PACIFIC ISLANDS
APRIL 2018

Forest Health *2017 highlights*

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2017 Summary

- **Cycad aulacaspis scale (CAS)** long-term monitoring plots on Guam had 25 cycad deaths per 2.5 acres and no new seedlings in 2017.
- **Coconut rhinoceros beetles (CRB)** were found on Rota for the first time in 2017. An eradication project is ongoing.
- **Little fire ant (LFA)** was found on Yap in 2017; Yap's governor issued a State of Emergency. An eradication project is ongoing.
- A **new stem borer (*Cryptophlebia* sp.)** was detected in the Guam Department of Agriculture, Forestry & Soil Resources tree nursery in May 2017. Monitoring is ongoing.
- Research continued in 2017 to discover the ways that ***Phellinus noxius*** spreads.
- American Samoa began using **Unmanned Aerial Systems (UAS)** to map invasive plants in 2017.

Forest Resources

The US-affiliated Islands of the western Pacific span an area larger than the continental United States, with a total land mass of 965 square miles. 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.

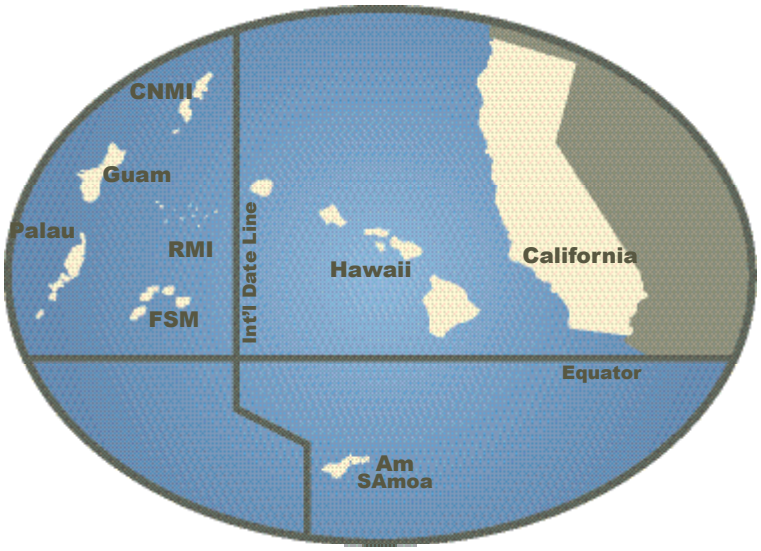

Figure 1. U.S. Affiliated Islands in relation to the United States

Forests in the Pacific are host to a variety of insects and pathogens and are subject to natural and human-caused disturbances which adversely affect forest health. Forest health issues vary widely among islands, and most pest issues result from introductions via multiple pathways due to the increase in travel and trade throughout the Pacific.

Invasive plants remain one of the greatest forest health issues on the islands, most of which have active invasive plant survey and control programs. Invasive insect introductions are becoming more frequent, increasing the need for early detection and novel integrated pest management tools.

Cycad Aulacaspis Scale (CAS)

Cycad aulacaspis scale (CAS), *Aulacaspis yasumatsui* invaded Guam in 2003. Since initial detection, the scale and plant health of the native cycad *Cycas micronesica* has been monitored by Dr. Thomas Marler, University of Guam (UOG), in part, with funds from the Cooperative Lands Forest Health Management Program (USDA Forest Service, R5). The endemic range for *Cycas micronesica* extends from some islands in the Republic of Palau through Yap State in the Federated States of Micronesia, Guam, and Rota in the Marianas. Forest inventories in 2002 revealed *C. micronesica* was the most abundant tree species in Guam's various habitats (Donnegan et al. 2004). They are an ancient group with a long history. There are few living survivors, and fossil records date back to over 250 million years old. As such, cycads have great intrinsic interest both to the scientific community and to the general public as a survivor from eras long past - and as a possible window on life in those times. Cycads are of cultural and religious significance to many different peoples around the world, have considerable economic importance in horticulture, contain unique and potent toxic compounds that have caused problems to people and livestock, and are of interest to the pharmaceutical industry. Cycads also fix atmospheric nitrogen, important in maintaining health and fertility of soils. In November 2015 *Cycas micronesica* was added to the Threatened list under the Endangered Species Act of 1973.

