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< APRIL 2012

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# Forest Health

## 2011 highlights

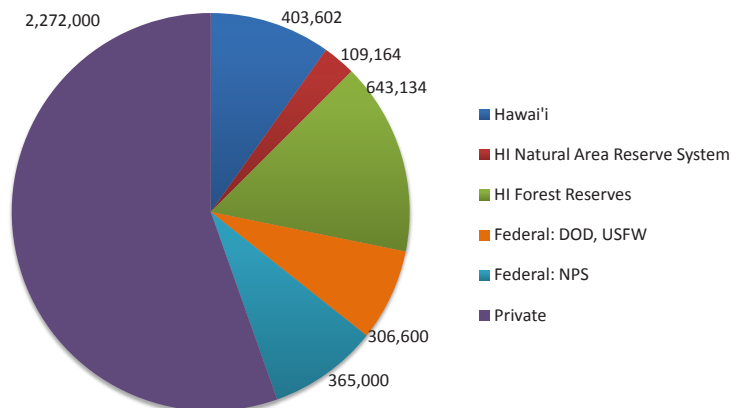
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## Forest Resource Summary

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 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 Hawaiian 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. There are no lands in Hawai'i managed by the US Forest Service.

Land Ownership in Hawai'i

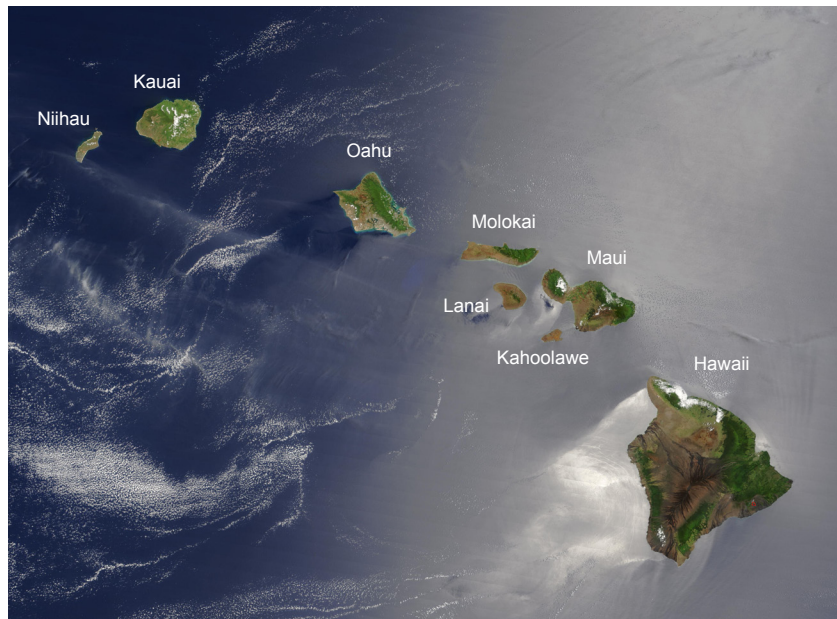


The remaining land – 2,272,000 acres – is privately owned. Increasing amounts of private forestlands in mountainous areas are being managed for watershed conservation in concert with publicly owned lands under established partnerships. These watershed partnerships manage upland areas comprising a patchwork of federal, state, and private parcels. They currently manage a combined total of 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. The monitoring objectives include the spread and impact of invasive plants, invertebrate pests, diseases, biological control, and ungulates. These programs use ground surveys, transect monitoring, helicopter surveys, road surveys, photo points, and remote sensing for gathering data.

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 remote 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 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 Hawaii's forests are located.

## Disease Activity

### 'Ōhi'a 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*) growing 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 and 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 it infects many species in Myrtaceae present in Hawai'i. The disease is present on all major islands and can cause severe damage to 'ōhi'a seedlings growing in nurseries.

Previous 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 determined that the disease in Hawai'i is a single genotype. Interestingly, none of the rust genotypes in Brazil matched Hawai'i's genotype. Other genotypes isolated in Brazil were used to inoculate 'ōhi'a seedlings grown from seeds collected from all the major Hawaiian islands. The seedlings were more susceptible to some of these isolates showing extreme symptoms.

Using the information from these studies, the Hawai'i Division of Forestry and Wildlife and the Department of Agriculture are working together to create restrictions on entry of potential host material to the state to prevent additional genotypes from becoming established. Of recent concern is the import of eucalyptus clones from South America to be used for new plantations to supply feedstock for bioenergy operations. Potential recombination of pathogen genotypes could generate new virulent races with unpredictable consequences.

Ongoing surveillance continues with field monitoring in forest plots on the island of Hawai'i to track disease occurrence and damage. The disease appears during the wettest times of the year and at lower elevations. A challenge to disease monitoring is accessing tree canopies. Most disease detections are on seedlings and epicormic branching. The University of Hawai'i continued working on host range testing and processed molecular samples to determine whether new strains have entered Hawai'i.



