PACIFIC ISLANDS
APRIL 2017

Forest Health 2016 highlights

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Forest Resource Summary

The US-affiliated Islands of the western Pacific cover 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.

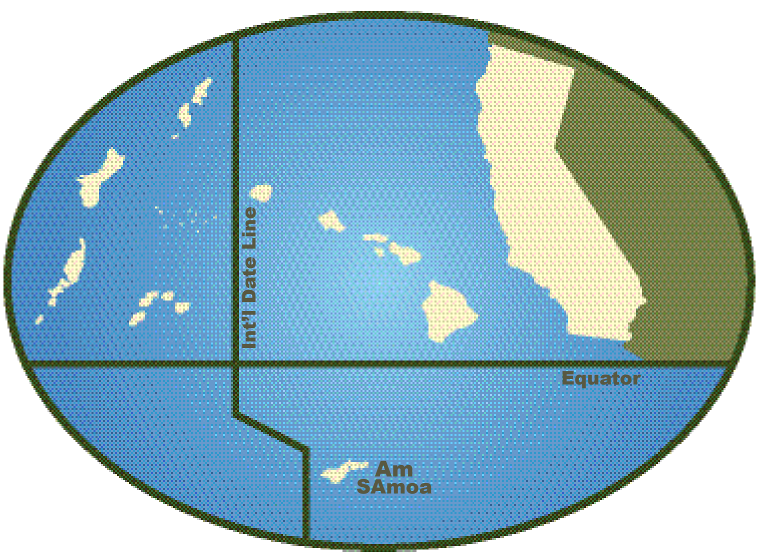

Figure 1. U.S. Affiliated Islands in relation to the United States

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 multiple pathways for introduction 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). In November 2015 *Cycas micronesica* was added to the Threatened list under the Endangered Species Act of 1973. Dr. Marler's monitoring of cycad populations also includes those on Rota, Yap, Tinian and Palau. His 2016 assessment of survival and health in the permanent plots on Guam indicated mortality was similar to previous years, with an absolute mortality rate of 20 trees per hectare. From 2010 to the end of 2016 he estimates 14 trees are dying per hectare per year and that tree density will fall below 200 trees per hectare for the first time during 2017. Based on this decline trend, Dr. Marler predicts cycad extirpation from Guam habitats about 2030. In addition, there were no seedlings within his transects this year and over the past five years, only one short-lived seedling was found in 2015.

The mean level of scale infestation on cycad plants in Rota reached a maximum immediately after the scale population entered the plots. This maximum level was fairly stable for five years, and has

Figure 2. Plants in extremely poor health (left) accounted for 41% of the population and those in extremely good health (right) accounted for only 6% of the population based on 2016 surveys on Guam. Source: Dr. Thomas Marler, University of Guam

been declining since 2013. These patterns are similar to the patterns observed on Guam. The Yap cycad population continues to appear extremely healthy, with no signs of herbivory from arthropods or mammals. Yap is the only location worldwide where large contiguous *Cycas micronesica* populations occur in the absence of any known non-native herbivores.

Figure 3. Yap habitats characterized by high density, healthy cycad plants in late 2016. Source: Dr. Thomas Marler, University of Guam

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 *Chilades* butterfly larvae, *Erechthias* leaf miner, and *Dihammus* stem borer was recorded on some of the trees this year. For *Dihammus* stem borer, this year revealed a rise in the percentage of trees exhibiting stem damage from the larvae. For *Erechthias* leaf miner damage, the proportion of live trees that exhibit damage is controlled by *Aulacaspis yasumatsui* behavior. This leaf miner does not oviposit in young cycad leaves, so during the past decade when scales killed leaves at a young age, the extent of leaf miner damage dramatically declined. The decline in leaf miner infestation recorded in the most recent health survey resulted from including data from the many plants that were leafless. If these trees were removed from the data set and the leaf miner infestation was restricted to trees with leaves, the infestation would have been 100% of the tree population. The added pressure caused by wild pig herbivory has never subsided since the scale invasion. Consumption of stem tissue continues for fallen stems but also for standing stems of unhealthy trees. No new pests on cycads or biocontrol organisms have been found on Guam or Rota since early 2013 when the parasitoid *Arrhenophagus chionaspidis* was discovered on Guam. Known biocontrol remains restricted to this parasitoid and to the predator *Rhyzobius lophanthae*.