Consistent funding for the past several years have enabled this project to sustain the important long-term data collection in the monitoring plots on Guam, Rota, and Yap. Those cumulative data have become crucial to understanding mortality rates and predicting local

extirpations. Dr. Marler's monitoring of cycad populations also includes those on Tinian and Palau. His 2017 assessment of survival and health in the permanent plots on Guam indicated about 25 plants died per hectare, compared to 20 in 2016 and 10 in 2015. These same plots had ~3,500 plants per hectare in 2004 prior to invasion by CAS. In only 13 years, they have reached 94.5% mortality. Based on this decline trend, Dr. Marler predicts cycad extirpation from Guam habitats about 2031. Similar to recent years, there were no new seedlings within the plots in 2017.

Dr. Marler is also continuing to monitor the persistence of the cascading insect threats and ecosystem changes on Guam and Rota. Extreme damage to cycads from CAS, Chilades butterfly larvae, Erechthias leaf miner, and Dihammus stem borer was recorded on some of the cycads this year. The incidence of armored scale and injury by stem borers declined slightly, the incidence of injury by butterfly larvae increased slightly, and the incidence of injury by leaf miners increased dramatically (Figure 2).

Figure 2. Plant injury caused by Erechthias leaf miner was more severe in 2017 compared to previous years. Left photograph depicts typical historical injury levels with the youngest leaf cohorts avoided. Right photograph depicts the increase in plant injury observed in 2017. Source: Dr. Thomas Marler, University of Guam.

Coconut Rhinoceros Beetle

Coconut rhinoceros beetle (CRB), *Oryctes rhinoceros*, was first detected on Guam in 2007 and has defied containment and eradication efforts since initial detection. The infestation on Guam was the first new infestation on a Pacific island in over 40 years. The coconut rhinoceros beetle poses serious threats to the fragile environments of the scattered islands of Micronesia. There is high risk of transporting CRB to other islands in Micronesia (see below for information on new CRB infestation on Yap), and to the Pacific at large as Guam is a US military and civilian air and sea transportation hub for the Western Pacific Basin. Adult CRB kill palms when they bore into crowns to feed on sap. Since initial detection in 2007, CRB has spread throughout Guam, infesting about 50% of coconut palms and killing about 20% of those infested. The coconut tree is known as the tree of life. Many pacific islanders still depend on it for food, shelter and raw materials. Products traditionally provided by the coconut palm include roofing material (from leaves), ropes and strings (coir from husks), beverages (coconut juice, toddy from inflorescences), food (coconut, palm heart), fuel (from husks, nuts and dried leaves), wood (from the stem) and oil pressed out of copra, the dried kernel of the nut.

Figure 3. Surveying for and eradicating coconut rhinoceros beetles on Rota. Source: James Manglona, Department of Lands and Natural Resources, CNMI, Rota.

CRB-G is genetically distinct from other populations of CRB in the Pacific, is resistant to all currently available isolates of OrNV (biocontrol agent), is highly invasive, and has a very low response to pheromone traps baited with oryctalure aggregation pheromone. CRB-G is involved in all new CRB outbreaks in the Pacific (Guam, Oahu, Palau, Solomon Islands, and Papua New Guinea) and most recently, in 2017, Rota. Dr. Aubrey Moore, University of Guam, is continuing his efforts to find an effective biocontrol for CRB-G.

