2015

Western Pacific Tropical Research Center
IMPACT REPORT

College of Natural and Applied Sciences
University of Guam

Buenas yan Hafa Adai,

To be is to do . . .

The Western Pacific Tropical Research Center is once again proud to showcase some of our 2015 research, extension and instructional outcomes and the relevance WPTRC plays in the advancement of "Good to Great" within the University of Guam and our island and regional communities.

This year we highlighted projects that exhibit the wide diversity of what we are doing on Guam and in the Pacific region. The cover, centerfold and first article are about saving Guam's indigenous tree snails that are under the threat of extinction. There are also four studies that were conducted in the Philippines, which show the depth of our research outside of Guam and how it can be applied to our own island ecosystem. We have a team of scientists and recent agriculture graduates working on generating a rare plant nursery to propagate rare Guam flora for future out-plantings on Guam. For the local farm community, there is a team of scientists and farmers working together to have a better understanding of a devastating tomato disease and testing for virus-resistant plants. We also get a great update about combating Guam's new invasive little fire ants and an innovative way that our entomologist can track the coconut rhinoceros beetle. Our senior aquaculturist provides an update on shrimp genetics and RNAi immune response. And finally, to show the breadth of WPTRC, we conclude our impact report by highlighting a study about childhood obesity on Guam and in the Pacific region. A must read!

I want to personally thank all who have contributed to the 2015 WPTRC impact report and especially to my administrative team members who set true examples of leadership. This year's report exemplifies what a small group of scientists is capable of doing and the impact they have on the lives of our island and regional communities. To be is to do . . .

Si yu'us ma'ase,

Lee S. Yudin
Dean/Director
CNAS/WPTRC

Hafa Adai,

It's been an exciting year for the Western Pacific Tropical Research Center, in part because we've expanded our research base by extending WPTRC funding to other UOG faculty within the College of Natural & Applied Sciences. The projects highlighted in this year's Impact Report demonstrate the variety of important issues being studied at the University of Guam.

In 2015, we continue to address the challenge to Guam's tropical agriculture industry, our region's environment and natural resources, and we are studying the growing problem of child obesity. We also strive to extend our current capabilities beyond the boundaries of Guam to become an internationally recognized tropical research center.

The hardworking faculty and staff of WPTRC continue to remain competitive in securing extramural funding. We continue to focus on our opportunities, such as: partnerships with other entities in Micronesia, our proximity to Asia, clean ocean water for aquaculture research, commitment by the U.S. government to preserve native species on Guam, and interest by other research entities to collaborate. In 2015, we collaborated with multiple off-island scientists and institutions, provided employment to the local community, and offered students to opportunity to gain valuable research experience.

WPTRC is here to serve our stakeholders, so please feel free to contact my office if you have any questions or need additional information.

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Guam's *Partula radiolata* is one of three indigenous snails added to the federal Endangered Species list in 2015.

Centerfold
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Tiny *Samoana fragilis* navigates the mosses in its native Guam habitat.

Back Cover
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Save our snails!

The fragile tree snail, and all of Guam's indigenous tree snails, are under threat of extinction and have recently been added to the federal Endangered Species list. WPTRC biologist, Dr. G. Curt Fiedler, is working to conserve these species.

Although invasive Cuban slugs and giant African snails in your garden may not be desirable residents, Guam does have three indigenous tree snail species that are drawing increased attention since they were added to the federal Endangered Species list in 2015. Historically, Guam had four native tree snail species, and they were once common and colorful inhabitants in limestone and strand forests on the island. One of them, the Alifan tree snail (*Partula salifana*), went extinct in the 1950s from its limited range on southern Guam peaks. The remaining three are on the decline due to habitat destruction and introduced predators. Dr. G. Curt Fiedler and his Snail Team from the Terrestrial, Marine and Freshwater Invertebrate Laboratory in the Natural Sciences Division are studying these snails.

The Guam tree snail (*Partula radiolata*) is still somewhat widespread, at more than 20 locations on Guam, and may number in the thousands. Given that this snail is only known from Guam, this is a good thing. However, many of its populations are declining and all are at risk.

Although still relatively widespread, Guam tree snail populations are in decline and at risk.

The humped tree snail (*Partula gibba*) is known from several Mariana islands. This snail was once so common it was used to make handbags and jewelry from the 1940s-1970s. Unfortunately, these snails are disappearing fast from most of their native range, and the Guam population is estimated to be little more than one hundred individuals at Haputo.

Humped tree snail shells were once used to make jewelry and handbags, but now less than 150 individuals remain on Guam.

The fragile tree snail (*Samoana fragilis*) historically occurred on both Rota and Guam, but was last reported from Rota in 1996. On Guam, this snail is known only from four locations, with small populations (10-60 individuals). Worse, this species may be the most vulnerable to predation from Manokwari flatworms (*Platydemus manokwari*).

This fragile tree snail is encircled by a Manokwari flatworm, the main threat to all endemic snails.

Tree snails seem to prefer shady, moist forests, with nearby fresh water, and broad-leafed plants. Unfortunately, such locations on the coastlines are prime sites for development. Also, the presence of unchecked populations of pig and deer degrade native forests reducing leaf litter and promoting growth of invasive plant species that are not good homes for tree snails.

Although there are natural predators of tree snails, introduced animal predators are now the major source of mortality, including rats and pigs. The careless introduction of two additional snail-specific predators has made the situation worse. The Manokwari flatworm is the biggest threat. Although this voracious predator eats introduced pests, like the giant African snail, its impact on native land snails has been devastating. Empty shells of dead snails litter the ground in many forested areas.

