The wiliwili tree, threatened by the Erythrina gall wasp

HAWAII

APRIL 2007

Forest Health *highlights*

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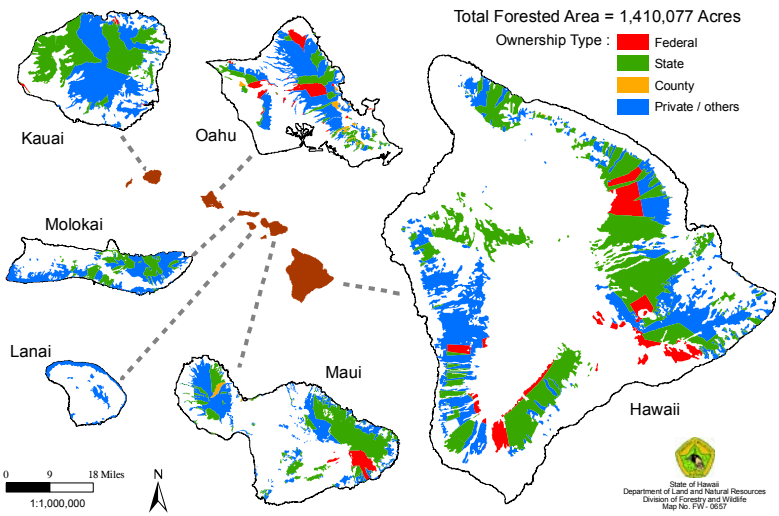
Forest Resource Summary

This report is for the State of Hawaii which includes eight main islands (Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui, Hawaii, and Niihau) totaling 4.1 million acres. Public lands occur on all islands except Niihau and Lanai, 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 Kea and Mauna Loa on the island of Hawaii and Haleakala on the island of Maui.

The State of Hawaii 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 Hawaii'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 Hawaii managed by the US Forest Service.

State of Hawaii : Forested Area by Ownership



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 Hawaii

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 Hawaii 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.

Hawaii's island-level Invasive Species Committees (ISCs) became active in the 1990s with the goal of being able to respond to threats of alien pest infestations and to control established pest populations on a species by species basis. The Maui Invasive Species Committee (MISC), the Molokai subcommittee of MISC (MoMISC), the Big Island Invasive Species Committee (BIISC), the Kauai Invasive Species Committee (KISC), and the Oahu Invasive Species Committee (OISC) are already well involved in the battle against invasive species. Each ISC is a voluntary partnership of county, state, and federal agencies, private businesses, nonprofit organizations, and individuals united in cooperative efforts to control the alien pest species that pose the greatest threats to each island's ecosystems, watersheds, economy, public health, and quality of life.

Hawaii is unique in our extreme isolation from other terrestrial biodiversity centers. Even once an invasive species becomes established in the state, individual islands may remain free of pest species through intra-state quarantine practices and constant monitoring followed by effective control. Island-wide eradication is the most cost-effective, long-term protection for native ecosystems. While several of the highest priority plant species are fairly widespread compared to current eradication strategy reviews, new targets will be prioritized by the level of the threat they pose to native ecosystems and the feasibility of eradication.

The ISCs work to prevent incipient species from becoming established in Hawaii's watersheds and natural areas. While the ISCs' geographic scope is island-wide, much of their work is focused in the lower elevation areas, at or near the boundaries of the Watershed Partnerships, on residential or rural properties, or on disturbed forest lands. When the ISCs work in forested mountain areas, they often collaborate with the Watershed Partnerships. ISCs may also work on targeted agricultural pests. ISCs typically do not work on controlling species such as pigs or goats which are both widespread and not good candidates for species based management.

Early Detection

Early detection is the best prevention against invasive species. This approach, which includes building and refining a target list, performing targeted surveys and prioritizing species for control, helps determine what is being introduced to Hawai'i, what is safe, and what might jump the garden fence. Across the state, Invasive Species Committees have implemented early detection and rapid response programs as the best prevention against invasive species. ISC crews survey roads, nurseries and other pathways of introduction to protect the islands from weeds while they are still easy to control.