The US Forest Service is supporting CRB detection efforts on Saipan, Tinian and Rota in cooperation with Dr. Ross Miller, University of Guam. No CRB were found in any of his traps on these islands in 2017. However, CRB were reported in a large stand of coconuts in October 2017 about 200m south of Rota's West Dock where DeFence traps had been established. USDA-APHIS and CNMI-DNLR immediately destroyed infested trees after finding numerous larvae and some pre-emergent adults in standing trees. Additional infested trees were later found about 0.5 km east of the infested coconut stand and were destroyed. As of early December 2017, 41 beetles and approximately 500 grubs had been collected. Subsequent visual surveys have revealed no additional infestation; periodic surveillance is ongoing. This incident served as a wake-up call to government officials tasked with protecting the islands from invasion by noxious invasive species, and calls into question the efficacy and attractiveness of the DeFence traps established in the proximity of the seaport relative to naturally occurring coconut trees.

Figure 4. Google earth photos of little fire ant infested sites on Yap. Photo on left depicts the Delibenaw/Angel site (0.1 acres) and the photo of the right depicts the Gagil/Wanyan infested site (2.3 acres). Source: Francis Ruegorong, Yap Department of Agriculture and Forestry

The little fire ant (LFA)

The **little fire ant (LFA)**, *Wasmannia auropunctata,* was detected on Guam in late 2011 by staff of the Guam Coconut Rhinoceros Beetle Eradication Project as they were being bitten by the ants while unloading plant material at the dump. Management of and surveying for LFA on Guam are being supported by the US Forest Service. LFA is considered among the top 100 most serious invasive insect pests in the world. Previous LFA infestations in the Pacific Basin include those on the five major islands of Hawai'i, New Caledonia, and Northern Queensland, Australia, and most recently Yap (see below) in the Federated States of Micronesia (FSM). These LFA-infested regions all have air and sea connections to Micronesia, many of which pass through Guam. The devastating effects of LFA on agriculture and forest ecosystems observed in LFA-infested areas in Hawai'i, Australia, and New Caledonia are being repeated on Guam and have the potential to occur on any other Micronesian island infested by LFA. LFA's spread to and throughout Guam is most likely due to human transport of infested plant material.

Insecticide treatments were completed at 7 LFA-infested sites on Guam during 2017. Sites were treated with a water-resistant granular formulation of Siesta®, followed a week later by Tango® applied to the upper boles of trees within a gel matrix. A week following the granular applications, another detailed delimiting survey was performed. This sequence was repeated every six weeks at each site for at least eight treatment cycles.

On August 28, 2017, the state of Yap's main island, Yap Island Proper, became the latest Pacific island with confirmed infestations of the invasive little fire ants (LFA). Less than a month later, on September 15, 2017, Yap's governor issued a State of Emergency, outreach information was developed (Figures 5 and 6), and communities were notified to be on the look- out for LFA in their communities. In response, the US Forest Service provided emergency funds to combat the infestations, and Casper Vanderwoude, Research Director of the Hawai`i Ant Lab visited the island in November, bringing with him equipment, pesticides, and experience from combating LFA in Hawai`i.

Francis Ruegorong, a coordinator with the Yap Department of Agriculture and Forestry, shared via email his reaction regarding the presence of LFA: "We are very worried and sad

