

# Forest Health

## 2020 highlights

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○ APRIL 2021

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### 2020 Summary

- Detection, monitoring, and management of **Coconut rhinoceros beetles (CRB)** (*Oryctes rhinoceros*) continues on Guam. Additional new infestations on Rota (CNMI) prompted a government declaration of Significant Emergency. CRB monitoring is occurring on Yap (FSM), but it has not been detected.
- Work to eradicate **little fire ant (LFA)** (*Wasmannia auropunctata*) is occurring on American Samoa, Yap (FSM), and Guam.
- **Phellinus noxius** is present on all of the US-affiliated Pacific Island groups. A management document will be released soon.
- Workshops covering survey and detection of coconut rhinoceros beetle and little fire ant occurred on Guam and Saipan and were provided remotely to forest health personnel on Yap, Pohnpei, Palau, and Majuro.
- Monitoring, management, and eradication of **invasive species** specific to each island continue on Yap and Kosrae (FSM); Saipan, Tinian, and Rota (CNMI); and Tutuila (American Samoa).

### 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 Republic of Palau, the Republic of the Marshall Islands (RMI), and the Commonwealth of the Northern Mariana Islands (CNMI). Approximately 325,000 acres are forested.

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.

### Coconut rhinoceros beetle (CRB)

#### Guam

The coconut tree is the tree of life to the people of Guam and other neighboring Pacific islands. Islanders derive food, shelter, tools, and medicine from every part of the tree. In addition to its role as an island cultural icon, the coconut tree is economically important, providing aesthetic value in the tourism industry and material for local craftsmen. Full-grown fruit-bearing coconut trees can cost several thousands of dollars each to replace and take several years to grow. Protecting such a valuable commodity and cultural symbol is a high priority for all Pacific islands.

Collaborative efforts to manage **coconut rhinoceros beetle** on Guam continued in 2020. The Department of Interior-Office of Insular Affairs provided funding to support management of CRB at Guam's ports of entry. To date, 203 dead palm trees and approximately 170 cubic yards of green waste have been removed from