When a new plant species is detected, the Weed Risk Assessment is used to predict the plant's propensity to become weedy. The WRA was developed in Australia and New Zealand and modified for use in Hawai'i and other Pacific islands by Professor Curt Daehler of the University of Hawai'i. The WRA screens plant species and assigns them a score based on their propensity to become weedy. Plants that have a high level of threat to the island and a low level of establishment represent the highest priority for control and become rapid response species. Once a species is included as a rapid response target, crews begin to systematically survey and control all known populations to eradicate it from the island.

The Weed Risk Assessment is available at:
http://www.botany.hawaii.edu/faculty/daehler/wra/

For example, on Oahu botanists are surveying areas with high potential for new introduced plants that may be invasive. These "hotspots" encompass myriad sites that were categorized and prioritized to provide the best sampling possible. The hotspots include areas such as experimental agriculture sites, botanical gardens and nurseries. From over 22 hotspot surveys, the Oahu team identified and documented over 1,200 species. Of these, 175 were not already catalogued at the Bishop Museum's Herbarium Pacificum, meaning they are possibly very recent arrivals to Oahu. Seventeen of these 175 species have been documented as weeds elsewhere in the world and may become targets for OISC eradication. Subsequent work will focus on prioritized roadside surveys throughout the island.

The Oahu Invasive Species Committee had two successes in early detection/rapid response during 2006. Himalayan raspberry (*Rubus ellipticus*) and tibouchina (*Tibouchina herbacea*), both invasive plants causing widespread impacts on other islands, were detected by OISC crews and controlled. Monitoring of the sites for regeneration continues and no new populations have been found on the island.

Priority Target Species

All of the species targeted by the ISCs are able to outcompete or drastically alter existing communities, resulting in a change in ecosystem components, structure and function. Some plants, like fountain grass and bushy beardgrass, also change the fire regime of an area. Animal species like coqui consume large amounts of insects, and veiled chameleons are able to take birds, disrupting pollination services and further jeopardizing threatened and endangered species. Some species also impact ecosystems and human health and quality of life, such as long-thorn kiawe, little fire ants and coqui frogs. The following is a description of several ISC target species, but it is not a comprehensive list of ISC targets.

Data Management

During 2006, staff from the U.S. Geological Survey's Pacific Basin Information Node continued working with the Invasive Species Committees to unify portions of each ISC's data management system. The result of this process was the establishment of a reliable and efficient statewide reporting system on invasive species. The new, integrated reporting system was operational by June 2006 and will continue to be improved to provide current information about efficacy and status of control efforts.

The following is a description of several high profile Invasive Species Committees target species, it is not a comprehensive list of ISC targets. For more information visit: **http://www.hear.org/**

Fountain Grass (*Pennisetum setaceum*)

- Bunch grass native to Africa, introduced as an ornamental.
- Produces many seeds per year, wind dispersed.
- Seeds remain viable for 7 or more years.
- Promotes and fuels wildfires.
- Potential range is all dry and mesic forests.
- Priority Target for KISC, MISC, OISC.

Pampas Grass (*Cortaderia selloana* and *C. jubata*)

- Large bunch grass native to South America, introduced as an ornamental.
- Produces many seeds per year, wind dispersed. Promotes and fuels wildfires.
- Potential range is all mesic and wet forests.
- Priority Target for KISC, MISC, MoMISC, OISC.

Long-Thorn Kiawe (*Prosopis juliflora*)

- Tree or sprawling shrub native to Africa, introduced for agriculture, possibly accidentally.
- Produces many seeds that are water and animal dispersed.
- Potential range is unknown; appears able to hybridize with short-thorn kiawe.
- Priority Target for KISC.

