

The State of Hawai'i 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) making Hawai'i's state forest the 11th largest in the nation. The NARS was created to preserve unique native Hawai'ian ecosystems and is also managed by the Division of Forestry and Wildlife. 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. Currently, there are no lands in Hawai'i managed by the US Forest Service.

Land Ownership in Hawai'i



The remaining land – 2,272,000 acres – is privately owned. Increasing amounts of private forestlands in mountainous areas are being managed for watershed conservation in concert with publicly owned lands under established partnerships. These watershed partnerships manage upland areas comprising a patchwork of federal, state, and private parcels on approximately 850,000 acres throughout the state.



Forest Health Monitoring in Hawai'i

Monitoring of forest health conditions occurs throughout the state on private, state, and federal lands. Monitoring programs include the spread and impact of invasive plants, invertebrate pests, diseases, biological control agents, and ungulates. Ground surveys, transect monitoring, helicopter surveys, road surveys, photo points, and remote sensing are used to gather data.

Monitoring forest health in Hawai'i presents many challenges associated with its climate and geology. The extremely rugged terrain limits ground access to many areas and increases the difficulty of remote 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 making monitoring data collected over extensive areas very difficult to interpret. Identifying species, as well as 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.

Environmental Conditions

In 2010 the islands of Maui and Hawai'i experienced extreme drought conditions which threaten forests that occur in leeward areas. Extended drought contributed to forest decline by stressing plants and creating conditions for wildfires. A wildfire burned 2,000 acres of forest on the slopes of Mauna Ke'a on the island of Hawai'i destroying native forest that is unlikely to regenerate naturally. Loss of native vegetation to fire is a constant threat in Hawai'i, where most native vegetation is not adapted to fire. Burned vegetation is quickly replaced with fire-promoting grasses such as fountain grass (*Pennisetum setaceum*), an invasive grass widely established on the west side of Hawai'i. As forest vegetation is replaced with fire-promoting invasive grasses the cycle continues, destroying native vegetation. Hawai'i's dry forests are especially impacted, with only 5% of this ecotype remaining today.



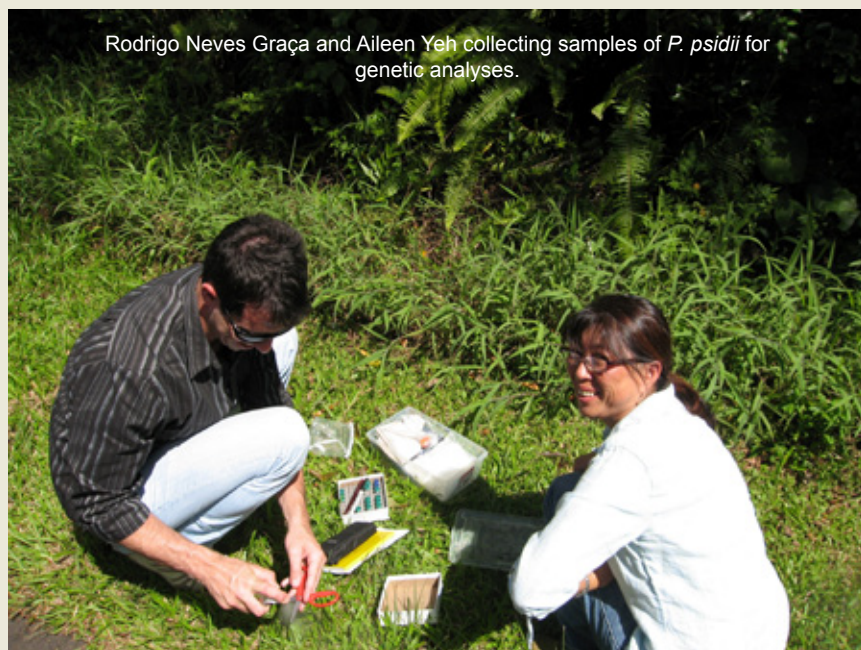
Vog damage to koa tree (*Acacia koa*).
Photo: Paul Sowcroft, USDA Forest Service

The island of Hawai'i is home to Kīlauea, the most active volcano in the world. Volcanic fumes, referred to as vog, include sulfur dioxide and other gases that can damage agricultural crops and forest species. An increase in volcanic activity accompanied by increased levels of vog was observed in 2010. The extent of damage to forests caused by vog has not been assessed, but due to prevailing winds, the southern part of the big island is most affected. While some native species such as 'ōhi'a are resistant to damage, many other species show signs of injury such as chlorosis.