Coconut Rhinoceros Beetle

Coconut rhinoceros beetle (CRB), *Oryctes rhinoceros*, first detected on Guam in 2007, defied containment and eradication efforts. Adult CRB kill palms when they bore into crowns to feed on sap. Rhino beetle larvae feed only on dead plant material at breeding sites and they do no damage. In order to eradicate rhino beetles, all breeding sites must be found and destroyed. A density dependent biocontrol agent is urgently needed on Guam to suppress an uncontrolled outbreak of the CRB-G biotype triggered by abundant breeding sites left in the wake of Typhoon Dolphin which hit the island in May, 2015. CRB-G is a newly discovered invasive biotype which has escaped from biological control by *Oryctes rhinoceros* nudivirus (OrNV). Prior to discovery of CRB-G, OrNV was used as a very effective classical biocontrol agent to mitigate damage whenever Pacific islands were invaded by CRB. When applied to non-CRB-G biotypes, damage to coconut palms was reduced by up to 90% within a few months and the CRB population was perpetually suppressed. CRB-G is genetically distinct from other populations of CRB in the Pacific, is resistant to all currently available isolates of OrNV, 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 is likely to spread to other islands if these outbreaks cannot be suppressed. Resistance of CRB-G to OrNV was discovered when bioassays of several isolates of the virus provided by AgResearch New Zealand failed to result in significant pathogenicity. 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 2016, project director, Dr. Ross Miller, University of Guam, was able to hire a research associate stationed on Saipan to lead the survey efforts. This is a cooperative project between Northern Marianas College, the National Park Service at the American Memorial Park, the CNMI Department of Lands and Natural Resources, the CNMI Department of Forestry, and the biosecurity authorities at airports and seaports. Bucket and barrel traps are being maintained at the Saipan International Airport, the Seaport in Tanapag, at the National Park Service's American Memorial Park in Garapan, and at the airport on the adjacent island of Rota. "DeFence" traps are also in place on Saipan, Tinian, and Rota. These consist of a doubled layer of tekken fish netting with a 1 cm mesh size which is attached to a cyclone fence with plastic ties. A CRB pheromone bait and a solar-powered UV LED is attached to the center of the net. The tekken netting acts as similarly to a gill net that entangles the thorax of rhino beetles attracted to the light or pheromone. Three traps are currently maintained at the Saipan International Airport and Saipan Commercial Seaport on cyclone fences surrounding those facilities. An additional trap is maintained at the American Memorial Park. Three traps are maintained each at the seaport and airport on Tinian. A single trap is maintained at the West Dock on Rota. No CRB detections occurred in 2016.

Figure 4. Map of Umatac 3 (Southern Mountain Overlook) on Guam showing the results of the initial delimiting survey conducted in early autumn of 2014 (left) and of a follow-up survey conducted about six months following the eight prescribed treatment episodes of insecticides (right). Baits consisting of peanut butter smeared on a chopstick were placed in a grid at a spacing of approximately 5 meters. Flags in red indicate baits on which little fire ants (LFA) were collected; yellow flags indicate sampling sites where no LFA's were collected on the baits. Dense rugged terrain and mountainous topography was a factor in preventing further treatment of the mountain side and cliffs and was a likely factor in the reappearance of LFA along the northern periphery of the treated area. Source: Dr. Ross Miller, University of Guam

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. LFA attend mealybugs, scales and other insects which can protect them from natural enemies and move them from leaf to leaf and plant to plant. This can result in stunting of growth, premature fruit excision, and fruit spoilage. LFA is an arboreal ant species that loves shade and moisture. Walking through the forest, enjoying outdoor activities and gardening are almost impossible in infested areas. Management of and surveying for LFA on Guam are being supported by the US Forest Service. Insecticide treatments continued in 2016 on a second set of six LFA-infested sites. A third set of six LFA-infested sites has been selected for treatment during 2017. Treatments have concluded on the first set of plots. An initial delimiting survey is performed at each site to determine the boundaries of the LFA infestation. Sites are then treated with a granular formulation of Amdro® or the more 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 is performed. This sequence is repeated every six weeks at each site and is repeated for at least eight treatment cycles.