## Insect Pests

### 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: the life cycle of the wasp (egg to adult) has been observed as short as 21 days in Hawaii; the adult's life span varies from 3-10 days.

Once introduced, the tiny wasps were easily dispersed by wind

and the movement of people and goods and spread rapidly to all neighboring islands where host species are present (Hawaii, Kahoolawe, Maui, Molokai, Lanai, Oahu, Kauai, and Niihau). 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, thus providing a year-round reservoir of Erythrina gall wasp populations.

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



Galled seed pods on wiliwili (*Erythrina sandwicensis*).

infested with mortality as high as 50% in some stands.

Biological control was aggressively pursued by the Hawaii Department of Agriculture (HDOA) and the University of Hawaii. After initial exploratory trips to Africa, several potential agents were brought back and tested in containment facilities in Hawaii. After extensive host range testing, the first agent, a wasp in the family Eurytomidae, was released in 2008 by HDOA at several wiliwili populations 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 range from 20-100% depending on location of the stand, time of year, and recent weather events. Gallings levels on wiliwili trees have been reduced considerably and trees are recovering. In some areas managers are beginning to outplant wiliwili in restoration sites again. Flowering, which had ceased in some stands at the height of the gall wasp infestation, has now resumed. However infestation rates in flowers remains high, and consequently seed production is adversely impacted. Ongoing monitoring in collaboration with the HDOA and UH will continue to assess the impact of the released biocontrol on the health of the wiliwili trees and their reproductive capacity. One other agent found in Africa is currently being held in containment facilities in Honolulu for future release if necessary. Testing has been completed which demonstrates that the other agent would increase control of *Erythrina* gall wasp, and does not adversely compete with the eurytomid agent.

### Myoporum Thrips

#### *Klambothrips myopori*

A new insect pest, Myoporum thrips, was detected on naio (*Myoporum sandwicense*) on the island of Hawaii (the "big island") in early 2009. Myoporum thrips was first described in California in 2005, when it was observed infesting landscape plantings of *Myoporum laetum* from New Zealand. It has



Monitoring biological control of the *Erythrina* gall wasp (*Quadrasticus erythrinae*) on a flowering wiliwili tree (*Erythrina sandwicensis*).

been determined that *Klambothrips myopori* originate from Tasmania, based on extensive surveys across the Australia and New Zealand, the native range of *Myoporum*, and molecular analyses. 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. Hawaii 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, and via wind. Given the natural dispersal capacity of thrips, it was only a



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

matter of time before the pest was identified infesting naio in natural areas. The pest is now widely distributed over the north, central and west sides of big island, and isolated populations have been detected on landscape plantings to the east in Hilo.

Damage to the host in California has included complete defoliation and has often resulted in plant death. The damage resembles galling and can lead to stunting of shoots and branch dieback. The areas infested in Hawaii were initially not as extremely affected as they were being treated with insecticides. While insecticides have been found to be effective in controlling *Myoporum* thrips damage (Dr. Arnold Hara, pers. comm.) widescale treatment of naio in natural areas is not practical. The State of Hawaii DOFAW provided funding to locate *Myoporum* thrips in their native range, the first step towards initiating a biological control program. If additional funding is secured, a search for natural enemies in Tasmania could be pursued.

*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 Hawaiian 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 Hawaiian honeycreeper, the palila. If the 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 Hawaii. 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 has resulted in tree mortality at some sites. Early detection surveys of nurseries and natural populations are being carried out on the other islands by Hawaii Department of Agriculture, DOFAW, and invasive species committees.

