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# Forest Health

## highlights

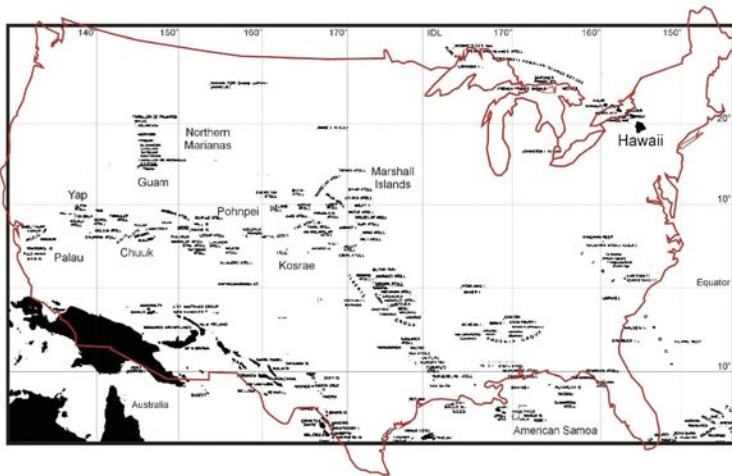
- PACIFIC ISLANDS
- APRIL 2008



## Forest Resource Summary

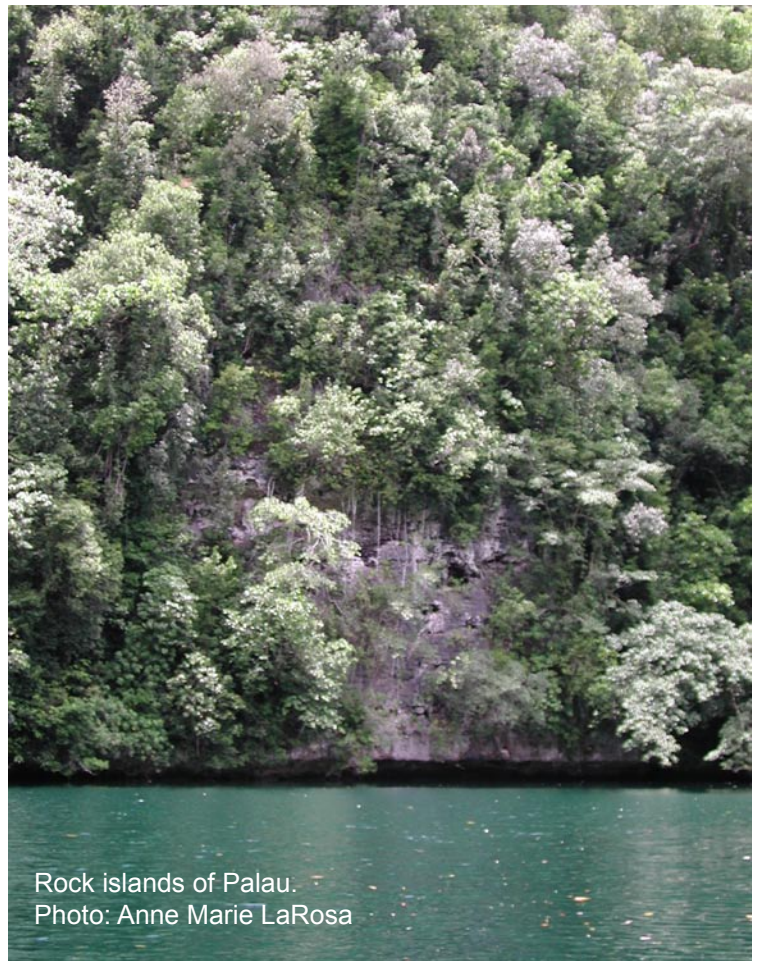
### Forest Resource Summary

The U.S.-affiliated Islands of the western Pacific cover an area larger than the continental United States, with a total land mass of only 2,500 km<sup>2</sup> (excluding Hawaii). The area includes the Territories of American Samoa and Guam, the states of Chuuk, Kosrae, Pohnpei, and Yap in the Federated States of Micronesia (FSM), the Republics of Palau and the Marshall Islands, and the Commonwealth of the Northern Mariana Islands (CNMI). Approximately 325,000 acres are forested.



