2016

WESTERN PACIFIC TROPICAL RESEARCH CENTER

IMPACT REPORT

College of Natural & Applied Sciences | University of Guam

Buenas yan Hafa Adai,

"Somewhere, something incredible is waiting to be known." - Carl Sagan

The Western Pacific Tropical Research Center is proud to showcase some of our 2016 research, extension and instructional outcomes and the relevance we play in the advancement of science in our small island of Guam. We strive to make communities better by taking on complex issues and solving them efficiently with a focus on local circumstances.

This year we have highlighted projects that portray the diversity of what WPTRC is engaged in on Guam and in our region. Inside you will find articles related to one of our newest invasive insects, the greater banded hornet and its possible impact on humans and animals; variety trials with both kale and bell peppers; another invasive insect that has devastated Guam's cycads; how one of WPTRC scientists has begun addressing the lack of data needed to support conservation decision-making policies; studying vegetation recovery following climatic catastrophes; a group of faculty and students aim to prevent the extinction of Guam's rare plant species; an invasive plant pathogen, citrus canker, that targets most citrus varieties on Guam; best practices to improve the health of goats on Guam; more bad news with regards to the coconut rhinoceros beetle; a new study showing the relationship between shrimp genetics and water salinity tolerance; and last but just as important as the work listed above, how Guam is dealing with child obesity issues and healthy activities that help aid with this issue.

I want to personally thank all those individuals who have contributed to the 2016 WPTRC impact report and especially to my administrative staff who set true examples of leadership. Collectively we are making a difference in the lives and welfare of our community and as a land grant institution this is a major goal.

So yes, "Somewhere, something incredible is waiting to be known."

Si yu'us ma'ase,

Lee S. Yudin
Dean/Director

Hafa Adai,

It's been a great year for the Western Pacific Tropical Research Center, and the projects highlighted in this year's impact report demonstrate some of the important work happening at the University of Guam. In 2016, 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. WPTRC may be a small research unit with limited financial, logistical, and human resource support; but we focus on our opportunities, such as: our proximity to Asia, clean ocean water for aquaculture research, partnerships with other entities in Micronesia, commitment by the U.S. government to preserve native species on Guam, and interest by other research entities to collaborate.

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 2016, 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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A honey bee with full pollen baskets enters a dragon fruit flower in Santa Rita.

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Hornets and bees and ants, oh my!

Hymenoptera, the name of the third-largest order of insects, includes ants, bees, wasps, hornets and sawflies. Entomologists have recorded 46 species of ants on Guam. The number of species of bees is unknown at this time and a new species of hornet has been recently found on island.

Big, beautiful and dangerous is a good description of Guam's newest invasive insect the greater banded hornet. *Vespa tropica* is originally from Asia and it is not known how this hornet found its way to Guam.

Discovered on island on July 12, 2016 by UOG graduate student Christopher Rosario, this new invasive was initially identified by UOG biology major Lee Roy Sablan and later verified by USDA. This hornet can be very aggressive if its nest is threatened. "The sting from this large wasp is very painful and can be deadly for people who are allergic to bee, wasp and hornet venom," cautioned Dr. Ross Miller, "Unlike bees, hornets and wasps can sting their victims multiple times and inject much more venom than honeybees."

Greater banded hornets are known to attack the nests of Polistines (paper wasps) in order to obtain the larvae to feed their own larvae. It is said to be almost exclusive in choice of prey. However, they sometimes catch honeybees.

Since the greater banded hornet has been found on Guam, Dr. Miller's lab has received

Above is the front side of a greater banded hornet nest with eggs and larvae. Below is the back side of the nest, which was built on the ground.

calls daily regarding sightings of individual insects and nests. Luckily, many of the calls have turned out to be false alarms. However, his lab is tracking all reports and conducting a delimiting survey using input from the public to understand just how widespread and abundant the wasp is on the island. Since the sting is painful and the venom potentially lethal to certain individuals, Miller suggests that if a greater banded hornet nest is found near a residential area or school it is best to contact one of the many professional pest control companies on island for removal.

Despite their ability to sting, most bees, wasps and hornets are beneficial for the environment in that they provide pollination services to flowers and crop plants. They also prey on other insects, especially their larvae, which helps keep the insect pest population under control.

Dr. Miller removes an adult greater banded hornet from a nest that was found then placed in a freezer to kill all the occupants.

Continued on next page →

Hornets and bees and ants, oh my!

The Entomology Lab is uncovering some very interesting information about honeybee health in the Marianas. Chris Rosario (holding bees at right), research associate with the WPTRC, has been surveying bees on Guam and in the region as part of the USDA-sponsored Honeybee Health Survey.