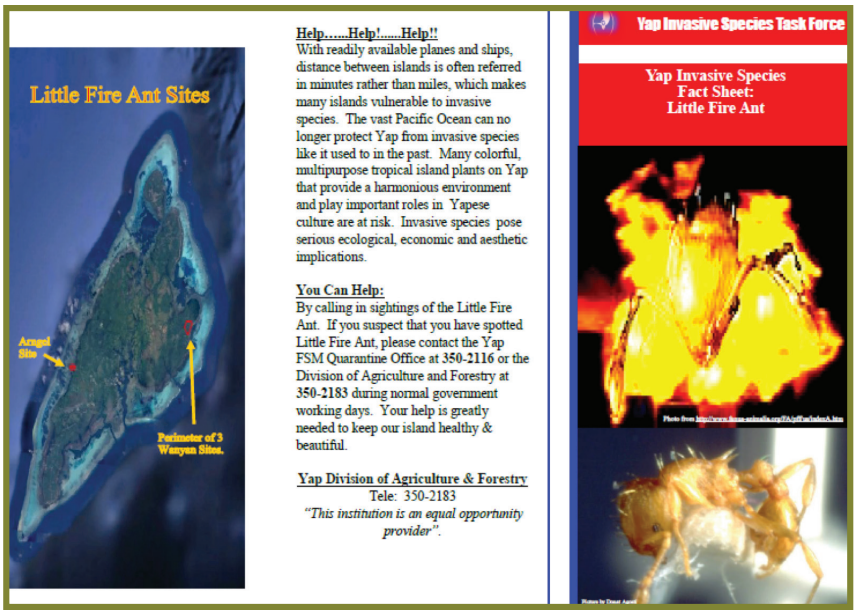

Figure 5. Side one of tri-fold developed for education and outreach to communities on Yap regarding infestations of little fire ant. Source: Francis Ruegorong, Yap Department of Agriculture and Forestry

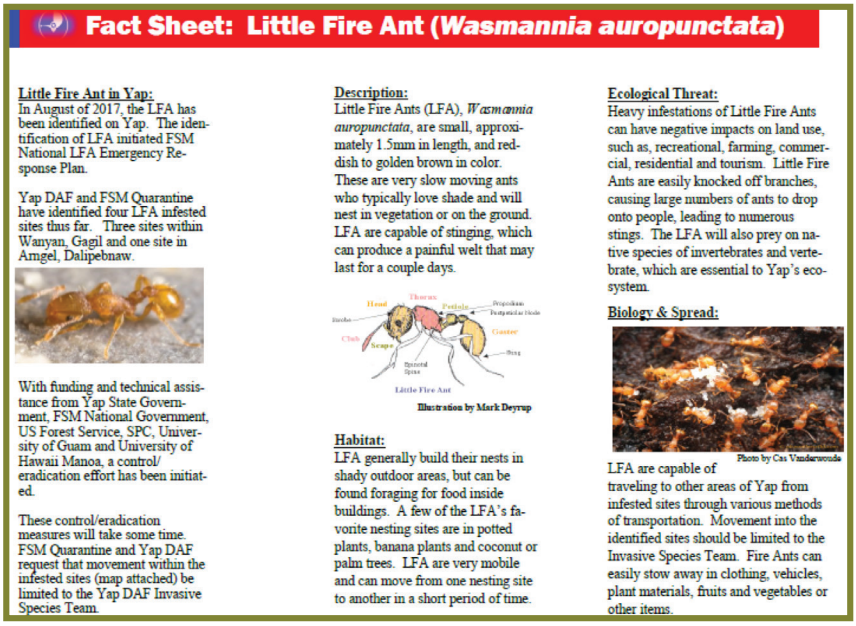

Figure 6. Side two of tri-fold developed for education and outreach to communities on Yap regarding infestations of little fire ant. Source: Francis Ruegorong, Yap Department of Agriculture and Forestry

because this tiny ant has the potential to impact the island way of life and many people are concerned." What makes eradicating LFA difficult is their sheer numbers and persistence. A heavily infested area may have up to 80 million LFA per acre.

The human-health risk has substantially affected agroforestry on other islands. On the Galapagos islands, workers are unable to harvest coffee beans, and this could become a reality on Yap as well. Trees above houses, and the normal husbandry, management, and harvesting that goes on in maintaining food gardens becomes a real problem. Controlling the infestations on Yap is critical. With Yap's professional and trained invasive species community, eradication of LFA should be successful; however, this serves as yet another example of the importance of preventing movement of invasive species, implementing detection efforts followed up with rapid response, and having communities trained in the recognition of pests and plant injury. (Some excerpts from Andrea Watts via The Forestry Source, Feb. 2018, Copyright 2018, The Society of American Foresters).