Ohia Rust

Puccinia psidii

A rust disease on 'ōhi'a lehua (*Metrosideros polymorpha*) seedlings was first detected in a nursery on O'ahu in 2005. The same disease was later found infesting rose apple (*Syzygium jambos*) in forests on O'ahu. The disease was eventually identified as *Puccinia psidii*, commonly known as "guava rust" in Florida and as "eucalyptus rust" in Brazil. It is considered 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 many species in the Myrtaceae family that are present in Hawai'i are also susceptible. The disease is present on all major islands and can cause severe damage to 'ōhi'a seedlings growing in nurseries.



Rodrigo Neves Graça and Aileen Yeh collecting samples of *P. psidii* for genetic analyses.

During 2010, work in collaboration with the University of Hawai'i Mānoa, the USDA Forest Service Rocky Mountain Research Station, and the Federal University of Viçosa in Brazil collected rust samples to determine the genetic variation of the disease. All of the material analyzed from samples in Hawai'i were identical, suggesting that the disease in Hawai'i is a single genotype. Interestingly, none of the rust genotypes in Brazil matched Hawai'i's genotype. The Division of Forestry and Wildlife is working with the state quarantine agency to create restrictions on the entry of potential host material into the state to prevent additional genotypes from becoming established. Potential recombination of pathogen genotypes could generate new virulent races with unpredictable consequences.

Erythrina Gall Wasp

Quadrastichus erythrinae

The erythrina gall wasp (*Quadrastichus erythrinae* Kim) was first detected in 2005 as galls on leaves and stems on ornamental Indian coral trees (*Erythrina variegata*) at the University of Hawai'i campus on Oahu. Emergent adult wasps were then positively identified as *Quadrastichus erythrinae* Kim, a species only recently described (2004) from specimens from Singapore, Mauritius and Reunion. The current distribution of the erythrina gall wasp (EGW) includes Taiwan, mainland China, India, American Samoa, Guam, and Florida. Adult wasps show a preference for ovipositing in young tissue and galls have been observed on leaves, petioles, young shoots, stems, flowers and seed pods. Generation time is rapid: from egg to adult takes only 21 days; the adult life span varies from 3-10 days.

Once introduced, the tiny wasps were easily dispersed by wind and the movement of people and goods. They spread rapidly to all neighboring islands where host species were present (Hawai'i, Kaho'olawe, Maui, Moloka'i, Lāna'i, O'ahu, Kaua'i, and Ni'ihau). Most *Erythrina variegata* trees have been killed and removed. *Erythrina crista-galli*, also a common landscaping tree, is more resistant and trees continue to survive with minimal infestation.

The native wiliwili (*Erythrina sandwicensis*) is the dominant tree species in most of Hawai'i's dry forests. Although



Dead wiliwili tree (*Erythrina sandwicensis*) in highly damaged stand on Oahu.



Monitoring biological control of the erythrina gall wasp (*Quadrastichus erythrinae*) on wiliwili tree (*Erythrina sandwicensis*) on the island of Hawaii.

still considered abundant, little regeneration of wiliwili is occurring due to widespread seed predation by a bruchid beetle (*Specularis impressithorax*), competition from introduced grasses, fire, and severe browsing pressure on seedlings by introduced ungulates, in addition to the recent outbreak of erythrina gall wasp. The impact of the gall wasp on natural wiliwili populations was variable; some populations remained relatively healthy while others were moderately to highly infested with mortality as high as 50% in some stands.

Biological control was aggressively pursued by the Hawai'i Department of Agriculture (HDOA) and the University of Hawai'i. After initial exploratory trips to Africa, several potential agents were brought back and tested in containment facilities in Hawai'i. The first agent, a wasp in the family Eurytomidae, was released in 2008 by HDOA at several wiliwili sites throughout the state to control the gall wasp. The adult eurytomid wasp oviposits on galls; when its eggs hatch, the larvae consume the larvae of EGW. The biocontrol wasp spread quickly and has established throughout the state. Parasitism rates of EGW larvae inside galls are consistently around 90%. Galling levels on wiliwili trees have been reduced considerably and trees are recovering. Flowering, which had ceased in some stands at the height of the gall wasp infestation, has now resumed. In some areas managers are beginning to outplant wiliwili in restoration sites again. Monitoring efforts, conducted in collaboration with the HDOA and UH, will continue to assess the impact of the released biocontrol on the health of the wiliwili trees. Two other agents found in Africa are currently being held in containment facilities in Honolulu for future release if necessary.