Forest health issues vary widely among islands but due to the prevalence of travel and trade to Island states many pests are widespread throughout the Pacific. Large scale or widespread disturbances can result in undesirable changes in forest structure, composition and function, including altering of native forest dynamics, facilitating the spread of invasive species, soil erosion and siltation in streams and on coral reefs. This report highlights forest health issues in the US-affiliated Pacific Islands in 2007 and their effects on island cultures and livelihoods. It is not an exhaustive review of all forest health issues nor an in-depth analysis of any particular issue.

Forests in the Pacific are locally and globally important. Pacific Islands support a diversity of forest types including coastal strand, mangrove forest, lowland tropical rain forest, and, on the higher islands, montane rain forest and cloud forest. Species diversity is high and many species are endemic to the region or single islands and globally threatened. Forests in the Pacific are host to a variety of pests and pathogens and subject to natural and human-caused disturbances which adversely affect forest health. Agroforests are areas of mixed tree and traditional cropping systems managed to provide food, fiber and medicine, and are common throughout the Pacific. Each Pacific island developed its own complex agroforestry system(s) and these, in turn have been modified by modern ideas and techniques. Integral to island life, these systems fall prey to both forestry and agriculture pests.



Rock islands of Palau.  
Photo: Anne Marie LaRosa

Forest health conditions have been monitored throughout the US-affiliated Pacific on private, community and government-owned lands since 2002. Attention has focused on survey and control of invasive plants, although insect outbreaks are becoming more frequent and problematic and are also monitored. Ground and/or road based surveys are most common. Forest Inventory and Analysis (FIA) plots with forest health indicators have been established on all islands except the Marshall Islands, which is scheduled for 2008. Monitoring forest health is challenging, expensive and time consuming on remote Pacific islands. Rugged terrain, dense forest cover, poor quality roads, limited access to aircraft, and the sheer distances between widely dispersed islands present substantial logistic hurdles. Varied and complex land ownership patterns present additional challenges.

## Changes in Forest Cover Over Time

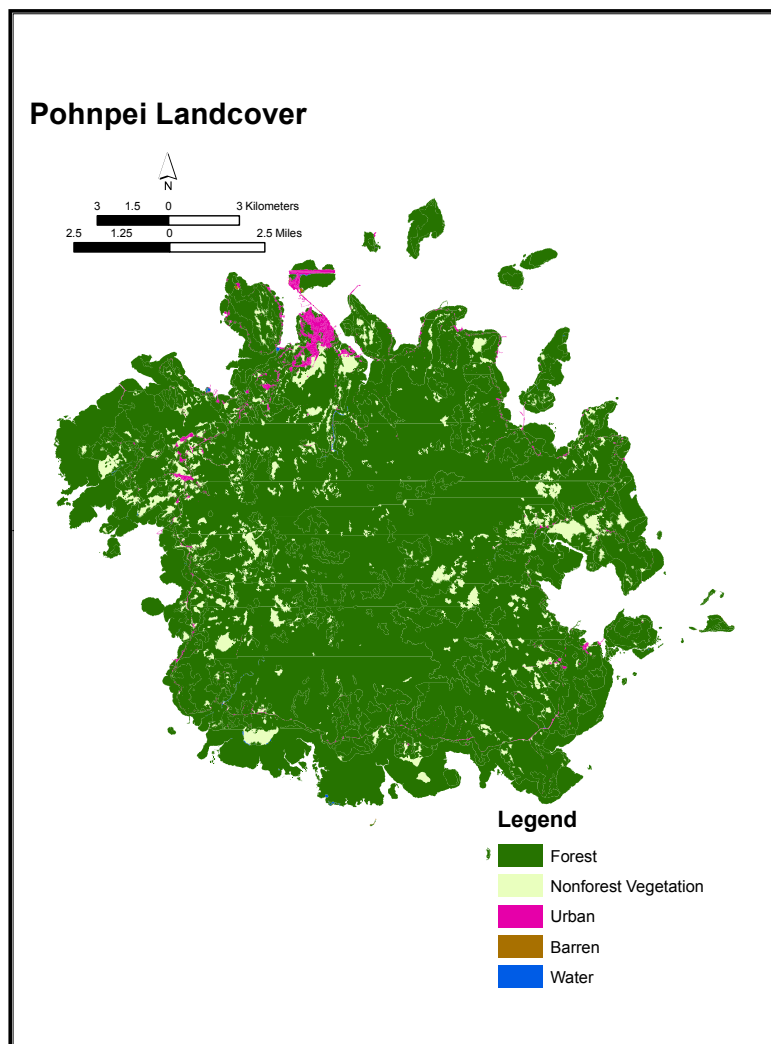
Forest Health Protection maps basic land cover types using high resolution remotely sensed data in cooperation with the Pacific Northwest Research Station, FIA. These land cover maps provide a baseline of forest cover and, over time, a means for detecting the magnitude of change in overall cover and forest type conversion. Currently, land cover maps have been completed for American Samoa, Guam, Palau, CNMI, and Yap and digitized vegetation data are available from the Forest Health Protection Web Site at: <https://www.fs.fed.us/r5/spf/fhp/fhm>