Ambrosia beetles and tree health in American Samoa

When American Samoans think of tree pests, usually the first that comes to mind is the coconut rhinoceros beetle (*Oryctes rhinoceros*). This large, well-known insect has been damaging coconuts and other palms in American Samoa since it was accidentally introduced over a century ago. However, a much less prominent group of beetle pests may be causing as much or more harm to a much broader range of tree species in the territory. Ambrosia beetles, usually only a couple millimeters or less in length, can cause damage far out of proportion to their diminutive size. Female beetles burrow into twigs, branches, stems of saplings, or the boles of fully grown trees, forming galleries where they deposit their eggs and a special fungus which, as it grows, serves as food for the beetle's offspring. The resulting damage to the tree's vascular tissue can result in branch dieback or even death of entire trees. Because the beetles themselves and the holes they leave are tiny and inconspicuous, the cause of damage or tree death often goes unnoticed. The Samoan islands have a relatively rich native ambrosia beetle fauna, but little is known about the impacts of these species on the American Samoa's forests. In addition to these

Figure 5. Metotagivale Meredith sets a multifunnel trap for ambrosia beetles in secondary forest on Aunu'u island, American Samoa. Source: Mark Schmaedick, American Samoa Community College

natives, several accidentally introduced species, such as the black twig borer, *Xylosandrus compactus*, are known pests in nurseries and agroforestry systems. Elsewhere in the world exotic invasive ambrosia beetles such as the redbay ambrosia beetle (*Xyleborus glabratus*) and the polyphagous shot hole borer (*Euwallacea fornicatus*) in the U.S. have severely harmed fruit tree crops and urban, riparian, and upland forests. 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 for the first time 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 througout the islands in unmanaged native forests (Figure 5), agroforests, urban forests, and in areas such as ports and warehouses at high risk for accidental introductions of exotic species. After preliminary sorting (Figure 6) the beetles will be shipped to taxonomists for species identification. 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, as well as providing a baseline for future exotic ambrosia beetle early detection surveys.

Figure 6. Ambrosia beetles and other beetles captured in multifunnel trap placed in Leone village, American Samoa. Source: Mark Schmaedick, American Samoa Community College

New Pest Detections

A new species of wasp was recently found on Guam and identified by entomologists at the College of Natural and Applied Sciences (CNAS), University of Guam, as *Vespa tropica*, also known as the greater banded hornet. These wasps are large and aggressive which make them a possible health hazard to individuals with allergies to bees and wasps, as well as children and the elderly.

Vespa tropica is found in China, Japan, Malaysia, Hong Kong, Singapore, India, and the Philippines. These wasps raid the nests of other wasp species to take larvae back to their own nest to feed their larvae. The greater banded hornet has a distinct, bright yellow band around its abdomen. They build their nests in hollow trees and other protected areas or underground. Queens are about 30mm in size and the workers average 24-26mm, which is slightly larger than the diameter of a quarter.

Figure 7. Adult greater banded hornet compared to the size of quarter. Source: University of Guam

Two colonies were found on Guam in 2016, one in Upper Tumon and one in Yona. "Residents of these areas called the CNAS Entomology Lab for assistance because people were getting stung. The sting from this large wasp is very painful. Both colonies have been destroyed, but since they were found in two different parts of the island this hornet may already be established on Guam," said CNAS entomologist Dr. Ross Miller. Extension entomologist Dr. Aubrey Moore has prepared an informative fact sheet on the greater banded hornet. Fact sheets on *Vespa tropica* and other recently arrived invasive species may be downloaded from cnas-re.uog.edu/guam-new-invasive-species-alerts/.