## Invasive Plants

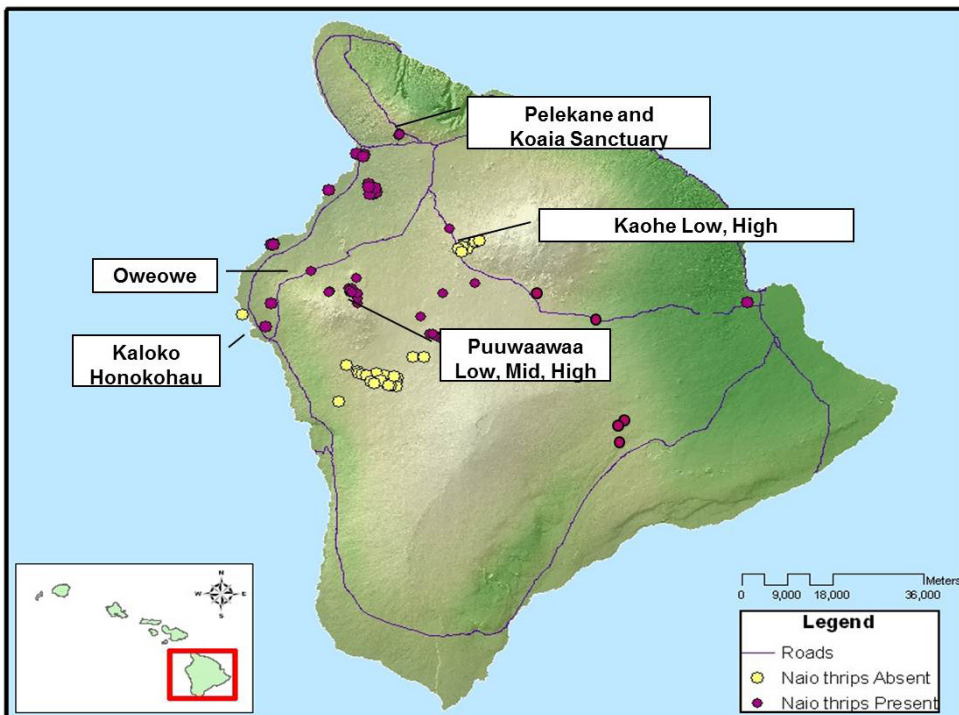
### German Ivy

*Delairea odorata* (formerly *Senecio mikanioides*)

German ivy, also known as cape ivy, is a shrubby perennial vine in the Asteraceae native to South Africa. It reproduces vegetatively and by producing many small, wind-dispersed seeds equipped with a parachute in the fashion of dandelion seeds. Its rapid growth rates allow it to overtake and smother slower growing native trees and shrubs.

German ivy was first collected in Hawai'i in 1910 and has become an invasive pest on the island of Hawai'i, especially in high elevations forests such as Mauna Kea where it threatens mamane-naio forests which provide habitat for the endangered Hawaiian honeycreeper, the palila. The invasive vine also occurs on the islands of Maui and Lāna'i and was recently detected on O'ahu.

On Mauna Kea, German ivy is routinely controlled by resource managers protecting palilia habitat. The palila feed on mamane (*Sophora chrysophylla*) seeds, the production of which is hindered by trees being overtaken by the invasive vine. In order to control German ivy, plants are mechanically removed followed by spot spraying with glyphosphate. Effective control can require up to three treatments making this a challenging weed to control. This species will require constant management because it is already widespread on the big island. No biological control project for this species has been initiated to date due to lack of resources and an abundance of other targets in Hawai'i.



State of Hawaii, Department of Land and Natural Resources - Division of Forestry and Wildlife

Map of *Myoporum* thrips distribution on the island of Hawai'i.

Botanists with the O'ahu Early Detection team, a joint project between O'ahu Invasive Species Committee (OISC) and the Bishop Museum, recently discovered German ivy on private property in the Wai'anae Mountains while conducting invasive plant surveys. OISC's partners assisted in contacting the landowner and gaining permission for the OISC crew to access the site. The OISC crew completed a 391 acre delimiting survey and determined that the approximately 30-acre population is localized in the Palehua area of the Wai'anae Mountains. The crew proceeded to treat 13.6 acres and will be able to finish treating the remaining population in 2012. It is hoped that this population can be eradicated from the island of O'ahu before it gets a foothold and requires long-term management.

This operation illustrates the effectiveness of partnerships in invasive species management. The Oahu Invasive Species committee is a partnership of public, private

# Restoration

and non-profit organizations interested in the prevention and control of invasive species which damage the environment, economy and way of life on the island. Without help from private and government partners, OISC would not have had access to the land or have discovered the German ivy in time to eradicate it. In turn, OISC's work in eliminating the German ivy assists neighboring land managers who now have one less weed to manage.



German ivy (photos by Forest and Kim Starr [www.hear.org](http://www.hear.org))

## Maui Restoration of Koa Forests

Non-native ungulates, invasive fire-tolerant grasses, and repeated wildfires have eliminated 90% of leeward Haleakala's native forest, including Koa (*Koa acacia*) forests. The Leeward Haleakala Watershed Restoration Partnership was developed to reforest leeward east Maui and includes partners from the National Park Service, Hawaii Department of Land and Natural Resources, Department of Hawaiian Homelands, 8 private land owners, Hawaii Agricultural Research Center and the Maui Restoration Group. Reforestation is progressing quickly and volunteers are "planting" their way across the project area. Volunteers have manually controlled weeds over 43 acres, cleared fireweed from the road surrounding the eastern enclosure perimeter, and outplanted 24,949 native seedlings of 24 different species since June 2010. Survival rates continue to remain well above 90%. Positive integrated elements including diversifying rural employment, providing nearly unlimited silvicultural possibilities, and perpetuating Hawaiian culture by restoring koa are all benefits from the partnership.



Leeward Haleakala Watershed Restoration Partnership staff and volunteers working in the project area.



Leeward Haleakala Watershed Restoration Partnership staff and volunteers after a hard day's work planting in the mountain.

# Additional Information

## 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 Forest Inventory and Analysis Program was recently introduced to Hawai'i , but results from the survey are not yet available.

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