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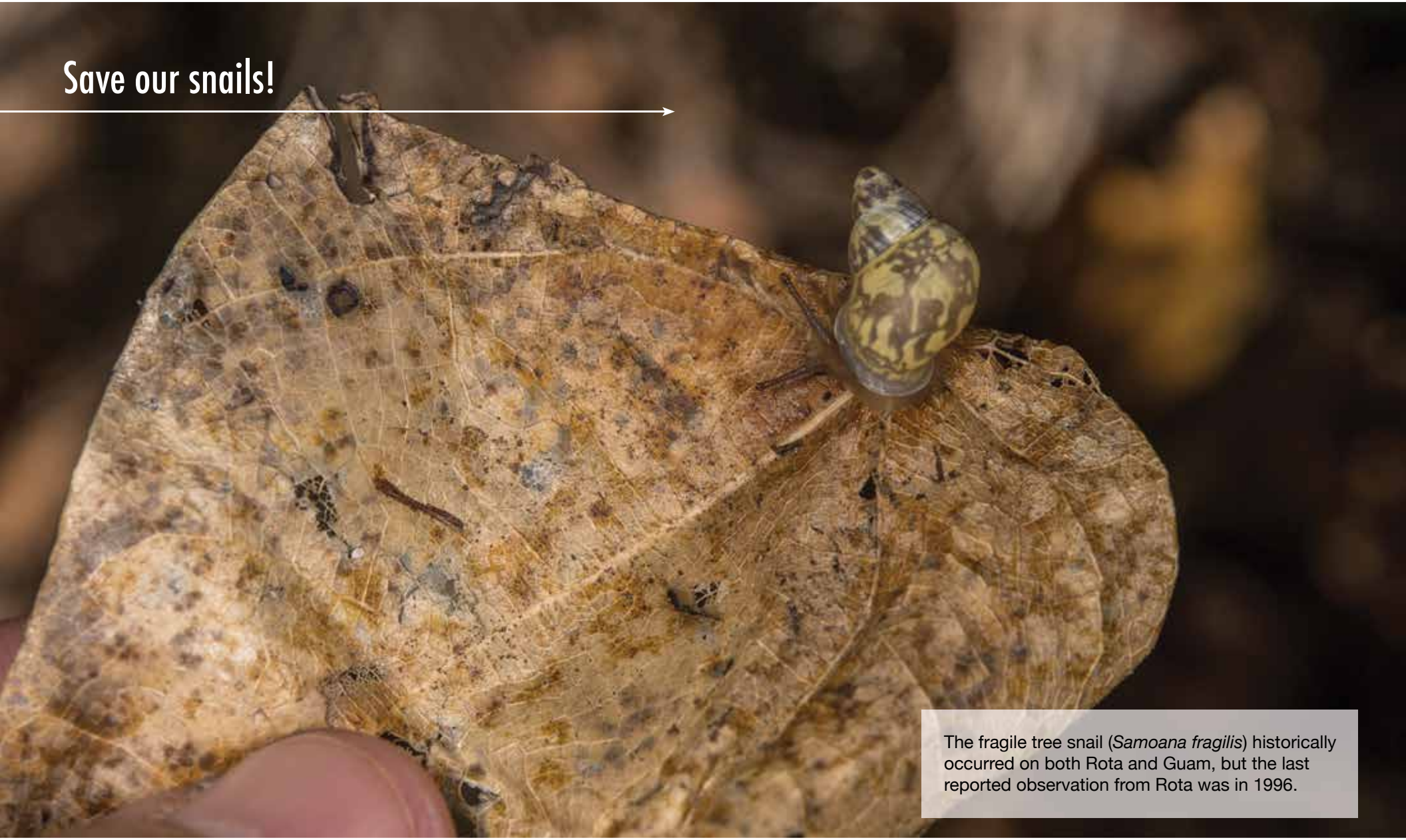
Save our snails!



The fragile tree snail (*Samoana fragilis*) historically occurred on both Rota and Guam, but the last reported observation from Rota was in 1996.

Dr. Fiedler's interest in tree snails began in part because of his photography hobby. In his first week on Guam, he photographed Guam tree snails at Sella Bay overlook and Asan Park. "When I found out what they were, I started noticing them more and became pretty good at spotting them," explained Fiedler. These skills helped him as part of a 2013 team of UOG and University of Hawaii biologists conducting surveys of tree snails and rare butterflies funded by the US Department of Defense. Subsequently, he decided to focus his own research on these snails because of the dire conservation status of all three species.

In the two years since, Fiedler and his team have located several additional populations of Guam tree snail, and two additional populations of the very rare fragile tree snail. He's also helped with relocation of three populations of snails in harm's way, including one at Asan Beach Park that was impacted by the invasive little fire ant (LFA). Snail Team also conducts a monthly survey of fragile tree snails at Hilaan, and is working to estimate size and distribution of all known Guam tree snail populations. Fiedler plans to also assess tree snail populations in the Commonwealth of the Northern Mariana Islands in the future, in collaboration with their Department of Land and Natural Resources.

"Counting and finding snails isn't enough," cautioned Fiedler, "We need to expand our limited understanding of their basic biology and ecology." Snail Team has an intern analyzing the contents of snail feces to assess dietary components, and recently added a graduate student to help with various projects. Fiedler also has begun to examine activity patterns of tree snails and their home plant preferences. He hopes to conduct captive rearing of the most vulnerable species once federal permits are obtained from the US Forestry and Wildlife Service.

Collaborators in this research include Dr. Alex Kerr at the UOG Marine Lab, the Hawaii Snail Extinction Prevention program, Guam's Department of Aquatic and Wildlife Resources, the US National Park Service, CNMI's Department of Land and Natural Resources, and the US Fish & Wildlife Service.

Funded by USDA, US Forest Service McIntire Stennis grant & the US Navy

"Counting and finding snails isn't enough, we need to expand our limited understanding of their basic biology and ecology."

Guam tree snails can still be found at over 20 locations on island.

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Testing for virus-resistant tomato plants

Sheeka Tareyama meets with local tomato farmers in their fields to evaluate plants infected with a tomato virus.