Ambrosia beetles and tree health in American Samoa

Little is known about the current status of American Samoa's ambrosia beetle fauna. The most recent surveys were done many decades ago and did not use more recently developed efficient trapping methods and lures. A 2014 survey on Guam detected five species that had never been recorded there before. Solid knowledge of the local pest fauna is essential for land managers charged with protecting trees and forests and for biosecurity agencies in conducting import risk assessments and exotic pest detection surveillance. To alleviate this critical knowledge gap, the American Samoa Community College Division of Agriculture, Community, and Natural Resources Forestry Program, supported by the US Forest Service, is conducting a territory-wide ambrosia beetle survey. Lindgren multifunnel traps baited with ethanol or quercivorol lures were placed throughout the islands in unmanaged native agroforests, urban forests, and in areas such as ports and warehouses at high risk for accidental introductions of exotic species. After preliminary sorting, the beetles were shipped to US Forest Service entomology offices, where species identification is ongoing. The resulting species lists for each island will provide a foundation for understanding the impacts of these beetles on the local trees, improving forest health through targeted management and improved biosecurity risk assessment, and providing a baseline for future exotic ambrosia beetle early detection surveys.

New Pest Detections

A stem borer (Figure 7) (*Cryptophlebia* sp. of moth in the family Tortricidae) was detected in the Guam Department of Agriculture, Forestry & Soil Resources tree nursery in May 2017. The stem borer had killed a number of ifit trees (*Intsia bijuga*) in the nursery (Figure 8). Sample specimens (larval stage) were sent to California Department of Food and Agriculture for identification. The insect was not detected on any other seedlings in the greenhouse. Ifit is the official territorial tree of Guam and is culturally important throughout the Mariana Islands. Ifit, also called ifil or ifel, belongs to the legume or pea family (*Fabaceae*) and subfamily *Caesalpinoideae*. Ifit is indigenous from Madagascar to western Polynesia and is native in tropical countries such as Australia, Cambodia, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Fiji, Guam, Indonesia, Madagascar, Malaysia, Myanmar, Papua New Guinea, Republic of Palau, Samoa, Solomon Islands, Thailand, and Vietnam. The wood from the ifit tree is often referred to as merbau. Naval assistant Governor of Guam and botanist William E. Safford described ifit in 1905 as being the most important tree species of Guam. The hard durable wood was used as posts and pillars in houses and churches. Ifit was also popular in constructing tables and chairs, as well as constructing wooden floors (http://www.guampedia.com/guam-trees-ifit/).

Figure 7. Larva of a Cryptophlebia sp. detected in the Guam Department of Agriculture, Forestry & Soil Resources tree nursery in May 2017 killing ifit trees (Intsia bijuga) in the nursery. Source: Dr. Aubrey Moore, University of Guam (https://www.inaturalist.org/observations/5647098)

Figure 8. Stem injury caused by a stem borer resulting in mortality to an ifit seedling. Source: Guam Department of Agriculture, Forestry & Soil Resources Division

Forest Pathology in the US Affiliated Islands of the Pacific

The forest pathogen that received the most attention in 2017 was *Phellinus noxius*. This is a very aggressive basidiomycete fungus that can attack and kill over 400 tropical tree species. The affinity of this fungus for breadfruit is especially alarming since this tree is commonly planted on many tropical islands in the Pacific and is a staple in the diet of most islanders. Once this fungus starts growing up the outside of a tree, that tree usually dies within a few months. This fungus also has a set of five specific enzymes which, collectively, allow it to digest 100% of the woody components of a tree. As such, infected trees usually lose strength quickly and fall over within a few months following tree death. Subsequently, this fungus also has a way of creating a protective rind for itself which can keep it alive on the forest floor for up to 40 years or until a tree root of another tree happens to grow into its vicinity, in which case that other tree generally becomes infected.

The US Forest Service and partners have found this fungus on almost all (but not quite all) of the major islands in FSM, CNMI, Guam and American Samoa. It is also common in relatively nearby places such as Taiwan, Hong Kong, Australia, Indonesia, and Japan.