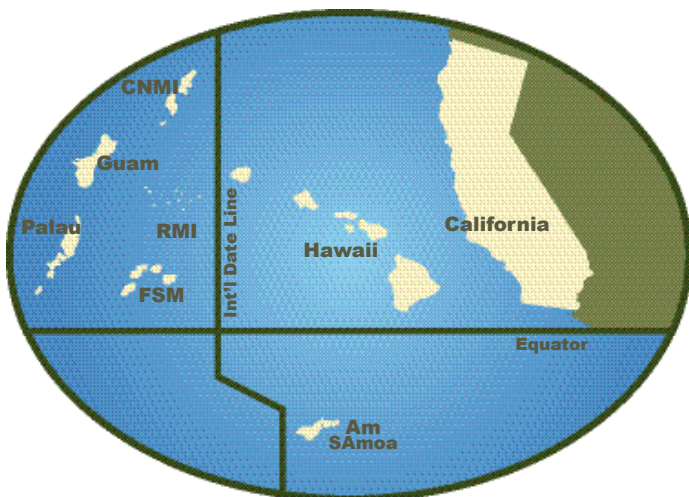


Figure 1. U.S. Forest Service, Region 5

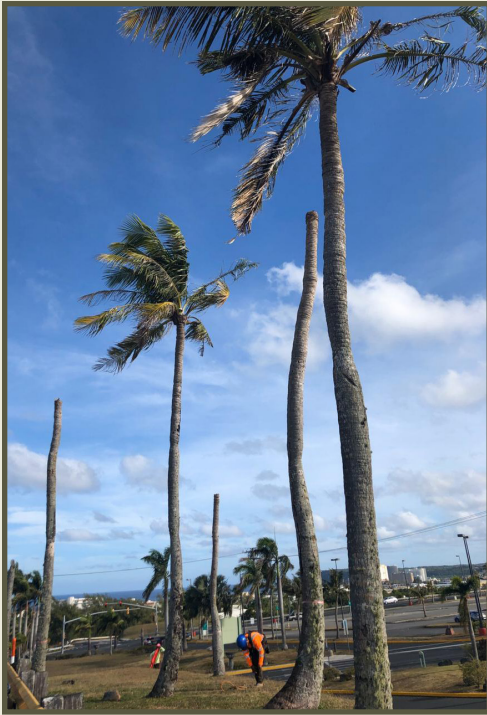


Figure 2. Field crews preparing to remove dead standing trees at Guam International Airport. Photo credit: Glenn Dulla, Guam Department of Agriculture, Biosecurity Division

the airport and seaports (Figure 2). The dead standing palms had remained unmanaged for several years and were ideal CRB breeding sites (Figures 3 and 4). This control work is critical to limit the CRB population on Guam and decrease the likelihood of CRB transport to other Micronesian islands, which would negatively affect food security and the health of palms.

Guam Department of Agriculture (DOAG), Biosecurity Division maintains a network of CRB panel traps around the ports of entry to monitor CRB populations and aid interdiction. It is expected that trap catches will decrease as breeding sites are removed or managed. Guam-DOAG also completed a preliminary palm tree health survey around the ports of entry which documented CRB damage on >2,000 palm trees. Panel trap and tree health survey data serve as a baseline to measure effectiveness of management practices.

DOAG, Biosecurity Division is also culturing the entomopathogen *Metarhizium majus* as an additional tool for management (Figures 5 and 6). *M. majus* infects all life stages of CRB and was documented to have limited effectiveness when released on Guam in 2014 as a free-moving classical biocontrol, but studies have shown *M. majus* can have a near 100% kill rate on larvae in ideal conditions such as high spore densities and limited UV exposure. DOAG hopes to use it as an additional management tool to address CRBs in tree crowns of live trees or remaining root balls of removed trees.

To improve detection of CRB, the University of Guam, under the direction Dr. Aubrey Moore, developed image recognition and analysis technology to quickly identify CRB-caused damage in coconut trees. Paired with roadside driving video surveys, image recognition and analysis technology can serve as an early detection tool and result in a data set to track tree health



Figures 3 and 4. Examples of breeding sites containing CRB larvae in dead trees removed at Guam International Airport. CRB larvae can be seen in Figure 4. Photo Credit: Glenn Dulla, Guam Department of Agriculture, Biosecurity Division



Figures 5 and 6. Conidia of the entomopathogen *Metarhizium majus* forming on an infected CRB pupa. Photo Credit: Glenn Dulla, Guam Department of Agriculture, Biosecurity Division

over large areas (Figure 7). About 22% of palm trees had some level of CRB-caused damage based on the results of the roadside survey completed in December 2020.

## Rota, Commonwealth of the Northern Mariana Islands

CRB was found in 2020 in the Gagani and Talakhaya areas of Rota, four miles from the original CRB quarantine areas at Twerksberry Beach Park and Papau designated in 2018 (Figure 8). After confirming via drone-conducted surveys that decaying coconut trees and scissor cuts on the palm leaves existed, the CRB team immediately began dissecting trees, setting traps, and recording CRB findings in these new areas – 660+ larvae and more than 60 adult beetles were found. Department of Fire and Emergency Medical Services and Department of Community and Cultural Affairs assisted the Department of Lands and Natural Resources (DLNR) in the response.

The new infestations prompted the Mayor of Rota to declare a State of Significant Emergency due to CRB's negative impacts on Rota's agriculture and food security. Collaboration with local landowners remains critical to detect and eradicate CRB. With continued support from the public, federal partners, and local governments, the Municipality of Rota is optimistic they can contain the spread and prevent CRB from reaching Tinian and Saipan.

## Yap, Federated States of Micronesia

Forest managers on Yap surveyed for CRB across 600 acres and installed CRB tekken netting and bucket traps at entry points and commercial areas. To date, CRB has not been detected on the island. Education and outreach activities included distributing 130 CRB posters to the Yap State Government offices, Yap Elementary School, stores, communities, and to the outer islands.