In 2007 a mysterious disease was reducing the yield of tomatoes by 10% in northern Guam. Farmers noticed their tomato plants exhibiting symptoms of leaf curl, yellowing, and stunted growth. By spring of 2011 some farmers were experiencing a total loss of their tomato crops, apparently to the same problem. This prompted samples to be sent off-island for genetic sequencing. Forward and reverse sequences of the samples had a 93% identity to Ageratum yellow vein virus (AYVV).

In an effort to identify the virus species with greater precision, additional samples were collected and sent to Dr. Kai-Shu Ling at the U.S. Vegetable Laboratory in South Carolina. Using an enzyme linked immonosorbent assay (ELISA), samples were found to be negative to most common tomato viruses but positive for Begomovirus using PCR. Dr. Ling reported, "Due to the high level of sequence diversity found, it is likely that Guam has a unique strain of AYVV."

"We conducted farm trials in August 2014 to compare 17 commercial tomato varieties for virus resistance and production suitability against the control variety Season Red," explained Extension Associate Sheeka Tareyama. "We created a tomato virus severity scale to visually evaluate the tomato varieties for AYVV. We then compared tomato varieties against the control and Karl Schlub, project statistician, analyzed this and other


Infected leaves


Healthy leaves

data using a cumulative logic model." Partial analysis identified 12 varieties with virus resistance superior to Season Red and five with inferior resistance. Using real-time PCR protocol developed in Dr. Ling's laboratory, AYVV was detected in one superior variety and four inferior ones. When symptomless tomatoes were tested, only one of the 18 varieties were positive for AYVV.

Top varieties selected by producers include: Olivia, Carmine, Affinity, Ornela, and Felicity. Due to Olivia's fruit characteristics and growth habits, it is only recommended for production in Guam's dry season or in a hoop house. The other varieties are recommended for year round production on Guam based on field data showing strong virus resistance, high yield, and low levels of cracked and unmarketable fruits.

Through this collaborative research, WPTRC helps all Guam tomato farmers maximize their profits and gives consumers better choices for fresh, locally-grown produce.

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Disturbing an idyllic tropical forest

WPTRC employees Gil Cruz and Thomas Marler compare the 2015 list of species in Mount Pinatubo's caldera with the list from past years.

Intense but relatively infrequent disturbances influence many ecosystem traits, and they need to be studied from theoretical and empirical perspectives to gain an understanding of the impacts. For example, islands in the north-western Pacific are frequented by typhoons, and these disturbances affect plants, animals, microorganisms, and many ecosystem processes such as nutrient cycling and food web interactions. Our understanding of how intense disturbances affect the resistance of island biology to damage and resilience of habitats following damage is limited by lack of context-dependent research.

The 1991 eruption of Mount Pinatubo devastated agroforest ecosystems in a manner that had not occurred for centuries. WPTRC scientist Thomas Marler has been studying the vegetation dynamics of the habitats in order to better understand the fundamental aspects of how the barren landscapes have recovered. The core of the field work has been repeated surveys of the plant species and their interactions within permanent plots for the past 10 years.

One of the foremost drivers of ecosystem recovery has been distance from human settlement. Proximity to human settlement appears to exert direct influence on ecosystem recovery by way of continued small-scale disturbance. For example, the habitats closer to the permanent barangays exhibited more alien plant species, likely vectored into the habitats by human activity. Some of these alien species have international reputations for being highly invasive, so keeping a close eye on the increases or decreases of these species has given the WPTRC an opportunity to contribute to the global understanding of invasive species.

A second major driver of ecosystem recovery has been elevation. Research on vegetation recovery from most other volcanic eruptions has also identified elevation as a major factor for understanding recovery following disturbance. However, in most of those other examples the temperature gradient explains much of the means by which elevation controls ecosystem recovery.

Our research has identified two alternative factors that mediate the elevation response on Mount Pinatubo. First, the highest elevations of the habitats that were completely barren in 1991 are directly impacted by clouds. The vegetation responses to direct exposure to clouds creates a unique habitat type that is called montane. For example, the first epiphytes that we have identified have been restricted to the montane forest elevations. Epiphytes are plants that grow on other plants, rather than in the ground. Second, soil surface stability has become tightly correlated with elevation in recent years. Surfaces in the highest elevations are becoming more stabilized, while surfaces in the lowest elevations continue to be inundated with massive amounts of soil deposits. The source of the eroding soils is the middle elevations, where deep canyon walls remain unstable and collapse to place enormous deposits of soil on the canyon floor.

In sustaining the uniqueness of the WPTRC, Marler's lab remains the only research facility worldwide that is consistently studying the recovering aftermath of the 1991 Mount Pinatubo eruption.

Habitats in the highest elevations of Mount Pinatubo are often impacted directly by clouds. These montane habitats harbor unique species and develop distinctive tree canopy architecture.

Stabilizing and destabilizing forces drive Mount Pinatubo recovery

The small grass *Pogonatherum crinitum* starts vegetation recovery by preferentially colonizing erosion rills, which in turn creates safe sites for other species to become established.

During the aftereffects of an intense disturbance, the speed of ecosystem recovery is under the influence of multifarious interacting factors. An empirical approach with frequent site visits to recovering habitats is often required to disentangle the mechanistic drivers of the process. The WPTRC has been busy for the past 10 years doing that in attempts to more fully understand how tropical island forests recover from complete biological destruction following a disturbance.

Almost 25 years after the eruption of Mount Pinatubo, our work has illuminated that the mid-elevations continue to be characterized by highly unstable canyon walls that often define the rate of ecosystem recovery at the fine scale. These canyon walls collapse in "mass waste" events during high rainfall storms, depositing immense piles of soil and plant debris in the process. The fate of these piles of volcanic debris is governed by a feedback loop. If the new soil surfaces can stabilize long enough, then immigrating plants can colonize them before they are carried away by the rivers. In turn, as more plants become established, the soil surfaces become more stable due to the protective cover of the vegetation and the consolidating strength afforded by the roots.