Trend data are not yet available from FIA plots or vegetation mapping efforts.

Most land on tropical Pacific high islands without distinct dry seasons was almost certainly forested prior to human settlement. Space is greatly limited on islands and humans have been clearing land for agriculture and other uses for several thousand years and it continues today. Changes in prehistoric and historic forest cover vary in amount from very little to a lot. For example, Guam, the largest island in Micronesia, with a population of about 175,000 and a land area of 541 km<sup>2</sup>, is highly developed and has lost more than 50% of its native forest to development and past land use. Forest conversion is likely to continue as the population of Guam is expected to increase substantially over the next 10 years. The scheduled transfer of over 17,000 U.S. marines, their dependents and the associated infrastructure development, is the largest buildup of forces and facilities on Guam since World War II.

Emerging nations like the Federated States of Micronesia have retained more forest. For Example, in Pohnpei State, with a population of 35, 000 and a land area of 332 km<sup>2</sup> (about 1/10 the size of our smallest state Rhode Island), an estimated 90 percent of the land remains in forest, although actual rates of forest loss are unknown due to a lack of adequate data for comparison. In American Samoa, population pressure and changing land use is resulting in the conversion of native forests to agroforests and from agroforests to residential use.

Natural disturbance also may significantly affect forest cover and composition on Pacific islands. Typhoons are a regular feature throughout most of the Pacific. No sizable typhoons struck the US-affiliated Pacific islands this year.



Residential areas encroaching on steep, forested hillside on Tuituila, American Samoa.  
Photo: Anne Marie LaRosa



## Invasive Species

Increasingly, invasive species are affecting the culture and livelihood of people living in the US affiliated islands of the Pacific. Most of the forest health concerns on the Pacific Islands are due to introduced species. In the age of globalization, with the movement of people and goods throughout the world, the Pacific Islands sit in a vulnerable position between the economies of Asia and North America. Guam sits at the center of this trade pathway and serves as a stepping off point for the remainder of Micronesia. Many pests are first detected on Guam and later elsewhere in Micronesia. Guam has suffered greatly from the accidental introduction of the brown tree snake in the late 1940's, via off-island cargo. This single introduction is credited with the permanent loss of nine of Guam's original 11 native bird species. The cost to Guam of lost productivity and direct damages is estimated at one to four million dollars annually. Guam and other Pacific islands spend over a million dollars annually to control the snake and prevent its movement between islands.

The potential for the spread of invasive species from Asia to Guam and then to the rest of Micronesia and Hawaii is significant with increasing global trade, and the sizeable increase in military and civilian cargo associated with military expansion on Guam. From Hawaii, spread of certain pests to the U.S. mainland and American Samoa is likely to occur in the future. The considerable influx of new species of plants, insects and pathogens that may be expected with this increased movement of people and goods will likely have a significant effect on the culture and livelihood of Pacific peoples. The magnitude will depend, in part, upon the availability of adequate prevention, quarantine and early detection programs in the region.

Invasive plants remain one of the most serious threats to forest health throughout the Pacific. The Pacific islands potentially have list more than 300 naturalized plant species that may be causing harm. Invasive weeds follow closely in openings created through natural and human forest disturbance. A much smaller number of plants are able to spread into and through intact forests. Pacific islanders have recognized the serious threat and the need for action by organizing into island, national and regional invasive species groups, several of which have strategic plans in place. Priority species are controlled through mechanical, chemical and biological methods. Weeds of widespread importance in the western Pacific that are currently under control actions include cogon grass (*Imperata cylindrica*), mile-a-minute vine (*Mikania micrantha*), Siam weed (*Chromolaena odorata*), Koster's curse (*Clidemia hirta*), giant sensitive plant (*Mimosa invisa*), root beer plant (*Piper auritum*) and Molucca albizia (*Falcataria moluccana*).