Bushy Beardgrass (*Schizachyrium condensatum*)

- Tufted grass native to Central and South America.
- Introduction history unknown.
- Produces many seeds, spread by wind and humans. Promotes and fuels wildfires.
- Priority Target for OISC.

Rubber Vine (*Cryptostegia grandiflora*)

- Climbing woody shrub native to Madagascar, introduced and still sold as an ornamental.
- Produces many seeds that are spread by wind.
- Moist forests at risk.
- Priority Target for MISC.
- Large infestation of *C. madagascariensis* on Molokai cannot be controlled by MoMISC with current resources.

Ivy Gourd (*Coccinia grandis*)

- Vine native to tropical Asia, introduced as a food crop.
- Produces many seeds that are bird dispersed; spreads vegetatively.
- Potential range is unknown.
- Priority Target for KISC, MISC.

Cattail (*Typha latifolia*)

- Wetland rush native to North America, North Africa and Eurasia, introduction history unknown.
- Reproduces and spreads vegetatively and by wind-dispersed seeds.
- Potential range is all low elevation wetlands.
- Priority Target for KISC.

Australian Tree Fern (*Cyathea cooperi*)

- Large tree fern up to 40 feet, native to Australia.
- Introduced and still sold as an ornamental.
- Produces many lightweight spores that are spread long distance by wind.
- Priority Target for MoMISC.

Miconia (*Miconia calvescens*)

Miconia is the highest priority statewide for invasive weed control and was originally introduced to Hawaii as an ornamental plant. It has since established at varying levels on Hawaii, Maui, Oahu, and Kauai (listed in order of most severe to least). Early detection aerial surveys have yet to detect miconia on Molokai, but introduction there is a serious concern. Because the level of infestation differs on each island, management goals and strategies vary among ISCs. Each ISC uses helicopter surveys combined with ground surveys to locate trees, saplings and seedlings. Helicopter surveys are essential in Hawaii because of the extremely rugged terrain, and they have proved very effective at detecting mature miconia trees. Ground surveys conducted by invasive species technicians and volunteers locate and eliminate miconia plants in accessible areas. The USDA Forest Service Institute of Pacific Islands Forestry and Hawaii Department of Agriculture are conducting host specificity studies on insects an pathogens to release for biological control of miconia.

- Miconia is native to Central and South America, introduced as an ornamental.
- Produces millions of seeds per year dispersed by birds, rats, pigs and humans. Seeds remain viable for 10 or more years.
- Potential range is all wet and mesic forests to 6000 ft. elevation.
- Priority Target for BIISC, KISC, MISC, OISC

Site-led Management

In contrast to the ISCs' "species-led" management, many entities in the state carry out "site-led" management of established invasive species. Examples include Hawaii's Watershed Partnerships, the National Park Service, The Nature Conservancy of Hawaii, the Department of Defense, and the Natural Area Reserve System. Target species include established ungulates and invasive plants such as strawberry guava, clidemia, Kahili ginger, and tibouchina. Targets are monitored and controlled using manual, chemical, and sometimes biological control.

Many of these established invasive plants will only be managed effectively in the long-term with the use of biological control. USDA Forest Service and Hawaii Department of Agriculture carry out biological control research essential to weed management in the state. A new biological control agent for strawberry guava that will be released soon by Forest Service researchers on the island of Hawaii offers hope for reducing the impact of this destructive weed, as well as reducing the amount of resources necessary for controlling it with herbicides in protected areas. Release sites will be monitored by Forest Service personnel for several years to determine the level of control achieved by the introduction.

Miconia calvescens - Miconia (Melastomataceae)
Leaf at Hilo, Hawaii.
Photo by Forest & Kim Starr
Available at: www.hear.org

Ohia Rust

Puccinia psidii

A new rust disease on ohia (*Meterosideros polymorpha*) seedlings was detected in a nursery on Oahu in April 2005. The same disease was later found on rose apple (*Syzygium jambos*) growing in forests on Oahu. The disease was eventually identified through DNA analysis as *Puccinia psidii*, commonly known as "guava rust" in Florida and as "eucalyptus rust" in Brazil. The disease is referred to locally as "ohia rust" because of the importance of this native tree, but it infects many species in the Myrtaceae that are present in Hawaii in addition to ohia. The disease is present on all major islands and is likely to have spread between islands by wind and the movement of ornamental plants.