July 2010 August 2011 November 2015

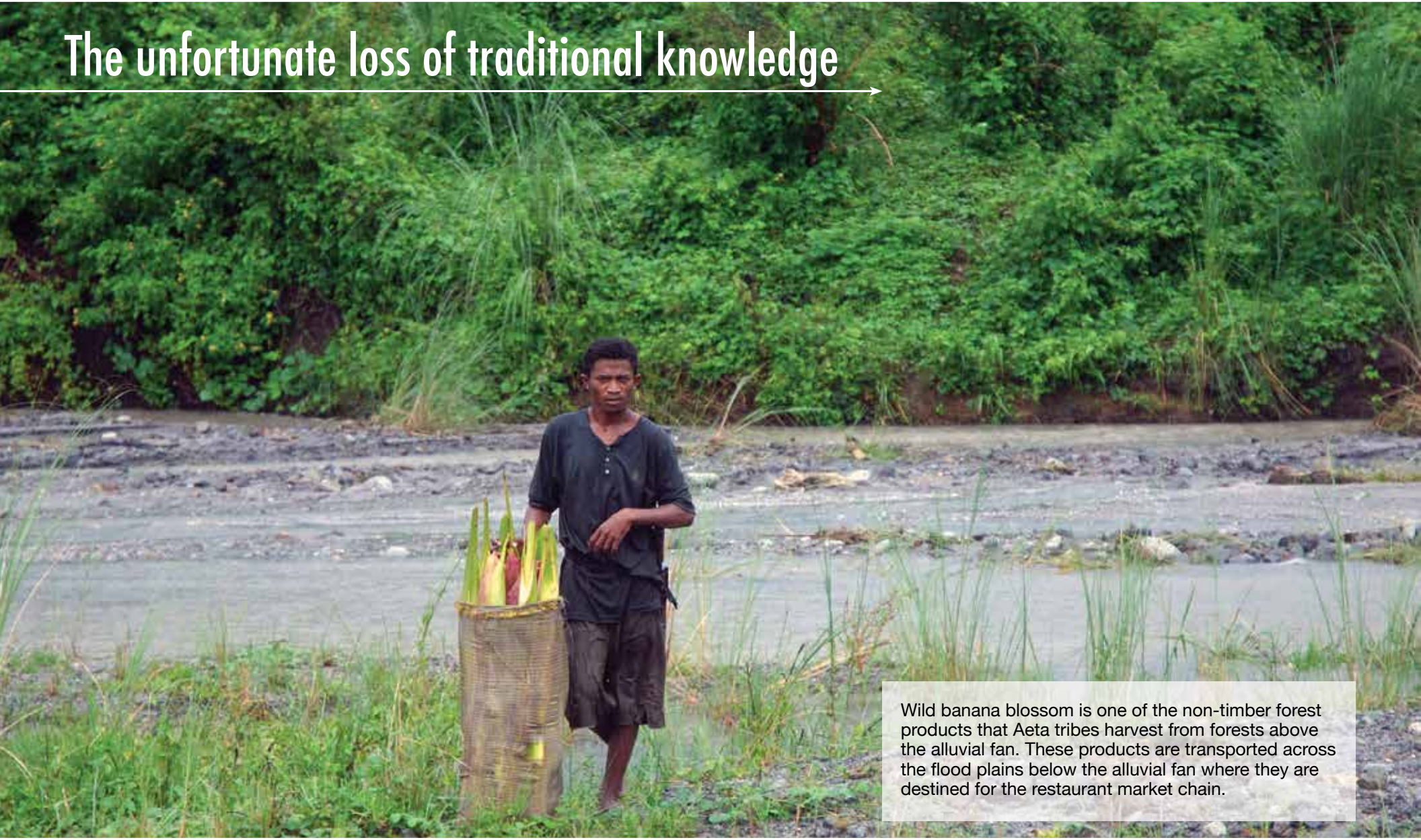
The ever-changing appearance of Mount Pinatubo canyon walls continues to reveal unstable surfaces almost 25 years after the eruption.

The successional dynamics of stabilizing Pinatubo's canyon walls with vegetation often begins with the small grass *Pogonatherum crinitum*. This one species is able to become established within the rills that develop on near-vertical surfaces. After this initial plant becomes established, secondary species are able to colonize the micro-sites with established *Pogonatherum crinitum* plants.

This WPTRC research is adding to a global understanding of major ecological concepts. The concept of "environmental filtering" is revealed when *Pogonatherum crinitum* seeds arrive on the canyon wall surfaces then preferentially colonize the rills. No other species is able to colonize these surfaces until this small grass establishes first, then provides "safe sites" for seeds of these additional species to germinate. This case study shows how one species can exert extreme control over ecosystem developmental processes. Mount Pinatubo's habitats would not have recovered as well to date if this one grass species were absent from the palette of local species. These critical species are sometimes considered "ecosystem engineers."

This research has allowed the WPTRC to contribute to the global understanding of how elevation gradients affect ecosystem traits.

The unfortunate loss of traditional knowledge



Wild banana blossom is one of the non-timber forest products that Aeta tribes harvest from forests above the alluvial fan. These products are transported across the flood plains below the alluvial fan where they are destined for the restaurant market chain.

WPTRC scientist Thomas Marler has relied heavily on the Aeta tribal residents in the Mount Pinatubo habitats he has been studying for the past decade. Local companionship during the grueling treks and guidance through the surreal habitats proved invaluable during the initial years of the field work. But the generous sharing of traditional knowledge from the elder members of the various barangays in the riparian zones is what enabled Marler's success in identifying most of the plant species.

"Much of the Mount Pinatubo vegetation was unfamiliar to me, even though I had spent most of my life on a tropical island," said Marler. The customary approach for securing accurate identifications of unknown organisms employs the collection of specimens that are sent to international taxonomic experts. This approach was not available to Marler because of the daunting collection permitting process that is inhibitory of progress in the Philippines.

Although Marler was unable to collect actual field specimens of the unknown species, "learning the names of the plants in the Aeta and provincial Kapampangan languages established my alternative pathway for ultimately verifying the scientific names," said Marler.