Dr. Richard MacKenzie, Pacific Southwest Research Station (Hilo, HI), has been working with colleagues from the US Fish and Wildlife Service, US Geological Service (USGS), the Micronesia Conservation Trust (MCT), the Conservation Society of Pohnpei (CSP), and Pohnpei Forestry on a vulnerability assessment of mangroves to sea level rise. Mangrove forests in Micronesia are relatively intact systems compared to other areas of the world where mangroves have been, and continue to be, lost to development, agriculture, and aquaculture. A recent global analysis found that mangrove forests in Pohnpei and Kosrae are the most productive mangroves in the world. Protecting these systems from human activities and sea level rise (SLR) remains a priority in the region, as they are a vital source of food, fiber, and fuel that supports human livelihoods throughout Micronesia. The Forest Service has been working with crews from MCT, CSP, and Pohnpei forestry to install 42 permanent mangrove monitoring plots. Forest structure, carbon stocks and accumulation rates, as well as sedimentation rates have been or will be measured within each of these plots. Data will be used in a USGS WARMER model that, along with digital elevation models that will be created for the island, will be used to identify mangroves that are keeping up with sea level rise and that can effectively migrate inland. These systems should be prioritized in an overall conservation strategy as they may be the most resilient forests to SLR. Plots were also located inside and out of key areas set aside for the terrestrial component of the Micronesia Challenge, a regional decree in which every Micronesian nation has agreed to set aside and conserve 20% of their terrestrial resources and 30% of their near-shore marine resources by 2020. Data collected from these plots will be used to determine the effectiveness of those conservation efforts. Many plots also contain or will soon contain rod surface elevation tables (rSETS) that will be measured annually by Pohnpei Forestry. These data, in addition to the sedimentation rate data, will provide information on how mangroves are responding to increased rates of sea level rise.

Figure 10 (left). Mangrove forests sequester and store more carbon than any tropical forested ecosystem in the world. This is largely due to high belowground carbon stocks that result from root growth and the trapping of sediments from the oceanic and riverine waters that flood them. The crew tries to navigate the muddy conditions of this Sapwalap mangrove to set up a permanent plot. Source: Richard MacKenzie, USFS.

Figure 8 (top). Maybeleen Apwong and Gordon Obispo sample trees from a permanent plot created in the Sokeh's forest. Source: Richard MacKenzie, USFS. Figure 9 (bottom). Mangrove forests are some of the most intact and productive forests in the world. Kristin Jayd (lower left hand corner) stands next to a Sonneratia alba tree that was more than 1 meter in diameter and 30 meters in height. Source: Richard MacKenzie, USFS.

Figure 11. Merremia peltata near forestry office in Kosrae. Source: David Bakke, USFS

Figure 12. Merremia peltata in the landscape. Merremia is easily identifiable when viewed with adjacent native vegetation. Source: David Bakke, USFS

Mapping of merremia *(Merremia peltata)* on Kosrae, FSM

Using remote sensing methods, a map of the invasive vine merremia was completed for Kosrae, FSM. This mapping showed that about 5.3% of Kosrae's forest are infested with merremia. Merremia (Figure 11) is one of several smothering vines that grow throughout the Pacific. It is often associated with disturbed areas. At present there is some question as to where and whether it might be native in some regions of the western Pacific. Ongoing genetic analysis in New Zealand will hopefully answer that question.

High resolution satellite imagery (at a scale of 1:200 to 1:700) was used to develop the initial map in (Figure 13). It was determined that merremia could be distinguished by its visual difference against adjacent vegetation (Figure 12), with a brighter color and different texture. Ground-truthing of easily accessed locations (along roads and adjacent to farms) was used to verify this observational difference. It is understood that further ground inspection of mapped locations will be needed to confirm the mapping of merremia on Kosrae, as there is another plant species (Hibiscus tiliaceus) that appears to have a similar spectral image.