Early detection and eradication of weeds includes such species as African tulip (*Spathodea campanulata*) in Palau and Panama rubber tree (*Castilla elastica*) in American Samoa. For certain plants, biological control agents have been introduced and are spreading. These include the release of natural enemies to control ivy gourd, giant sensitive plant and Siam weed on Guam and Saipan.

## The Interaction Between Disturbance and Invasive Plants in Tropical Forests

Over 75% of Palau's 488km<sup>2</sup> (42,000 ha) is still forested, but development associated with a growing economy and population and the construction of a circum-island road on Babeldaob are encroaching onto forested lands. The new Compact Road has opened up secondary tropical forest land on the largest island, Babeldaob. Disturbance from construction associated with the Compact Road has facilitated the spread and encroachment of *Merremia peltata*, or kebeas, a native large-leaved vine, into adjacent forest and other introduced weeds. Using Forest Health Protection and Urban and Community Forestry funding, Palau is working with communities on Babeldaob, using regular volunteer cleanups along with limited government assistance, to control this plant along roadsides. *Merremia* is also a serious pest on American Samoa and several other Pacific Islands.

*Merremia* overtopping trees compact road Palau.



## African Tulip Tree (*Spathodea campanulata*)

- ▶ Native to West Africa, cultivated throughout tropics.
- ▶ Large tree to 80' in height.
- ▶ Invades agricultural areas and closed forest.
- ▶ Eradicated in Palau, except for two trees on private land. Targeted for eradication on American Samoa and for control on Yap and Chuuk.



*Spathodea campanulata*  
Photo: Warren L. Wagner



## Mile-a-minute Weed (*Mikania micrantha*)

- ▶ Native to South and Central America; invasive throughout the Western Pacific.
- ▶ Smothering vine spreads easily by seed or vegetatively.
- ▶ Used as cattle feed and cover crop in some areas.
- ▶ Palau is continuing to tackle this difficult to control species and has started a national mapping effort to determine the extent. Yap has changed from an eradication to a control strategy.

## Strawberry Guava (*Psidium cattleianum*)

- ▶ Native from southern Mexico to northern South America.
- ▶ Detected in American Samoa in 2005. Covers less than 10 acres.
- ▶ Seeds are probably spread by birds and bats and suckers profusely.
- ▶ Has formed dense, monospecific stands over large areas in Hawaii.
- ▶ Targeted for eradication in American Samoa. Known populations have been treated but re-sprouting is occurring.



*Psidium cattleianum*  
Photo: Anne Marie Larosa

## Early Detection in Palau

### *Praxelis clematidea*

- ▶ Member of the aster family and native to South America.
- ▶ In Australia, where it has been introduced, it can invade the understory of relatively undisturbed woodlands.
- ▶ Found during regular early detection survey along the Compact Road.
- ▶ Rapid response eradicated all known individuals, monitoring continues.



*Praxelis clematidea*  
Photo: Jeffrey Kintscher  
<http://www.kintscher.cc>

### *Schefflera actinophylla*, Octopus tree

- ▶ Native to Australia, New Guinea and Java.
- ▶ Fast-growing evergreen tree capable of invading intact forests.
- ▶ Widely grown as an ornamental and as a common houseplant in cooler climates.
- ▶ The seeds are dispersed by birds, seeds may also germinate epiphytically, where the plant can grow rather like a strangling fig.
- ▶ Found during regular early detection survey along the Compact Road.
- ▶ Rapid response eradicated all known individuals, monitoring continues.



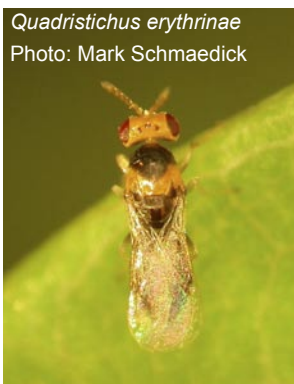
*Schefflera actinophylla*  
Photo: Forrest and Kim Starr, USGS

### *Indigofera hirsuta*, Hairy indigo

- ▶ Member of the pea family.
- ▶ Native range includes Africa and Madagascar to southern Asia, and eastward to northern Australia.
- ▶ Introduced and cultivated in Fiji and Niue, considered invasive on other Pacific islands.
- ▶ Found during regular early detection survey along the Compact Road.
- ▶ Rapid response eradicated all known individuals, monitoring continues.