Confirmed host species of *Puccinia psidii* in Hawaii.

Scientific Name	Common Name
*Eucalyptus dunnii**	Dunn's white gum
*Eucalyptus grandis**	Rose gum
*Eucalyptus microcrys**	Tallow-wood
*Eucalyptus smithii**	Gully gum
*Eucalyptus torelliana**	Cadaga
Eugenia koolauensis (H)	Nioi
Eugenia reinwardtiana (H)	Nioi/Beach cherry
Eugenia uniflora	Surinam cherry
Melaleuca quinqeunervia	Paper bark
Meterosideros polymorpha (H)	Ohia
Myriciaria cauliflora	Jaboticaba
Myrtus communis	True myrtle
Psidium guajava	Common guava
Rhodomyrtus tomentosa	Downy rosemyrtle
Syzygium cumini	Java plum
Syzygium jambos	Rose apple
*Syzygium malaccense**	Mountain apple
Syzygium paniculatum	Australian brush cherry

(H) Native to Hawaii
* Artificially inoculated in laboratory

The disease has been reported on twelve different species, three of which are native to Hawaii including one endangered species. An additional six species have been artificially inoculated using inoculum isolated from rose apple.

The disease infects young leaf tissue producing copious amounts of spores and causes stunting and shoot dieback on the plant. In some species it also infects reproductive material. The rust rarely kills its host however. Bright yellow-orange pustules develop on plant tissue until the tissue dies. Susceptibility of hosts varies widely among species. In Hawaii the non-native rose apple displays the most dramatic symptoms with observations of all new shoots within in a stand being killed by the disease. Infections on ohia have been reported mostly in nurseries where either environmental conditions or abundance of young, susceptible foliage appears to be conducive to outbreaks of the rust. Some ohia varieties do not develop symptoms when growing in infested nurseries. Detections of the disease in native forests have been at very low levels, and it does not appear to be strongly impacting ohia forests at this point.