## Little fire ant (LFA)

### Guam

The **little fire ant (LFA)**, *Wasmannia auropunctata*, was detected in November 2011 at a green waste repository in Yigo, a northern village of Guam. Subsequent LFA surveys throughout Guam found it to be established on over 35 widely dispersed sites. Previous LFA infestations in the Pacific Basin include those of the five major islands of Hawaii, New Caledonia, French Polynesia, and Northern Queensland, Australia. The devastating effects of LFA on agriculture and forest ecosystems observed in these other Pacific jurisdictions are being repeated on Guam and may potentially occur on other Micronesian islands. Human transport of plant related materials has facilitated LFA's spread into and throughout Guam, including a Government of Guam-maintained conservation forest.

The USDA Forest Service is providing funding to support the eradication of little fire ant in the 502-acre Cotal Conservation Area (CCA) to prevent the tremendous negative forest ecosystem impacts associated with infestations. The Forestry and Soil Resources Division

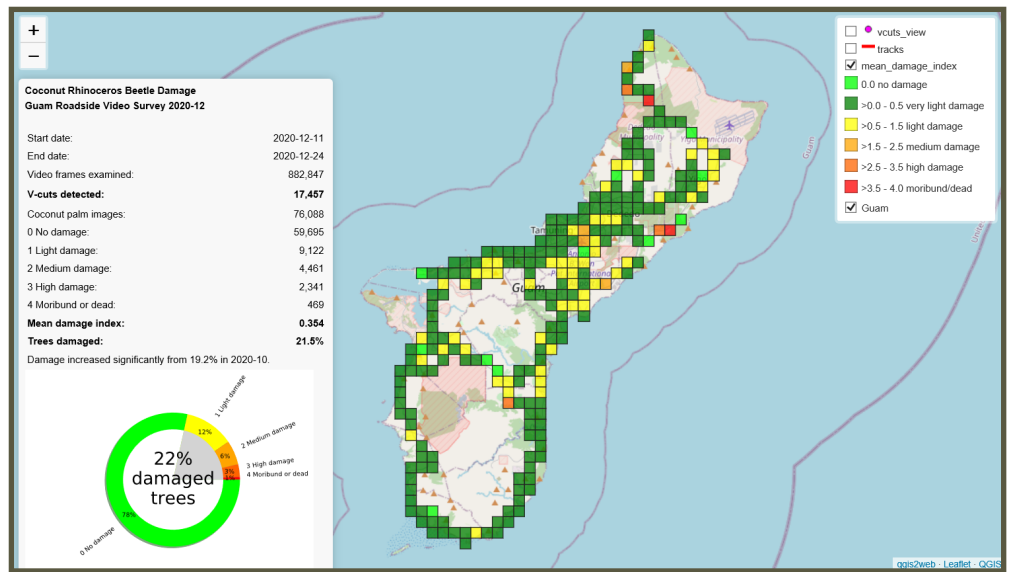


Figure 7. Screenshot of an interactive web map displaying results from a roadside video survey of CRB damage to palms on Guam (Dec. 2020) Source: <https://aubreymoore.github.io/Guam-CRB-damage-map-2020-12/webmap/v1>



Figure 8. 2018 CRB quarantine area (pink color) and locations of new infestations (orange color) detected in 2020 on Rota. Source: <https://governor.gov.mp/news/press-releases/third-coconut-rhinoceros-beetle-site-discovered-on-rota/>



Figure 9. Guam Department of Agriculture, Biosecurity Division field personnel pilot a drone to disperse pesticides, targeted at arboreal little fire ants, into the forest canopy. Technicians are (left to right) Ashley Toves, Tristan Lizama, and Jessi Hannah Mendiola. Photo Credit: Glenn Dulla, Guam Department of Agriculture, Biosecurity Division