Continuity of traditional skills and knowledge over the last several millennia has depended almost exclusively on inter-generational oral transmission of the information. This has been a reliable means of sustaining and expanding traditional knowledge over the ages, but when an outside force disrupts the process that reliability is threatened. The Pinatubo Aeta are known for their historical resistance to the acculturation process. But like most traditional cultures their means of passing on cumulative knowledge requires that they sustain uninterrupted contact with the biological resources integral to practice that knowledge.

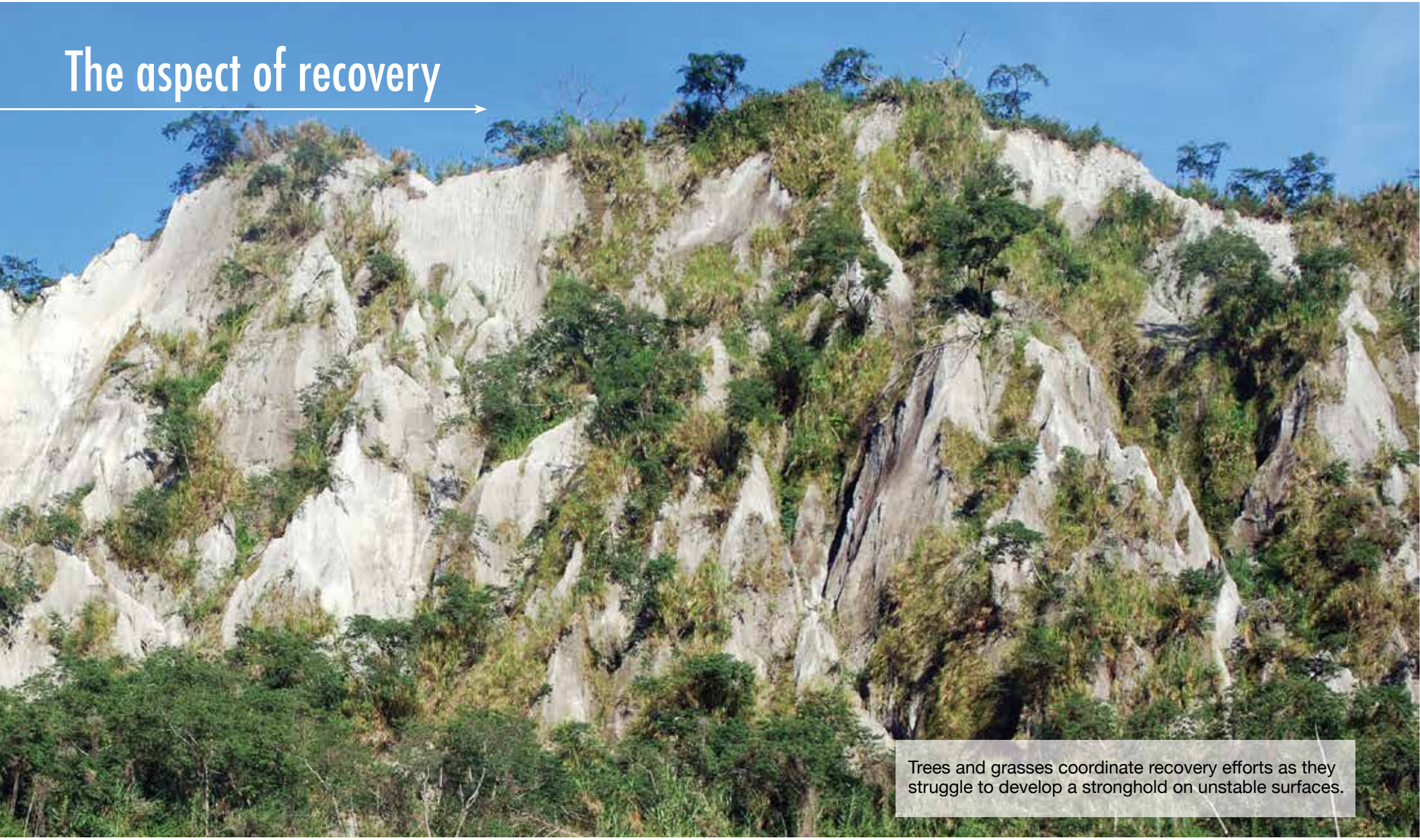
For example, in order to re-set the rivers a mosaic of healthy vegetation must develop to terminate the chronic shifting and braiding of the waters. Stable river channels must develop before fish and other aquatic resources can return to the previously barren landscape. But this process is still in its infancy almost 25 years after the eruption. The many unique Aeta approaches to harvesting fish and other aquatic resources represents one example of traditional knowledge that may not be fully passed on to the younger generations if the knowledge holders continue to be denied access to healthy fish populations in their rivers.

"I was very saddened when I learned about that while standing in one of the rivers used by the Aeta for thousands of years," said Gil Cruz. "All of what I learned about the culture of my ancestors on Guam was taught to me verbally by my grandmother. I would not be who I am today if she had been unable to do that."

International attention toward safeguarding against the erosion of traditional knowledge and cultural integrity has been inadequate. Marler is hopeful that the WPTRC's Mount Pinatubo ecology research may shed light on how the Aeta way of life has been placed at risk of disappearing from the cultural fabric of the Philippines.

Gil Cruz maneuvers the habitats near the alluvial fan of the Pasig-Potrero River on the south-east flanks of Mount Pinatubo. The highest elevation of permanent Aeta settlements on each of the rivers is located at the alluvial fan.

The aspect of recovery



Trees and grasses coordinate recovery efforts as they struggle to develop a stronghold on unstable surfaces.

In complicated interpersonal, inter-agency, or multi-state relationships, an aspect is a particular feature or characteristic of something. In ecology, an aspect is the compass direction that a slope faces. In all situations, understanding every aspect can be of utmost importance.