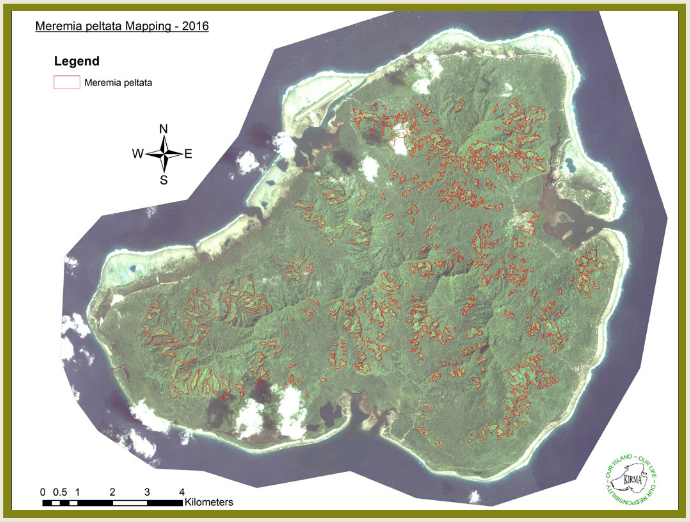

Figure 13. Remote sensing methods identified the locations of merremia on Kosrae. Source: David Bakke, USFS

Cogon grass *(Imperata cylindrica)* eradication plan completed in Palau

A renewed effort to eradicate cogon grass from Palau has begun with the development of a new eradication plan to tackle several populations of this highly invasive cogon grass or imperata (Figure 11). Most of the existing populations are at or near the airport. These populations have been sporadically treated since the early 2000's and although there hasn't been any great expansions of the populations, there also hasn't been much of any reductions. Because of the concerns about imperata's highly invasive nature and its ability to impact natural fire regimes, it is important to get this weed under control. This new eradication plan should serve as a blueprint to move closer to eradicating this plant from Palau.

Figure 14. Joe Tiobech, an invasive plant tech, is holding imperata grass at the Palau airport. Source: David Bakke, USFS

Figure 15. Jason Tonorio poses by a Serrianthes tree being attacked by the "black sock" of Phellinus noxius (Navy Hill, Saipan). 33% of all standing trees were infected at this site. Source: Phil Cannon, USFS

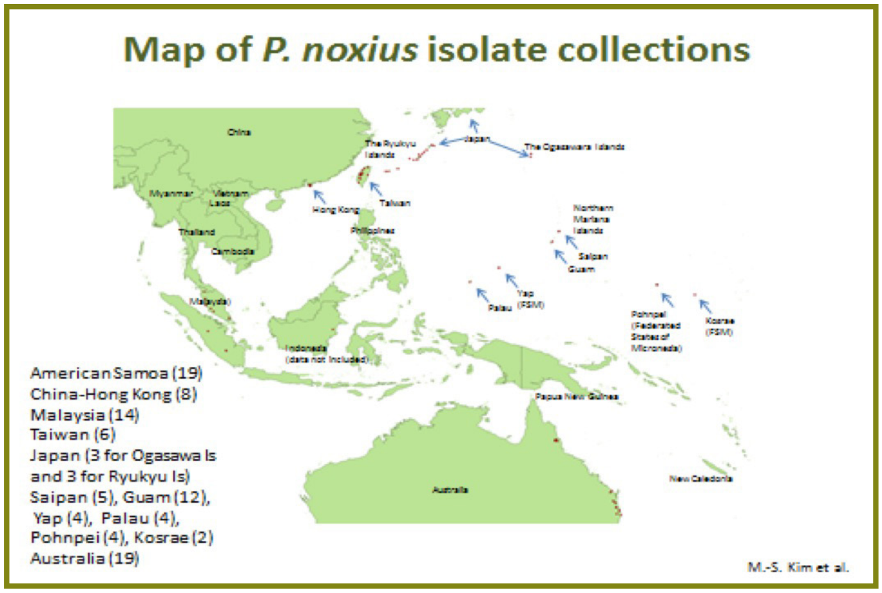

Figure 16. The origin of all samples included in the study of the molecular genetics of Phellinus noxius in the western Pacific (sample locations marked with red dots).