## Erythrina Gall Wasp –Threats to native forests, birds and fruit bats

The Erythrina gall wasp (EGW), *Quadristichus erythrinae*, is currently found in the Pacific in American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands where populations continue to affect *Erythrina* species (Coral trees). A major source of spread has likely been by accidental movement in major transportation systems between islands; wasps have been documented first near major ports and airports on several of the Hawaiian Islands. A recent survey of EGW in American Samoa revealed that the wasp has now spread to all major islands. Infested trees were observed near ports and transport of infested leaves by boat travel may be responsible, in part, for the spread of this pest between islands. In the Northern Mariana Island chain, the wasp has reached Guam, Saipan and Tinian but has not been found on Rota, which is located between Guam and Tinian. Air and boat travel is relatively infrequent between Rota and the other islands which may explain the current distribution pattern.



*Quadristichus erythrinae*  
Photo: Mark Schmaedick



Mariana Fruit Bat  
Photo: Ann Bell, FWS

Most injury on Pacific islands (outside of Hawaii) has been to non-native Coral trees. On some Micronesian islands, Coral trees are roost sites and the flowers and leaves a significant food resource for increasingly rare native fruit bats, *Pteropus* spp. Fruit bats are a traditional Micronesian delicacy and are threatened by poaching and habitat loss. Several species are listed as endangered. In American Samoa, the flowers and leaves of Coral trees are used by many native birds and the Samoan and Tongan fruit bats. Severe injury and some mortality is occurring to the introduced cultivars, including *E. variegata* var. *variegata*, an attractive variety with variegated leaves and the Tropic Coral variety used for living fences and windbreaks. The native *E. variegata*, var. *orientalis* is also heavily infested with only minor damage to the introduced agroforestry species, *E. subumbrans*. Curiously, no infestations have been found on the native *E. fusca*, a wetland species of limited distribution. On Guam, injury by EGW has been moderate, but ornamental Coral trees are also host to the larval stage of the fruit piercing moth (*Endocima fullonia*), a highly destructive agricultural pest.

so additional impacts may be observed. Eradication of Coral trees has been suggested as a means of controlling the moth and would also control EGW populations on Guam.

## Asian Cycad Scale and Cycad Blue Butterfly on Guam and Rota: Interactions on cycads, a keystone understory forest species

Asian cycad scale (*Aulocapsis yasumatsui*), a pest of both native and ornamental cycads, was first detected on the ornamental king sago (*Cycas revoluta*) in Tumon Bay, a popular tourist area located only one mile from Guam's International airport. In Guam, the cycad scale infests ornamental cycads in urban areas and native cycads (*Cycas micronesica*, or fadang), a dominant mid-to-upper-canopy forest component in the island's limestone forests and riparian ravine habitats. Fadang is also an important plant in Chamorro culture. The unprocessed seeds of fadang are considered poisonous, but the starchy pith can be made into flour, and historically was a part of the Chamorro diet and on occasion used as a famine food.



*Aulocapsis yasumatsui*  
Photo: Aubrey Moore, University of Guam, Extension

Since the initial discovery of the scale in 2004, the infestation has continued to spread throughout the island and now occurs throughout Guam. Native cycads are highly susceptible to *A. yasumatsui* and early cycad mortality was largely of seedling and juvenile cycads, followed by death of more mature plants. In 2004 a coccinellid beetle (*Rhizobius lophanthae*) was introduced and has established on cycads. Initial predation rates by scales were high, ranging from 80 – 100%, but initial cycad mortality was very rapid and high. At first, dispersal of released beetles was poor but they now appear to be dispersing from the original control sites. Where beetles are abundant relatively good control of the scale has subsequently been achieved on taller, mature cycads. Seedling mortality continues to be high as beetles apparently do not feed near the ground or do not infest small, immature plants..