Myoporum Thrips

Klambothrips myopori

A new insect pest, myoporum thrips, was detected on naio (*Myoporum sandwicense*) on the island of Hawai'i in early 2009. Myoporum thrips was first described in California when it was detected in 2005 infesting landscape plantings of *Myoporum laetum* from New Zealand. The thrips origin remains unknown although most species in the genus are native to Australia. On the big island it was found infesting naio papa,

a low-growing variety planted along roadways in resort areas in South Kohala and North Kona districts, where the climate is very dry. Hawai'i Department of Agriculture and the Big Island Invasive Species Committee carried out surveys to determine the extent of the infestation. The infestation was determined to be too extensive to be eradicated; the thrips had likely been moved between resorts by landscape companies. Given the natural dispersal capacity of thrips, it was only a matter of time before the pest was identified infesting naio in natural areas. The pest is now widely distributed over the north and west sides of the big island, and isolated populations have been detected on landscape plantings to the east in Hilo.

Damage to host species resembles galling and can lead to stunting of shoots and branch dieback. The areas infested in Hawai'i initially were not extremely affected as they were being treated with insecticides. While insecticides have been found to be effective in controlling damage caused by myoporum thrips (Dr. Arnold Hara, pers. comm.) widescale treatment of naio in natural areas is not practical. The State of Hawai'i DOFAW provided funding to locate myoporum thrips in their native range, the first step towards initiating a biological control program. The development of biological control is unlikely to happen quickly however as the pest has not been described from its native range.

Myoporum sandwicense is a small tree or shrub that grows from sea-level to 9000ft in elevation, and is a common dominant species in a range of Hawai'ian habitats, from arid coastal strand communities to high elevation wet forests. On Mauna Kea on the big island, naio and mamane (*Sophora chrysophylla*) are codominant trees making up a forest that is the last remaining habitat for the endangered palila. If the

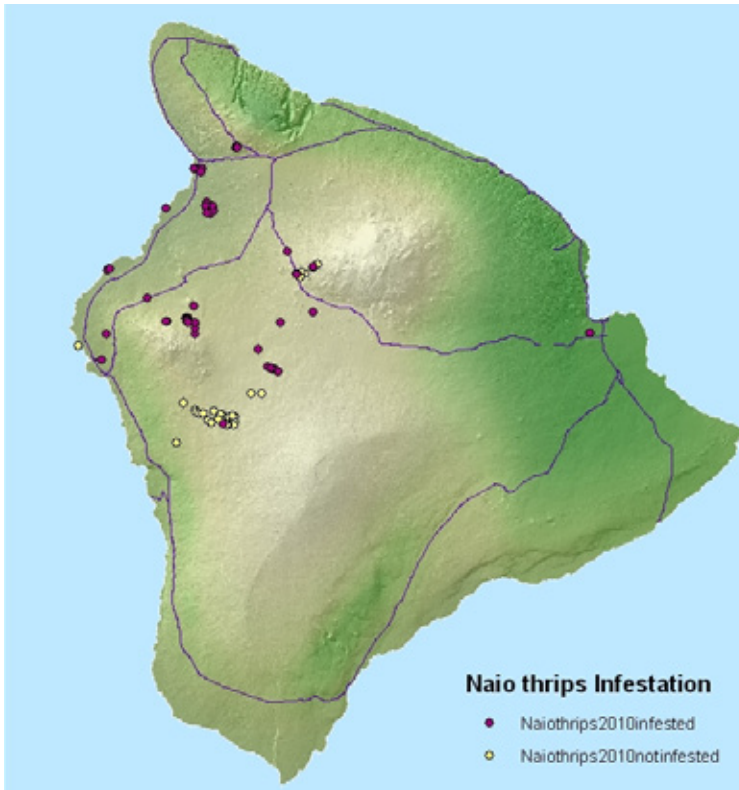


Damage to naio (*Myoporum sandwicense*) by myoporum thrips (*Klambbothrips myopori*).

species were to suffer dieback due to this pest, a wide range of damage to ecosystems would result.