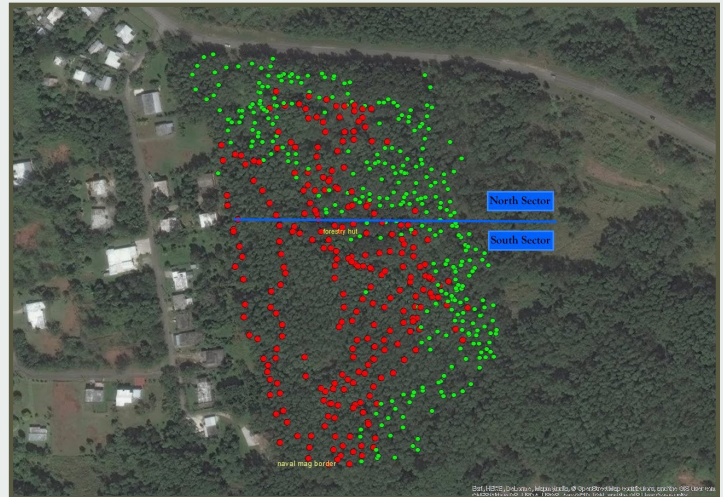


Figure 10. Delineation survey map depicting the presence of LFA (red dots) within the Cotal Conservation Area in June 2018. Negative points are shown in green. The blue line delineates the North Sector from the South Sector. Data was collected by the University of Guam. Map Credit: Glenn Dulla, Guam Department of Agriculture - Biosecurity

of Guam Department of Agriculture (DOAG) manages the (CCA) in Santa Rita, a southern village of Guam. The conservation area supports a nursery stand of acacia trees to achieve a long-term reforestation project aimed at returning nutrients to the soil, stopping erosion into the adjacent water reservoir, eventually replacing acacia trees with native flora such as the endangered *Serianthes nelsonii*, and ultimately reintroduce native fauna such as the Guam rail, an endangered flightless bird.

The LFA infestation occurred on approximately 70 acres in 2018 when it was first detected in the CCA, which borders residential homes and Department of Defense property. Eradication requires a combination of surveying and pesticide treatments at 6-week intervals with follow-up surveys for a total of eight times per year. Manual treatment at CCA focused on the 6.5-acre section bordering the residential homes, and drone pesticide dispersal was utilized on the southeastern 7.2-acre sector where terrain made treatment difficult (Figure 9). Utilizing a combination of manual and drone-assisted pesticide dispersal, LFA has been removed from all but approximately 2.1 acres concentrated on the west border of the forest (Figures 10 and 11).



Figure 11. Delineation survey map depicting the presence of LFA (red dots) within the Cotal Conservation Area in December 2020. Negative points are shown in green. Map Credit: Glenn Dulla, Guam Department of Agriculture - Biosecurity

The final segment of the project will be to eradicate LFA from the neighboring community. The DOAG, Biosecurity Division team is teaching residents how to treat LFA on their property. All but four households in the 40+ home community are participating in the LFA treatment program. All but one of the 13 households along the forest border are actively utilizing pesticides and allowing DOAG access to survey and monitor progress. Approximately 42% of the initial survey points in the 30-acre neighborhood were positive for LFA.

### Yap, Federated States of Micronesia

Since the detection of LFA on Yap in late August 2017, eradication efforts have been ongoing. In addition, public outreach and education efforts are critical to engage local communities to help detect additional infested locations. The US Forest Service continues to provide funds to combat the infestations. Surveys conducted in residential areas in 2020 resulted in the identification of two additional infestations (Daboch and Meeruru villages) in Tomil municipality. Currently 55 acres are being treated for LFA which includes a 100-foot buffer zone around each infested site. In 2020, surveys were conducted at entry points including the new airport, post office, commercial dock, and the dumping area - no LFAs were found.