The role of slope aspect on vegetation has been heavily studied in many geographic regions. For example, equatorial facing slopes are often more dry and barren than polar facing slopes. But the influence of aspect has been less studied in coastal zones, where it can exert unexpected effects on soils and biology.

The 1991 eruption of Mount Pinatubo leveled the terrain and playing field among the organisms. As the waterways began to recover and the rivers began to make their mark on the terrain, the plants and animals returned to their idyllic tropical paradise. Fast-forward 20+ years later, and Mount Pinatubo is now characterized by elaborate and surreal canyon systems. The deep and near vertical canyon walls have grown to superimpose highly contrasting niche habitats onto the landscape.

"Our 2006 botanical surveys began to illuminate some habitat features that may be controlling of vegetation recovery," said WPTRC scientist Thomas Marler. "We identified aspect as one of those features." The initial observations led to more elaborate studies that have revealed a decrease over time in the number of species that are shared in both equatorial and polar facing slopes.

Outcomes indicate that as the canyon systems have continued to develop in recent years, the diversity in forests has increased among small-scale niche habitats. The surveys identified trees as the functional group that has been most affected by aspect, with more relative tree cover developing on the polar-facing slopes and less relative tree cover developing on the equatorial facing slopes.

Identifying universal drivers of how habitats recover following a major disturbance event is critical for understanding our natural world. The lessons learned from this WPTRC research are making strides in understanding aspect as one of those drivers.

Funded by USDA NIFA

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Erosion rills become deep canyon systems over time as Mount Pinatubo habitats recover from the 1991 eruption.

Rare plant nursery

Kawika Davis, nursery manager, holds a specially designed orchid growing panel that can be easily carried inside with plants attached in the event of a typhoon.

The Guam Plant Extinction Prevention Program (GPEPP) logged hundreds of hours of fieldwork in 2015 carrying out multiple surveys around the island. These surveys serve as diagnostic tools for understanding the current conditions facing rare plants on Guam including population numbers, health, habitat, effects of invasive species on target populations, etc.

To prepare for the survey fieldwork, GPEPP research associates spend time checking reports at the Herbarium Pacificum at the Bishop Museum, Hawaii; the US National Herbarium, Smithsonian Institute in DC; as well as the University of Guam Herbarium in order to gain understanding as to the habitats and possible locations for the particular species they are investigating. The University of Guam Herbarium is an important resource for scientists studying flora of the region.

Once GPEPP staff head out in the field, the work is hot and the terrain can be problematic. "The surveys are organized around line transects of 10 square meters, which can be difficult in the karst terrain in parts of Guam," said Else Demeulenaere, project coordinator. "We have found some plants that have been recently put on the IUCN list of endangered species are in fact not as rare on Guam as was thought, but in the long-term they are still at risk as they are found in just a few concentrated areas." A good example of this is a small, endemic shrub called *Eugenia bryanii* found on Guam's cliff lines. The GPEPP team found thousands of plants but the plants were found in only two locations on island at this time.

GPEPP has other priority species including the not-so-common *Fagraea berteronana* var. ladronica. It is believed to be endemic, but genetic testing is necessary in order to know that definitively. *Hedyotis megalantha* is a beautiful flowering savanna species now extremely rare on Guam due to erosion and off-roading activities.

The rare plant nursery was built to propagate rare and priority species for future outplantings. Kawika Davis manages the nursery, which was designed to protect seedlings from insect and plant pests as well as allow the structure to be dismantled quickly and efficiently in the event of an imminent typhoon.

GPEPP surveys and cultivation of rare and endemic plants inform conservation efforts and promote biodiversity for Guam and the region.

Funded by US Forest Service, US Fish & Wildlife, US Navy, McIntire Stennis

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The good news about little fire ants

Although the little fire ants in this photograph look large, they are actually only 1.5mm, the size of the silver beads pictured below.

The little fire ant (LFA) is still steadily spreading across the island bringing its painful sting to all it encounters. Some homeowners in Umatac cannot allow their children to play outside as their yards are infested with little fire ants. The good news is the treatments being used to control the ants are working.

Dr. Ross Miller and his team's implementation of LFA control techniques is finding success. The techniques were developed in Hawaii and adapted for use on Guam. Several of the sites, where multiple treatments were applied for one year, are now declared free of little fire ants. One site located in Yigo sits next to the home of the island's only animal shelter, Guam Animals in Need.

Miller's team performed surveys at each treatment site to determine the magnitude and range of the infestation. The area is then treated with low toxicity granular bait called Siesta™. A second insecticide that interrupts the growth cycle of the ants, Tango®, is sprayed on tree trunks and leaves. One week later the team conducts a follow-up survey to check the effectiveness of the treatments, and then six weeks later both insecticides are reapplied and the site is again surveyed. Each site received a total of eight repeat treatments over a period of more than a year. "The only complication we have found is getting 12 straight hours without rainfall to apply the insecticides," said Miller. "The treatment is working beautifully, but the ants continue to spread because of the indiscriminate dumping of LFA infested garbage and green waste."

After typhoon Dolphin blew over the island in May 2015 there was a massive amount of green waste generated. Government of Guam officials opened a temporary green waste collection site at Oka point. Since that time, little fire ant has been found in the area around the collection site.

Miller's lab is also involved with surveillance on the islands of Saipan, Tinian and Rota for coconut rhinoceros beetles and little fire ants to keep these invasive insects from hitching a ride from Guam to other islands. His team is using the locally created rhino beetle Defence Trap to monitor the presence of coconut rhinoceros beetles.

Working with students in Costa Rica with the Native American and Pacific Islander Research Experience (NAPIRE) program, Miller has the opportunity to study little fire ants in their home environment. When comparing population density of LFA in Guam and in Costa Rica, Guam had a much higher density. This may be due to greater numbers of competitors and predators in LFA's home range. This research highlights the vulnerability of islands when invasive species are accidentally introduced.

NAPIRE program students use Berlese extractions for little fire ant research conducted in Costa Rica under the direction of Dr. Ross Miller.