The introduction of new pests to native ecosystems frequently has unknown and unintended consequences, and ecosystem level interactions are complex. Cycads are not only infested by scales, but also defoliated by the larvae of the cycad blue butterfly (*Chilades pandava*), which was accidentally introduced in July of 2005. Larvae feed on young cycad leaves, resulting in damaged leaves with greatly reduced leaf area and reducing the cycads' ability to recover from defoliation caused by the





*Chilades pandava*

Asian cycad scale. Larvae feed on young cycad leaves, resulting in greatly reduced leaf area and the feeding injury reduces the cycads' ability to recover from defoliation caused by the Asian cycad scale. Eggs of the cycad blue butterfly have been observed to be parasitized by a native

wasp (*Trichotoidia* sp.) but only one percent of the sampled population of larvae were infested by the parasite.

These two serious pests are joined by a number of other pests of cycads, both native and introduced. Secondary insect pests, including a native cerambycid stem borer (*Dihammis marianarum*) and a bark beetle, are heavily impacting stressed cycads, and herbivory by introduced ungulates is also occurring. Feral pigs, which normally feed on the starchy stems of fallen cycads are now pushing over cycads to get at the beetles within the stems. The combined effects of these pests are taking a heavy toll on Guam's cycads. In the last four years, monitoring of cycad population densities has shown a reduction of an average of 7400 plants per acre (3000/ha) in 2004 to a current density of only 500 per acre (200/ha) and many of the remaining live trees are in poor health.

In March of 2007, the scale was detected on *Cycas micronesica* on the island of Rota in the Commonwealth of the Northern Mariana Islands. The scale was likely present for several months before detection but it is still limited to an area of about one acre. The survey was followed by the rapid release of the *R. lophanthæ* beetles by Dr. Alejandro Badilles, Northern Marianas College in May of 2007. Fortunately, these biocontrol agents were being reared on Guam for release there and could be on Rota. A subsequent survey on July of 2007 by Dr. Jack Tenorio revealed that although limited cycad mortality was occurring, the beetle had established and was providing some control of the scale. Scales are apparently confined to within about 100 feet radius from the heaviest focal point of the infestation. Monitoring continues. The cycad blue butterfly is not currently found on Rota but does occur on neighboring Saipan. The scale remains a threat to other Pacific islands where the cycad is native or ornamental cycads are grown, including Saipan, Yap, and Palau.

The current strategy on Guam includes selection and maintenance of genetic stock on uninfested islands, maintenance of genetic stock in-situ in selected areas through periodic chemical control of the scale, and continued release of biological control agents. Additional biological agents are needed, particularly to control scales on cycad seedlings. If the cycad is to continue be a major understory component of Guam's forests and an important part of Chamorro culture, a better understanding is needed of the complex interactions of the suite of pests currently impacting cycads..

## Acacia whitefly

The acacia whitefly (*Trialeurodes acaciae*) was first detected on Guam on June 16, 2007 on tangan-tangan (*Leucaena leucocephala*) at Two Lover's Point, near Tumon Bay by a University of Guam Extension entomologist. A delimiting survey conducted several days later confirmed that this pest was widespread on Guam, with most stands of tangan-tangan infested. It was also found attacking *Gliricidia sepium*, *Erythrina* sp., and the endangered endemic tree *Serianthes nelsonii*. Infestations can be easily spotted as large adult swarms around host trees.



Acacia whitefly guam adult with eggs.  
Photo: A. Moore, UOG Extension

Native to California and Mexico, this whitefly has a wide host range, although legumes are the major host plants. Injury results from leaf feeding. Although the effects of widespread infestations on Guam are unknown, defoliation could result in degradation to Guam's already impaired watersheds and seriously hamper recovery efforts for *Serianthes nelsonii*. Although currently limited to Guam, this pest is a threat to other Pacific Islands where there are many native and introduced legumes, particularly tangan-tangan, which was widely planted and now dominates many watersheds throughout the Pacific.

## Coconut Rhinoceros Beetle

The coconut rhinoceros beetle (CRB) (*Oryctes rhinoceros* L.) was detected at Tumon Bay on September, 12, 2007. An initial delimiting survey showed that the beetle was present in Tumon Bay (960 ac) and Faifai (15 ac), indicating that it probably arrived on Guam one to two years previously. The beetle may have arrived on Guam as a stowaway in cargo – the resort community of Tumon Bay is only one mile from the International Airport and Dr. Jack Tenorio caught an adult beetle in a seaport warehouse on Saipan, an island 200 miles north of Guam, in September, 2006. The beetle is native to much of southeast Asia, including the Philippines, and has been introduced to Palau, American Samoa and Fiji. Past outbreaks of CRB elsewhere in the Pacific have caused widespread damage: nearly 50% of palms in Palau were killed soon after its introduction there in 1942.