### American Samoa

The little fire ant was first detected on American Samoa in October 2018 in a residential area in the western part of Tutuila Island in the village of Tefata. LFA had likely been there for quite a while, based on the density and extent of the infestation. Collaborations were established with families in five of six LFA-infested areas, and delimitation surveys were completed in all six areas. Detection surveys

were conducted at 14 additional sites, but they were negative for LFAs. With technical assistance from the University of Hawai'i's Hawai'i Ant Lab, American Samoa Community College - Agriculture, Community and Natural Resources Division (ASCC-ACNR) initiated eradication efforts in all infested areas using granular and gel-based insecticidal bait products. A total of 44 applications of insecticidal baits were completed across the six known infested areas. Subsequent assessments indicated near 100% reduction (no LFA detected) in five of the six infestations, and an 83% reduction in the sixth one. Staff with ASCC-ACNR are continuing to respond to calls from the public to investigate possible LFA detections in other areas. Since 2019, 84 people have participated in the LFA outreach programs and many more were reached via media PSAs. No additional infestations have been detected, but much work remains to continue to alert and educate the public to help with LFA detection throughout the territory. Also, with the assistance of a GIS specialist from American Samoa Community College, Forestry staff obtained aerial imagery to assist with delimiting the LFA infestation in Aloaou (16 acres) and Mapusaga (24 acres).

## Disease Activity

### *Phellinus noxius*

*Phellinus noxius* is a basidiomycete fungus that can attack and kill trees by causing a root and butt rot.

This fungus has been found on Palau; Guam; on islands of the Federated States of Micronesia, including Chuuk, Pohnpei, Yap, and Kosrae; on islands of the Commonwealth of the Northern Mariana Islands, including Rota and Saipan, and American Samoa. On some islands (Palau and Chuuck), the fungus has been found on only a few acres; on other islands (Rota, Kosrae, Saipan, Pohnpei, American Samoa, and Guam), hundreds of acres may be affected.

*Phellinus noxius* is capable of infecting and killing over 400 tree and shrub species that grow in the Tropical Pacific Region and has been particularly devastating to breadfruit (*Artocarpus altilis*), one of the principal food staples of the Pacific islands.

Recent research has clarified what makes this fungus so challenging to manage in the Pacific Islands and will hopefully aid in developing management approaches. The DNA of the fungus was recently analyzed, and more understanding was gained about the abundance of enzymes that collectively make *Phellinus noxius* one of the most effective fungi for degrading cellulose, hemicellulose and lignin, the three main components of wood (Ibarra Caballero *et al* 2020). This fungus can grow through the root systems of trees and from one tree to another at fast rates up to 20 feet per year under the most favorable conditions. Under hot and wet conditions that are common on many of these islands, the fungus can grow up the outside of the bases of trees. Finding this sheath at the base of a tree is one of the easiest ways to tell if a tree has been attacked by *Phellinus noxius* (Figure 13).

This fungus can also be spread by spores via wounds on trees. Typhoons and human negligence (as with the use of a machete) are the two most common sources of wounding, allowing a point of entry on a tree for spores to grow. Even after a tree is killed by this fungus, the fungus can seal itself off with a hardened rind-like material and survive for at least 10 years or until the root system of a still healthy tree grows into its vicinity. At that point, the *Phellinus noxius* can then reactivate itself and invade the root of the healthy tree.

There are effective ways of disposing of *Phellinus noxius*; however, the method most accessible on these islands involve intensive physical labor. All infected wood tissue must be collected and moved off site or destroyed, preferably by burning. So far, no landowner support or formal eradication programs exist for combating this disease.

A book that presents current knowledge and information on the etiology and management of *Phellinus noxius* will be published soon.

Ibarra Caballero, J.A.; Ata J.P.; Leddy, K.A.; Glenn, T.C.; Kieran, T.J.; Klopfenstein, N.B.; Kim, M.S.; Stewart J.E. 2020. Genome comparison and transcriptome analysis of the invasive brown root rot pathogen, *Phellinus noxius*, from different geographic regions reveals potential enzymes associated with degradation of different wood substrates. *Fungal Biology*. 124(2): 144-154.