Advances in the Understanding of *Phellinus noxius*

The Islands of Yap, Kosrae, Pohnpei, Saipan and Guam all received Forest Health Protection mini-grants to seek out and map the distribution of as many *Phellinus noxius* infection foci as possible on their respective islands and, in 2016, most islands made significant progress towards meeting this goal.

In addition, all of the isolations that were made by the R5 Regional Forest Pathologist and Island Foresters during the 2015 forest pathology trip had their DNA assessed using molecular genetics at the Ned Klopfenstein Lab. These were combined with similar results from a 2013 trip and *Phellinus noxius* samples provided by other labs in Australia, Indonesia, Hong Kong, Taiwan, and Japan. Figure 16 shows the origin of all of the *Phellinus noxius* samples that were included in this project. Figure 17 shows the degree to which all of these samples are related at a molecular level.

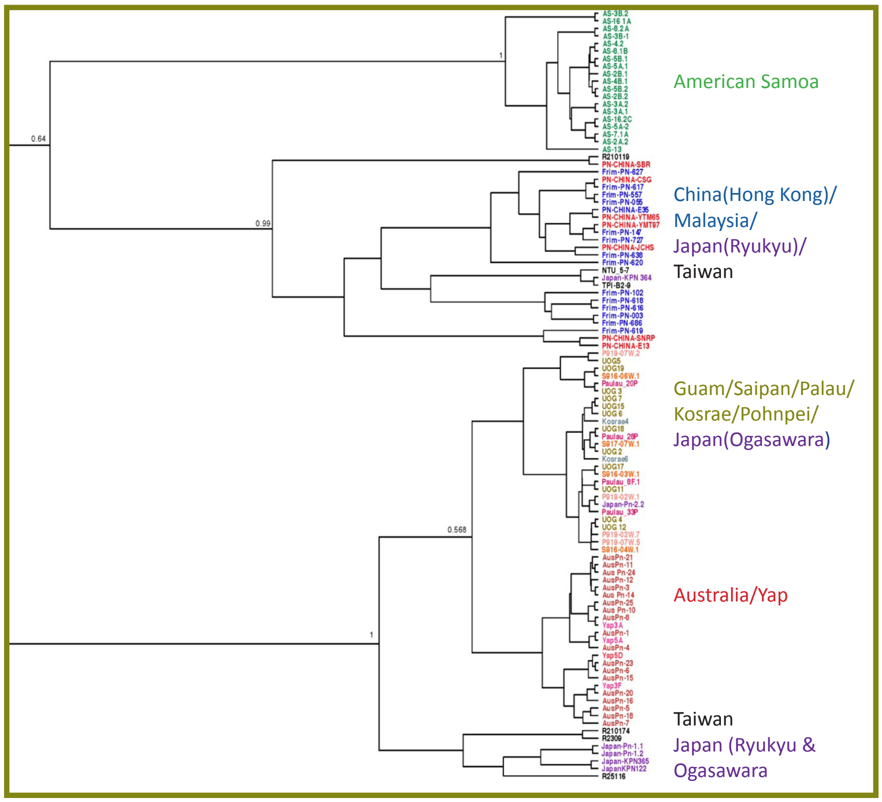

Figure 17. A neighbor joining tree showing the phylogeny of Phellinus noxius isolates from the western Pacific based on tef-1a sequences. Source: Mee Sook Kim

This information will be useful for determining the directions that this fungus has been spreading between islands (or land mass). On the scale of an individual island it will be extremely useful for determining if the movement of the fungus has been subterranean (spreading from an infected root of one tree to a healthy root on a neighboring tree) or if the dispersal mechanism is largely by spores. Possessing this information will be most important when deciding on which management practices will be most effective at controlling this disease.

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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