The high number of palms in urban settings and significant stands of coconut and beetle nut palms found in Guam's forests



Coconut rhinoceros beetle feeding injury.  
Photo: Ben Quicocho



are currently threatened by CRB. Habitat for this large scarab beetle is plentiful; larvae live in litter and debris, of which there is an abundance due to the presence of high levels of dead and dying coconut palms left in the wake of recent storms. Adult beetles bore into the crowns of palms to feed on sap, injuring emerging leaves and resulting in a characteristic v-shaped deformation of the fronds. Injury to the growing tip of the palm can result in death. Moreover, potential vertebrate predators of beetles, including native birds, have been largely eliminated on Guam by the brown tree snake.



Coconut rhinoceros beetle larvae.  
Photo: Ben Quicocho

An interagency incident command team is in place on Guam and a cooperative eradication program between the USDA (APHIS and the USFS), the Guam Department of Agriculture and the University of Guam is underway. The quarantine area encompasses over 5000 acres and delimiting traps are being used to determine the boundaries of the infestation. No confirmed sightings of the coconut rhinoceros beetle have occurred outside known areas. The eradication strategy targets both larvae and adults in the 1360 acre eradication zone. Pheromone-baited attractive traps are used to mass capture adults and sanitation of potential breeding sites is used to eliminate infested and susceptible host material and larvae. The efficacy of the pheromone is being monitored concurrently. A similar strategy on Niutopotapu Island in the south Pacific met with success but other efforts have not. In many countries

two diseases are used to kill coconut rhinoceros beetles, one fungal (*Metarhizium anisopliae*) and one viral (*Oryctes* sp.), and these may prove to be an important component in the IPM strategy on Guam.

## Other Invertebrates

### The Cuban slug, *Veronicella cubensis*

There are many reasons for the decline of *Serianthes nelsonii*, a federally listed rare tree, endemic to the Mariana Islands. While habitat loss played a role in the demise of the species, efforts to restore this tree have been hampered by a number of other factors. Although the factors are poorly understood, both seedlings and mature trees are subject to herbivory from feral ungulates and a host of native and non-native arthropods. Mature trees are also injured by high winds associated with typhoons. The most recent addition to this suite of pests is the Cuban slug.

Cuban slugs are a recent introduction to Rota; populations have multiplied rapidly and are currently the highest known for this species anywhere in the world. From their initial introduction, likely as a hitchhiker on agricultural or horticultural commodities, the slugs have spread widely throughout the island from urban settings to native forests. In addition to being an agricultural pest, slugs are impacting forest trees and medicinal plants that are important to the Chamorro people

Effective quarantine and public education are needed to confine the population to Rota: currently slugs are not known to occur on Saipan or Tinian, in the Commonwealth of the Northern Mariana Islands. The slugs hitchhike on unwashed plants and produce that are transported to other islands. The Cuban slug is a carrier of *Angiostrongylus cantonensis*, a parasitic nematode that causes rat lungworm, a potentially lethal disease in humans. The slugs are also found on Guam, but the plant injury they cause is much less.



Cuban slugs.  
Photo: David Robinson

## Data Sources

The data sources used for this report include data gathered by island Invasive Species Committees,, the Territorial Foresters of the US–affiliated islands (funded in part by Forest Service’s Forest Health Programs), the US Forest Service’s ,Forest Inventory and Analysis Program, the US Fish and Wildlife Service, the National Park Service, Secretariat of the Pacific Community, American Samoa Community College, and the University of Guam. The USDA Forest Service’s Forest Health Aerial Survey Program is not currently active in the Islands.

## For more information visit:

USDA Forest Service, Institute of Pacific Islands Forestry - <http://www.fs.fed.us/psw/ipif/>

Hawaiian Ecosystems at Risk project (HEAR) - <http://www.hear.org/>

USDA Forest Service, Pacific Southwest Region - <http://www.fs.fed.us/r5/spf/fhp/>

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