The impact of little fire ant on the ecosystems of Guam is not yet fully understood, but the work of WPTRC researchers proves that this invasive insect can be controlled.

Funded by USDA CAPS & US Forest Service

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Following radio-tagged rhino beetles to discover breeding sites

The coconut rhinoceros beetle was first discovered on Guam in 2007. Adults 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. Four dogs were trained to lead handlers to cryptic breeding sites on Guam. This detector dog program was effective but very expensive and it was shut down after a few years.

Aubrey Moore, a UOG entomologist, suggested following radio-tagged rhino beetles to breeding sites as a cost-effective alternative to using detector dogs. In August 2015, this idea was tested in a small feasibility study on Guam by a research team that included Moore; Dr. Matthew Siderhurst and his students, Kat Lehmann and Diego Barahona from Eastern Mennonite University, Virginia; Domenick Skabeikis from the USDA Pacific Basin Research Center in Hilo, Hawaii; and UOG technician, Ian Iriarte.

During the 10-day field trial, miniature radio transmitters were glued to the backs of rhino beetles. These beetles were released at the UOG Agricultural Experiment Station in Yigo and at Asan Beach Park and their locations were tracked for a few days using special radio receivers equipped with directional antennas.

The majority of beetles were tracked to coconut trees that had already been damaged by rhino beetles. A few other beetles quickly flew beyond the detection range of the

Dr. Aubrey Moore tracks radio-tagged coconut rhinoceros beetles to find cryptic breeding sites.

receivers and were never recovered. As hoped, several beetles lead the team to cryptic breeding sites. The transmitter from one of the first beetles to be released was found the next day in a hole in a rotting branch of a breadfruit about 20 feet above the ground. Three other adult beetles were found in the same hole indicating that the beetles had aggregated here to establish a new breeding site.

According to Moore, “It is very likely that the breadfruit branch was broken during Typhoon Dolphin, which visited Guam in May 2015. If this is the case, there must be thousands

of new, miniature breeding sites in Guam’s jungles resulting from typhoon damage. These breeding sites will be generating large numbers of adult rhino beetles within the next several months.”

Another unexpected result from the field trial is the fact that none of the 30 tagged beetles were caught in pheromone traps, even though all were released within pheromone trapping grids. This indicates that rhino beetle pheromone traps may be useful for detection and surveillance but are ineffective for population control.

Cryptic breeding sites can be found by following radio-tagged beetles and this method may be critical to the success of eradication attempts on newly invaded islands.

Funded by US Forest Service

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Shrimp studies: genetics and the environment

The United States is the leading global importer of fish and fishery products, with 91% of the seafood we eat (by value) originating abroad – half of which is from aquaculture. On Guam, the high demand for premium seafood is deeply rooted in the island's cultural and traditional lifestyle, as well as driven by the appetites of the over one million tourists that visit the island annually. As a result, approximately $11.5 million worth of seafood is imported annually to Guam. In order to meet such a high demand, the genetic selection of specific pathogen free (SPF) marine shrimp families in low salinity water could provide an alternative for local producers to grow the fresh product without the use of ocean water.

Working with two exchange scholars, Dr. Yun Li and Mr. Tao Huang from Shanghai Ocean University, China and three local staff members, Dr. Hui Gong Jiang investigates the interaction between genetics (shrimp families) and the environment (water salinity). Setting up 10 cages with 200 shrimp juveniles from each of ten families in two outdoor ponds (12m X 13m) initially filled with seawater, one pond was maintained with seawater (32ppt), and the other pond gradually shifted from seawater to freshwater (2.5ppt). Total acclimation took one week to complete.

Forty-five shrimp of each of the families from the two ponds were sampled every two weeks for growth throughout the eight-week trial. During the first six weeks, a few shrimp families were documented as growing faster in the low salinity water than in the high salinity water. At the end of the trials, final weights and survival numbers will be recorded and samples will be taken for biochemical analysis and immune responses. The familial difference in terms of various indexes will be evaluated for the genetic and environment interaction, as well as the decisions incorporated in potential family selection for low salinity conditions.

The results from this research will increase the understanding of how to improve shrimp production in different water salinity environments, and allow for genetic selection of the finest families for breeding in low salinity environments for local aquaculture producers, as well as provide useful information to both the aquaculture industry and researchers.

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RNAi and shrimp immune response

RNA interference (RNAi) is a relatively new technology that has revolutionized the way that researchers study gene expression. Andrew Z. Fire and Craig C. Mello were awarded the Nobel Prize in Physiology or Medicine in 2006 for their discovery of RNA interference. It is one of the most important technological breakthroughs in modern biology, allowing researchers to directly observe the effects of the loss of function of specific genes in animals. The application of RNAi in aquaculture is receiving more and more attention and has great potential for improving the health and performance of aquaculture species.

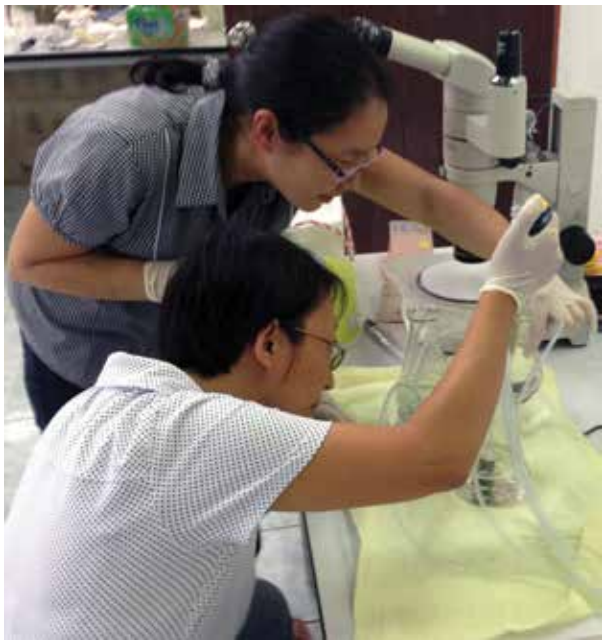
During her sabbatical leave, Dr. Hui Gong Jiang worked in Dr. Anchalee Tassanakajon's lab at Chulalongkorn University in Thailand. Using RNAi technology, she constructed gene-specific dsRNA and applied dsRNA in the freshwater prawn *Macrobrachium rosenbergii*. Using several means, her focus was to silence the insulin-like androgenic gland factor gene to produce neo-females. "Sex-reversed prawns, female to male, make for an all-male population. Male prawns grow faster than females, which is why farmers prefer males to increase their yield. Using RNAi we can also improve the animals' resistance to various endemics," said Jiang.