Figure 13. Manny Tenorio crouches by a tree at Navy Hill, Saipan with a mycelial mantle of *Phellinus noxius* growing up the tree base. Photo credit: Phil Cannon, US Forest Service

### Yap, Federated States of Micronesia

The FSM National Invasive Species Strategy and Action Plan states that Yap's goal is to "Keep Yap uniquely beautiful and safe by managing invasive species effectively" (NISSAP 2016). The Yap Invasive Species Taskforce (YIST) Terrestrial Invasive Species Eradication Program highlights several invasive plants for surveying and management prioritization: African Tulip (*Spathodea campanulata*), Lantana (*Lantana camara*) "Paper Rose" (*Operculina ventricosa*), Bronze-Leafed Clerodendrum or Februwari (*Clerodendrum quadriloculare*), "Cat's Tail" Grass (*Pennisetum polystachion*), Merremia or Wachathngal (*Merremia peltata*), Wedelia or Susuwan' (*Wedelia trilobata*), and Giant Sensitive Plant or Rachloy' ni Biech (*Mimosa invisa*).

This past year, US Forest Service funding has enabled Yap to continue to monitor and maintain control efforts for Imperata grass (*Imperata cylindrica*) and Chain-of-love (*Antigonon leptopus*) (4 acres), initiate control efforts for *Lantana camara*, and resume work on African Tulip. Sixty acres of Imperata-infested sites that had previously been treated were surveyed, and no regrowth of the grass was found. Similarly, Chain-of-Love has been declared eradicated. GPS mapping was completed of sites where Lantana had been found during rapid drive-around surveys. A total of 139 roadside Lantana sites (0.184 of an acre/ 8,025 square feet) were treated with herbicide spray. Yap also continued survey efforts in 2020 for African Tulip, revisiting all known eleven infested sites, covering 1.3 acres. Herbicide treatment was completed for approximately 100 African tulip seedlings, 300 juvenile trees, and 20 mature trees.

#### Outreach and Education

Yap continues to provide outreach and education on the importance of targeting invasive plants, which compete with native trees, reduce forest health, and contribute hazardous fuels for fire. Over the past year, Yap Cooperative Forestry distributed awareness materials during Yap's Agriculture Fair to approximately 40 people, solidified relationships with many private landowners with the goal of reducing invasive species, and provided a tour for students around the Agriculture Station, teaching them about the benefits of native trees and the problems that invasive species cause. Posters and brochures were distributed during Yap Day. The nursery provided 50 tree seedlings to the Yap High School science club to be planted on Earth Day and Tree Planting Day.

### Kosrae, Federated States of Micronesia

Kosrae Island Resource Management Authority (KIRMA) utilized grant money to reduce, minimize, and prevent potential threats and impacts caused by the introduction and spread of invasive plants. Kosrae has prioritized *Clerodendrum quadriloculare*, *Leucaena leucocephala*, and *Wedelia* for continued surveying, mapping, and eradication efforts. This past year, data was collected at Lelu ruins (480 sq. meters), and GPS points representing known infestations were used to update the invasive plants map. Suppression and control efforts were completed on an estimated 1.5 acres of *Clerodendrum quadriloculare* in Mosral-Malem. *Leucaena leucocephala* infestations were controlled in Kosrae's forests over an estimated 1.9 acres.

#### Outreach and Education

Kosrae continued enhancing public awareness and understanding of the impacts and effects of invasive plant species by utilizing US Forest Service funds to increase the capacity and capability of project and KIRMA forestry staff. In 2020, staff conducted three virtual conferences among the Regional Invasive Species Committee (RISC) members, consulted with Lelu Ruins and other stakeholders on invasive plant management, and increased awareness within schools and the community of invasive plant issues. The extra staff and involvement of the community over the past year has resulted in community roadside clean ups and identification and control of invasive plants infesting the roadsides.