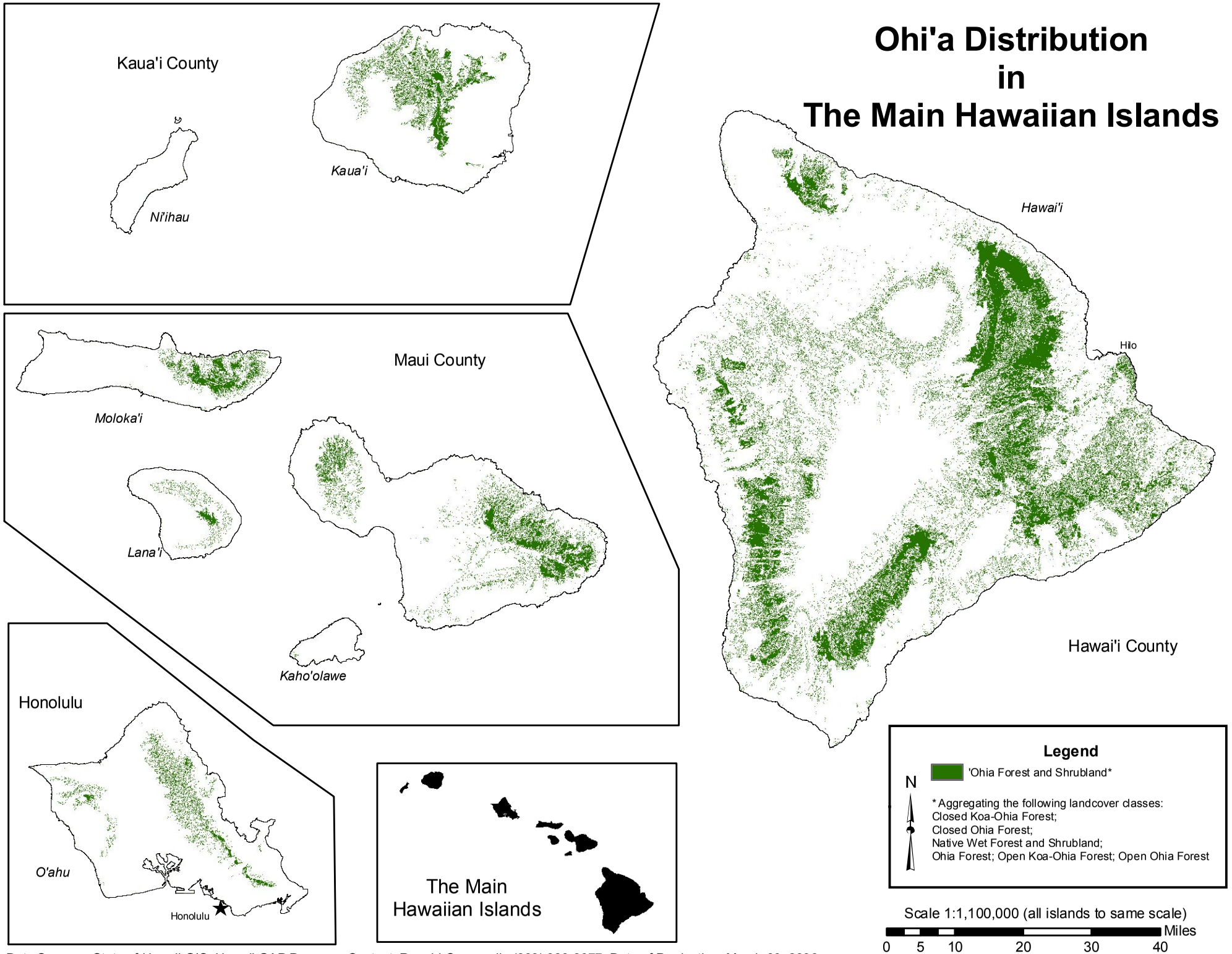
The disease is a serious threat to Hawaii's native forest. Ohia is the dominant tree species in much of Hawaii's remaining native forests and provides important habitat for endangered birds. Adaptation and increased virulence of the rust disease on ohia is considered a likely development. Commercial eucalyptus plantations could also be threatened, especially as plantations are harvested and replanted. Eucalyptus seedlings of commercial species such as *E. grandis* are very susceptible to damage from *P. psidii* in Brazil, although susceptibility in laboratories in Hawaii to local inoculum was found to be minimal on *E. grandis*.

A Special Detection Survey funded by Forest Health Monitoring is underway. The survey is being carried out by a University of Hawaii student and is attempting to document the host range to the disease as well as the environmental conditions that are required by the disease to infest its hosts. So far disease presence has been confirmed on all major islands and at elevations as high as 4000 feet.

Preliminary DNA analysis by University of Hawaii researchers suggests that the disease strain in Hawaii is different from strains in Florida and Brazil. Samples collected in the above survey will be analyzed to determine diversity of the disease present in Hawaii. Different strains have different host-ranges and can vary in virulence. Restrictions on imports into Hawaii of plant material of all species in the family Myrtaceae from infected regions are being pursued in order to prevent or slow disease adaptations that would increase its virulence.