Winning the battle against infectious disease outbreaks remains the ultimate goal and drive for seeking effective means of disease control in shrimp aquaculture. Among the infectious pathogens, viral epizootics have caused the most catastrophic loss for the industry over the years.

Shrimp rely solely on an innate immune system and, unlike humans, cannot manufacture immunoglobulins to combat infections. Instead, crustaceans use diverse defense mechanisms against pathogenic infections including cellular and humoral components, such as RNA interference and signaling pathways. The RNAi response is crucial in controlling virus replication and limiting virus-induced pathology and inherently provides specific antiviral response. Also implicated in antiviral responses, various signaling pathways lead to the activation of transcription factors and the subsequent expression of antimicrobial peptides.

The antiviral mechanism of RNAi in penaeid shrimp is Jiang's current focus. "Although basic research and application of RNAi technology in shrimp aquaculture are still in the very early developmental stages, the research I started in Thailand aims at gaining more understanding of RNAi application and applying this understanding to the study of the integrated immune network of shrimp and its interaction with viral pathogens," stated Jiang.

These continuous research efforts will expand the potential for the use of RNAi technology against various infectious diseases for the multiple aquaculture species in the Pacific region, and eventually lead to the development of effective strategies for controlling viral diseases from both preventative and therapeutic perspectives.



Using RNAi technology, Dr. Hui Gong Jiang works with Dr. Premruethai Supungul in the lab at Chulalongkorn University, Thailand.

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Children's healthy living

Childhood overweight and obesity is a growing epidemic that is occurring even earlier in life than previously observed and impacting children as early as the preschool (ages 2 to 5) years. The health and social consequences of excess weight are substantial, and obese and overweight children are at risk for serious chronic disease such as type 2 diabetes, heart disease and certain types of cancer. In the US, it is estimated that the rate of overweight/obesity prevalence in children ages 2 to 19 years is approximately 32%; however, a recent study on Guam suggests that the rate of obesity and overweight among children ages 2 to 19 years is approximately 39%.

The Children's Healthy Living Program for Remote Underserved Minority Populations in the Pacific Region (CHL) Program is a collaboration of land-grant institutions in Alaska, American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), Guam, the Federated States of Micronesia (FSM), Hawai'i, the Republic of the Marshall Islands (RMI), and the Republic of Palau (RP). In April 2011, CHL was awarded a five-year competitive Food and Agricultural Science Enhancement (FASE) Coordinated Agricultural Program (CAP) among Pacific Region USDA-defined Experimental Program for Stimulating Competitive Research (EPSCoR) grant from the United States Department of Agriculture. The overall goal of the CHL program is to

prevent early childhood obesity and improve the health of young children; and one of the specific objectives used to accomplish this was to design and test a community-based, environmentally-focused intervention program.

However, before the CHL environmentally-focused intervention program was launched, an extensive amount of baseline data was collected from approximately 1,000 young children, ages 2 to 8 years, from five different villages on Guam. This was done to determine the effectiveness of the intervention program efforts, and to learn more about the health and food consumption behaviors of young children living in Guam. Results from the baseline data collection have been entered and analyzed, and the following are some preliminary results on the dietary data collected in a sample of food logs from Guam.

Children's healthy living

What are children eating on Guam?

The following table lists the top five reported foods from the two-day food logs of children living in the following villages:

Agat / Santa Rita	Agana Hts / Sinajana	Yona/ Talafofo	Yigo
Water	Water	Water	Water
White rice	White rice	White rice	White rice
Sweetened tea	Milk	Milk	Milk
Milk	White bread	Sweetened tea	White bread
White bread	Soy sauce	White bread	Soy sauce

The next table reports the percentage of children from the different villages on Guam who consumed the recommended number of fruits and vegetables, as reported on their two-day food log.

Village	% Children who met recommended fruit intake	% Children who met recommended vegetable intake
n=187 Agat/Santa Rita	48%	9%
n=174 Agana Hts/Sinajana	33%	14%
n=252 Yona/Talafofo	70%	5%
n=168 Yigo	45%	0%

Baseline data indicate that the diets of young children on Guam have a lot of room for improvement.

Since baseline data collection was completed in 2013, the Guam CHL Program has focused on delivering an environmentally-focused intervention program that consists of six target behaviors to promote healthy weight among young children (ages 2 to 8 years) including: 1) increasing consumption of fruits and vegetables, preferably locally grown fruits and vegetables; 2) increasing physical activity; 3) increasing water consumption; 4) increasing hours of sleep; 5) decreasing consumption of sugar-sweetened beverages; and 6) decreasing screen time. These six target behaviors were promoted by the Guam CHL Program through many activities including community and school gardens, school-based nutrition and physical activity curricula, village walk-to-wellness programs, and other activities.

The Guam CHL Program has only just finished the 24 month data collection and the analysis will be completed by the end of 2016. They continue working with local partners to ensure the long-term sustainability of their efforts to promote a healthy lifestyle for Guam's children.

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The greatest danger to our future is apathy.
~Jane Goodall

United States Department of Agriculture

National Institute of Food and Agriculture

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All of Guam's indigenous tree snails are under threat of extinction and in 2015 have been added to the federal Endangered Species list.