### Commonwealth of the Northern Mariana Islands (CNMI)

In 2020, CNMI continued to monitor and suppress invasive species threatening the forest ecosystems on the islands of Saipan, Tinian, and Rota through chemical, physical, and mechanical means on infested acres that had been previously recorded. The funds also supported a field survey for invasive plants on the north and south sides of the island of Saipan. Surveys and analyses were also continued on the islands of Tinian and Rota, focusing on the new and rapidly spreading invasive plant *Muccuna Puriens*.

A 2020 US Department of Interior, Office of Insular Affairs grant was awarded to the Mariana Islands Nature Alliance (MINA) to control the spread of invasive vines on Saipan. MINA is a community-based non-profit organization that has managed coastal and ocean clean-up for the past ten years through a *Tasi-Watch* program. The word *Tasi* in Chamorro means "ocean". They will use the funds to recruit and train five additional Tasi-Watch rangers to help control the spread of invasive vines in priority watershed areas. Invasive vines on Saipan are smothering native plants and trees, leading to erosion and increased sedimentation in streams and in the ocean. Among the invasive vines identified on Saipan are: *Operculina* spp., *Ipomoea* spp., *Cryptostegia grandiflora*, *Coccinia grandis*, *Epipremnum aureum*, *Antigonon leptopus*, *Passiflora* spp., and *Mikania scandens*.

#### Outreach and Education

CNMI Forestry Staff capacity was increased with the addition of a position to manage the Forest Health program hired in 2019. Grant funds allowed increases in technological capacity so that staff could attend and participate in teleconferences and webinars and coordinate invasive plant work with MINA.

Funds from the 2020 DOI-OIA grant will also support the MINA Schools for Environmental Conservation program. This program provides hands-on conservation experiences for teachers and students in the community and offers trainings and opportunities for recent high school graduates to become community conservation rangers.

## American Samoa

Cooperative Forestry Assistance Programs (Forest Stewardship, Forest Health and Invasive Species and Urban Community Forestry) continued to provide funds in 2020 to the American Samoa Community College. Funds enabled a GIS Specialist to utilize an Unmanned Aerial Vehicle (UAV) to map the location of the nonnative, invasive tree Pulumamoe (rubber tree, *Castilla elastica*) over 10+ acres in the Maloata village.



Figure 13. *Castilla elastica* on Ofu-Olosega. Photo credit: DJ Sene, American Samoa Community College - Agriculture, Community and Natural Resources Division

# Capacity Building

- USDA-Forest Service provided funding to fill a liaison position at the University of Guam for the US-Affiliated Pacific Island State Foresters and their staffs on matters related to forest health and agroforestry management. As a local liaison for USDA (FS) forestry programs, the role of the liaison position was to convene conversations, provide technical assistance, and bring together appropriate specialists to address forest health and agroforestry management issues with the intent of enhancing the health and resilience of natural and agro-forests by providing policy makers and land managers sound management options.
- Dr. Ross Miller and Robert Bevacqua (University of Guam) developed and presented little fire ant and coconut rhinoceros beetle survey and detection workshops to foresters and other concerned agency and NGO personnel on Guam and Saipan. Due to the onset of Covid-19 travel restrictions imposed in March 2020, the remaining trainings were provided virtually to forest health workers in Yap, Pohnpei, Palau and Majuro via Moodle's Big Blue Button software.
- The US Forest Service also filled a permanent position located on Guam to provide technical assistance to island foresters regarding forest health and agroforestry. Michael Jordan (Figure 12) is located in the NRCS office on Guam.
- Yap hired six new employees to assist with the implementation of the consolidated grant program objectives, including a program coordinator, volunteer coordinator, nursery aid, two forest health/invasive plant positions, and a grant administrator.



Figure 12. Pacific Islands Cooperative Forester/Forest Health, US Forest Service, Pacific Southwest Region, Guam. Contact: Michael.jordan@usda.gov

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## 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), the University of Guam, and American Samoa Community College.

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

## For more information visit:

**USDA Forest Service, Pacific Southwest Region** - [www.fs.usda.gov/main/r5/forest-grasslandhealth](http://www.fs.usda.gov/main/r5/forest-grasslandhealth)

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