In April 2010, the US Forest Service began funding a special detection monitoring program which aims to track the spread of this pest, and assess the baseline ecological impacts on *M. sandwicense* in Hawai'i. Data on climatic and seasonal effects on pest damage, presence of natural enemies and interaction with other arthropod species are being collected. Preliminary data indicate that the pest is causing significant damage to native *M. sandwicense*, and appears to be causing tree mortality at some sites. Early detection surveys of nurseries and natural populations are being carried out on the other islands by Hawai'i Department of Agriculture, DOFAW, and invasive species committees.

Myoporum thrips distribution on the island of Hawai'i



Invasive Plants

Poison Devil's Pepper

Rauvolfia vomitoria

Local resource managers first noticed the spread of a fast growing, toxic tree called Poison Devil's Pepper (*Rauvolfia vomitoria*) on the island of Hawai'i two years ago. The African tree was introduced as a potential medicinal plant crop and inter-planted with macadamia nut trees. The tree, whose bright orange seeds are eaten by introduced birds, is spreading into agricultural lands and native forests at a rapid rate. Poison Devil's Pepper displays similar dispersal and growth traits as miconia, which is a well known forest invader and one of the state's worse invasive plants. Poison Devil's Pepper has already taken over pasture and forested areas, dominating sites and out-competing other aggressive invasive species, thus rendering the land useless for forestry or agriculture. Further spread threatens native forest ecosystems up to 8,000 ft elevation – essentially all remaining native forests on the island. These forests are home to many threatened and/or endangered forest bird and plant species.

Additional Information

The only known infestation in Hawai'i is limited to approximately 10,000 acres with a core infestation of about 1000 acres. The Big Island Invasive Species Committee (BIISC), a partnership of several government agencies, non-profits, and community groups is targeting this plant in collaboration with the Kohala Watershed Partnership, a partnership of private and public landowners that jointly manages forest resources across property boundaries. Aerial surveys over the past year have allowed managers to map the extent of the invasive tree and determine the most appropriate strategy for control and containment. Control efforts began in 2010 and funding was recently secured through the USDA Forest Service State and Private Forestry FY 2011 Western Competitive Resource Allocation to allow for the initial containment work by BIISC over the next two years. Long-term eradication goals will be pursued by the Kohala Watershed Partnership in collaboration with private landowners and through community outreach.

On O'ahu, early detection surveys funded by the state and Forest Service found a single Poison Devil's Pepper tree planted in the county's Ho'omaluhia Botanical Gardens. Because the tree ranks as a high risk on the Hawai'i Pacific Weed Risk Assessment and is known to be spreading on the big island, the garden managers agreed to remove the tree. The O'ahu Invasive Species Committee (OISC) began surveys of a 200 meter buffer area around the tree (based on flight distances of frugivorous alien bird species) to determine whether the tree had successfully reproduced, and fortunately no additional plants have been found. Early detection programs conducted by invasive species committees on the other islands included Poison Devil's Pepper as a target in their surveys to ensure that the only established population on the big island. Such coordinated efforts allow Hawai'i to prevent harmful invasive plants from gaining a foothold in its valuable forested watersheds.



Poison Devil's Pepper (*Rauvolfia vomitoria*) produces bright orange fruits which are dispersed by alien bird species present in Hawai'i.

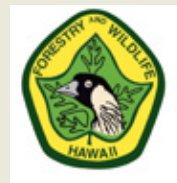
Data Sources

The data sources used for this report include data gathered by Hawaii's island-based Invasive Species Committees or ISCs (funded in part by USDA Forest Service, Forest Health Protection, Invasive Plant Program), Division of Forestry and Wildlife staff, Hawaii Department of Agriculture, University of Hawaii, and partner organizations such as the Hawaii Agriculture Research Center. Survey and monitoring data collected by the ISCs are entered into a statewide database created by the USGS Pacific Basin Information Node, and the data are analyzed at the local and state levels.

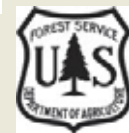
Hawaii's Watershed Partnerships, the National Park Service, The Nature Conservancy of Hawaii, and DOFAW's Natural Area Partnership System also conduct monitoring of invasive plants and ungulates to improve the effectiveness of their management activities, but those data are not the focus of this report. The USDA Forest Service's Forest Health Aerial Survey Program and Forest Inventory and Analysis Program are not currently active in Hawaii.

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