Over the past 3 years the US Forest Service and partners have been trying to figure out all of the ways this fungus spreads. Some of this work has been done by consulting with islanders who have seen fungus spreading into new areas on their islands over the course of their lifetimes. Some information about the spread of this fungus has also been obtained by collecting fungal samples from infected trees and then using molecular genetic techniques to determine the relatedness of the different samples. One alarming discovery has been that the fungus has inadvertently been spread to many new locations when breadfruit root suckers have been taken from an infected tree in an infected area and then planted in a new location. That transplanted sucker will soon die but so, too, will any other trees at the new location that have their roots come in contact with the fungus. By this means, and very quickly, a new infection center can quickly become established. In some situations it has been determined that the fungus is extending radially throughout the root matrix at a rate of up to 5 meters per year.

The US Forest Service and partners have also been trying to find ways of controlling this fungus. There may be some very effective methods for controlling this fungus, although these control methods all involve a fair amount of physical work. This method was explained this past year to five to ten foresters and other resource officers on Guam, Rota, Yap, Pohnpei, and Kosrae, who worked to rout the fungus from at least one infection center (typically 1/20th to one quarter acre in extent) on each of their respective islands. On some islands in the Pacific, where there are just a few infection foci, it may be possible to clear the whole island of *Phellinus noxius*, while on other islands, where there are many infection foci already, it may not be feasible to get all of these foci but at least the fungus can be cleared from some of the infection foci and then these lands, once again, can be a safe place for growing breadfruit and other tree species.

Other pathology problems worked on this past year in the Pacific Islands include working to solve the low pH-aluminum toxicity problem that impacts sizeable tracts of land on Yap, Palau and Guam; looking for biological controls for the Merremia vine; trying to find cultural means for minimizing the impact of the *Colletotrichum* spp. fungus on piper betel leaves; and determining the causes of the death of the majority of the giant *Serriathes nelsonii* trees on Rota.

Figure 9. James Manglona shows a Phellinus noxius-infected breadfruit tree on his farm. The "black sock" is easy to see. This white part of the root at the lower right in this picture shows where a chisel was used to remove a sample of this fungus. The fungus was later isolated onto selective agar on a petri plate and then sent to the Ned Klopfenstein Lab for molecular analysis. Source: Phil Cannon, USFS

Figure 10. Eric Wakuk bucks up a large breadfruit tree that had become completely colonized by Phellinus noxius. Source: Phil Cannon, USFS

Unmanned Aerial Systems (UAS) for Invasive Plant Mapping in American Samoa

The American Samoa Cooperative Forest Health Protection & Invasive Plant Management (CFHP-IP) Program closely collaborated with the American Samoa Community College Department of Agriculture, Community, and Natural Resources GIS Specialist to use the new UAS (Unmanned Aerial System) to map areas infested with invasive plant species. This is a first for American Samoa – the first local environmental agency to utilize this tool to post-process imagery captured from UAS-based sensors into a geo-referenced map. This UAS technology will help the CFHP-IP staff and other Forestry staff to easily identify invasive species (eg. red bead (lopa) *Adenanthera pavonina*, albizia (tamaligi) *Falcataria moluccana*, and rubber tree (pulu mamoe) *Castilla elastica*) threatening American Samoa's forests, especially on steep mountain slopes. The program was able to map 34 acres of infested area at Maloata.

Figure 11. The UAV being used in American Samoa.
Source: David Bakke, USFS

Figure 12. Neil Gurr, GIS Specialist for American Samoa Community College, handling the UAV control unit.
Source: David Bakke, USFS

Additional Information

Data Sources

The data sources used for this report include data gathered by US Forest Service, Pacific Southwest Region, Forest Health Protection staff, the Territorial Foresters of the US–affiliated islands (funded in part by Forest Service's Forest Health Programs), and staff at the Institute of Pacific Islands Forestry, US Forest Service, the University of Guam, and American Samoa Community College.

The USDA Forest Service's Forest Health Aerial Survey Program is not currently active in the Islands.

For more information visit:

USDA Forest Service, Pacific Southwest Region - www.fs.usda.gov/main/r5/forest-grasslandhealth

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