Puccinia psidii on ohia. Photo by Desmond Ogata

Ohi'a Distribution in The Main Hawaiian Islands

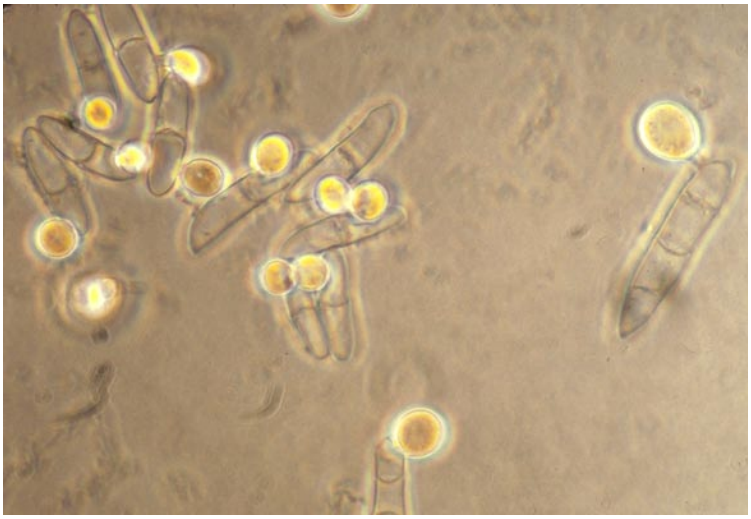


Data Sources; State of Hawaii GIS, Hawaii GAP Program. Contact: Ronald Cannarella (808) 383-3077. Date of Production: March 30, 2006

Koa Wilt
Fusarium oxysporum f.sp. koae

Koa wilt disease was first described in 1980 on the island of Hawaii and was attributed to the pathogen *Fusarium oxysporum* f.sp. koae. The pathogen infects trees through their roots and causes damage to the vascular system, sometimes leading to crown dieback and tree death. It is not known where the disease originated or how the disease spreads in the environment. Other areas of koa dieback were reported throughout the state thereafter, but little work had been carried out on the disease until the last few years despite the ecological, cultural, and economic importance of koa to the state of Hawaii.

Although wide scale dieback has not been observed in forests, there has been a high incidence of the disease causing high mortality rates in koa plantations, especially on former agricultural lands. A survey for koa wilt was conducted in 2004-2005 by the Hawaii Agriculture Research Center and DOFAW with funding from USDA Forest Service Forest Health Protection. The survey located areas with symptomatic trees and collected root, stem, leaf, and seed samples for isolating *F. oxysporum* in the laboratory. Diseased trees were sampled in both plantations and natural forests throughout the state.



Production of chlamydospores (resting spores) of *F. oxysporum* f. sp. koae by macroconidia
Photo by Donald E. Gardner, University of Hawai`i at Manoa.

Dead or dying trees testing positive for *F. oxysporum* were found on all of the major islands where koa commonly grows. Trees in both planted and natural forests were found infected with koa wilt disease. *F. oxysporum* was found most commonly on roots and soil near diseased trees. Interestingly other *Fusarium* species were also isolated from sampled tissue, and pathologists are exploring the role of these other species in the disease etiology. Methods of sampling for the disease were refined in this survey facilitating future survey and monitoring for the disease. Outreach materials on koa wilt were developed by the University of Hawaii and can be found at: http://www.ctahr.hawaii.edu/forestry/index.asp.

Many questions remain unanswered regarding koa wilt. The extent of the disease in natural forests is not known, nor is whether the pathogen exists in healthy forests. Knowing how the disease spreads in the environment is also crucial for management. What appears to be genetic resistance has been observed in koa plantations trials, and efforts to develop genetic resistance for plantations are being pursued. Koa families from each island are being screened for resistance by inoculating seedlings with pathogenic strains of *F. oxysporum*. Resistant families will be planted in seed orchards on respective islands to provide seed for plantings. A nursery survey is also being conducted to determine whether outplantings could be spreading the disease to forestlands.

Dying koa trees in upper elevation (5,000-6,000 ft.) forests of Hawai'i Volcanoes National Park.
Photo by Donald E. Gardner, University of Hawai`i at Manoa.

Erythrina Gall Wasp
Quadrastichus erythrinae
The Erythrina gall wasp (*Quadristichus erythrinae* Kim) continues to infest native and non-native *Erythrina* spp. It was first detected in April of 2005, as galls on leaves and stems on ornamental Indian coral trees (*Erythrina variegata*) at the University of Hawaii campus on Oahu. Emergent adult wasps were then positively identified as *Quadristichus erythrinae* Kim, a species only recently described (2004) from specimens from Singapore, Mauritius and Reunion. The current distribution of the Erythrina gall wasp also includes Taiwan, mainland China, India, American Samoa, Guam, and most recently 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). *Erythrina variegata* trees have been defoliated and are dieing throughout the state. Most urban trees are being removed. *Erythrina crista-galli*, also a common landscaping tree, is more resistant and trees continue to survive infestation.


Adult *Q. erythrinae*
Photo: Paul E. Skelley
FDACS-DPI-Florida State
Collection of Arthropods

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 the bruchid (*Specularis impressithorax*) competition from introduced grasses, and severe browsing pressure by introduced ungulates, in addition to the recent outbreak of Erythrina gall wasp. The impact of the gall wasp on natural wiliwili populations is variable, with some populations still healthy while others are moderately to highly infested. Wide scale mortality of wiliwili trees has not yet occurred.

Experimental trials using systemic insecticides such as imidicloprid have had mixed results. Soil drenches are difficult to apply effectively for uptake by the tree's root system and impractical in a forest setting. Several injection systems have been tested with some success but are costly, and infested trees must have leaves in their canopy for the chemical to be translocated. Foliar treatments have been effective but are expensive and less practical.

The Hawaii Department of Agriculture and the University of Hawaii have made exploratory trips to Africa for biological control agents. Three parasitoids of *Quadrastichus* spp. are currently being studied in quarantine facilities in Honolulu. The necessary host specificity and biological studies have been completed for one of the candidates, and it could be released as early as 2007 depending upon the regulatory process.

Ornamental trees are generally being treated with a soil drench of imidacloprid. Trials are underway on Hawaii, Oahu and Kauai to test the efficacy of various systemic insecticides, including imidacloprid and abamectin, for protection of Erythrina trees in dry forests. A bioassay and rating of insect damage levels and quantification of insecticide levels throughout wiliwili trees are included. Further treatment depends upon the results of the ongoing efficacy trials. Ongoing management activities by various agencies and organizations also include monitoring the spread and severity of the infestation, banking of wiliwili seeds in the event of widespread mortality, and exploration for biological control agents of the wasp.


Galls caused by *Q. erythrinae.*
Photo: Sheri Smith, Forest Health Protection


Experimental trials using systemic treatments to combat *Q. erythrinae.*
Photo: Sheri Smith, Forest Health Protection

Black Twig Borer
Xylosandrus compactus

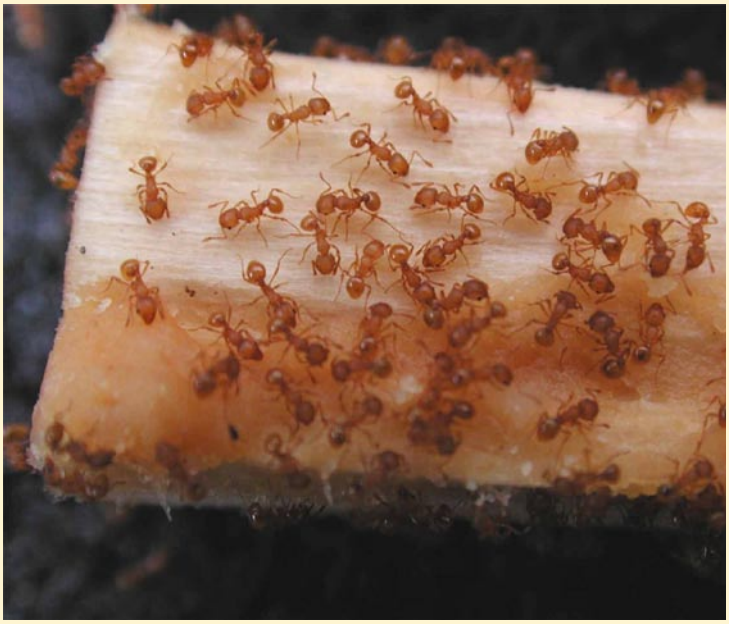
The black twig borer was first detected in Hawaii in 1931 and has an extremely wide host range. In Hawaii at least 108 tree and shrub species belonging to 44 plant families are attacked by the black twig borer. Several federally listed threatened and endangered species are impacted by black twig borer damage and its associated fungus *Fusarium solani* including *Flueggea neowawraea*, *Alectryon macroccoccus*, *Melicope saint-johnii*, *Gardenia mannii*, and *Caesalpinia kavaiensis*. The borer also commonly attacks koa, and koa seedlings can suffer high mortality rates in nurseries and outplantings due to the physical disruption of seedlings' vascular system caused by bore holes.

Black twig borer damage is usually worse during drought years but affects plants during wet years as well. The borer is ubiquitous in forested areas under 2500 feet elevation and host species are abundant in all forest types. Monitoring therefore is not a high priority, except for damage on rare and endangered species, which continues to be a problem.

Adult female black twig borer.
Photo by Lyle J. Buss, University of Florida

Little Fire Ant
Wasmannia auropunctata

- Small, slow moving red ant native to Central and South America, accidental introduction via infested plants.
- Spreads in infected nursery materials, particularly palms.
- Priority Target BIISC, KISC.



Feral Ungulates

Feral ungulates are extremely damaging to Hawaii's forest ecosystems. Pigs, cattle, deer, goats, and sheep all damage forests throughout the state by eating and trampling vegetation and causing erosion. They also contribute to the spread of invasive plants by dispersing seeds of aggressive weeds such as guava and by disturbing the forest floor and soil allowing some of the worst invasives such as clidemia to establish. Pigs are widespread on all major islands, but presence of the other animals varies from island to island. While public hunting suppresses animal populations in some areas, many of the more remote areas where native forests are located do not benefit from public hunting. Management activities focus on fencing to keep ungulates out of priority areas and reducing animal populations using public and staff hunters, traps, aerial shooting, and occasionally snares.

Monitoring ungulate populations in Hawaii is very difficult, and no accurate population estimates currently exist for any of the taxa mentioned above. Wildlife managers sometimes survey hunting areas to assess population levels before hunting seasons begin, and hunters are required to report kills at designated hunting stations. In 2006 about 4850 feral animals were killed by public and staff hunters on state lands including 1644 pigs and 1328 goats. Pig monitoring in conservation areas typically involves recording signs of animal presence along five meter wide transects. This type of monitoring occurs throughout the state primarily in native forests. These data can be used to direct hunting efforts or to strategically locate fences. Feral cattle in forest reserves on the island of Hawaii are monitored from helicopter. Cattle detected from the air are recorded with GPS and later hunted. Similarly pig damage and pigs are monitored during helicopter surveys in the Alakai Wilderness Area on Kauai.

Feral pig in Hawaii Volcanoes National Park. Photo by Jack Jeffrey

Veiled Chameleon

Chamaeleo calyptratus

- Large chameleon, up to 24 inches.
- Native to Yemen, illegal introduction for the pet trade.
- Spread intentionally by humans.
- Priority Target for MISC.

Coqui Frog

Eleutherodactylus coqui

- Native to Puerto Rico, accidental introduction via infested plants.
- Spreads in infected nursery materials.
- Priority Target for BIISC, KISC, MISC, OISC, although resources to control this pest have not kept pace with its spread.

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 Forest Service FHP Prevention and Suppression 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 Hawaii Natural Heritage Program, 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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