Rosario has been sampling domestic and feral hives to verify the presence or absence of the parasitic mite *Varorra destructor,* which uses its piercing-sucking mouthparts to feed on the blood of honeybees and their larva. Beekeepers fear finding the mite in their bee colonies as many bees die or are born with deformities caused by viruses carried by this mite. The varorra mite spreads the deformed wing virus in bee colonies, which causes wing deformity in honeybees and has a negative impact on their immune systems. Varroa mites are suspected of being the primary cause of "honeybee colony decline" worldwide.

Rosario has been sending samples of the varroa mites he has found on Guam, Rota, Tinian, and Saipan to Dr. Ethel Villalobos at the University of Hawai'i at Mānoa. "It is interesting how a region where varroa mites are found in bee colonies that neither the bees nor the mites test positive for deformed wing virus," said Villalobos. This leads researchers to wonder whether the deformed wing virus is not present in the Mariana Islands or, if the virus is present, whether the honeybees in the region are immune to the virus. "More testing is needed to really understand the ecology of the varroa mite and bee colonies in the region," said Rosario.

The good news for Guam is that honeybees continue to test negative for the presence of varroa mites. "Hives on Guam have not tested positive for varroa mites since June 2015," said Rosario.

In related activities, Miller's lab continues to conduct ongoing surveillance of little fire ants throughout Micronesia and invasive Asian citrus psyllids on Guam and the CNMI, as well as monitoring the Northern Mariana Islands for coconut rhinoceros beetle activity. As the hub of the region, any invasive insects found on Guam pose a serious threat to neighboring islands.

With only three entomologists in Micronesia, Guam Territorial Entomologist Russ Campbell and WPTRC entomologists Ross Miller and Aubrey Moore, the WPTRC Entomology Lab provides an invaluable service to Guam and the region.

Funded by USDA APHIS and US Forest Service

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Vitamins K and C for Guam

For several years running, kale has been touted as the new superfood. Articles on nutrition exhort the many benefits of eating this nutrient-rich plant encouraging folks to put it in their smoothies, salads and on their dinner plates. Kale can even be found ready to eat in health food stores dehydrated and seasoned as kale chips, a delicious and easy way to get vitamins A, B6, B12, C, D, E and K.

Extension Horticulturalist, Joe Tuquero, conducted Chinese kale and bell pepper variety trials at the Yigo Experiment Station to find out what varieties would be best suited to Guam's tropical climate. Both kale and Chinese kale are different cultivars of the same plant, *Brassica oleracea*.

Four varieties of Chinese kale and five varieties of bell peppers were transplanted into the field consisting of Guam cobbly clay loam; a commonly cultivated soil in northern Guam that is low in fertility. The four Chinese kale varieties used in this study were Peth Nam Eak, Yhod Fa, Emperor, and Green Leaf. The five bell pepper varieties were California Wonder, King Arthur F1, Intruder F1, Chinese Giant, and Gourmet F1. Tuquero examined the plants for growth characteristics and collected marketable yield data from each variety spanning 30 to 45 days.

All four Chinese kale varieties, except Green Leaf, grew to their potential with similar marketable yields with no significant difference amongst harvested yield of all varieties. Green Leaf produced an early quality harvest of young leaves and bolts, but this variety was clearly lower in yield size and weight than the other three varieties.

As for the bell peppers, prior to heavy mite and thrip infestations, only Gourmet F1, Intruder F1, and King Arthur F1 produced fruits to their potential sizes as indicated on their respective descriptions. All varieties produced marketable quality green fruit, but most fully maturing fruits were infected with anthracnose fruit rot. Sun scalding, fruit damage from extreme exposure to sun rays, occurred on a few fruits, particularly those not protected by canopy or leaf cover.

Chinese kale and bell peppers are nutritious vegetables that are served in many eateries on island. Chinese kale is primarily used in Chinese cuisine and with the many Chinese restaurants on Guam, there is a good market for this vegetable. It can be grown in Guam's climatic conditions, and it is fairly easy to cultivate. Chinese kale may be a potential commercial crop for Guam growers. All varieties of bell peppers produced well, but must be watched for infestations. Bell pepper is definitely a potential commercial crop for Guam growers.

Funded by USDA NIFA Hatch

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They just keep coming

Invasive insect species have devastated Guam's forests by selectively killing *Cycas micronesica*, which essentially removed the ecosystem services contributed by the tree. These before and after photographs are haunting.

The landing of Magellan's fleet 495 years ago began the written records of how alien arrivals cause the death of Guam's inhabitants. The killing began without delay. Over the centuries we have amassed a considerable list of examples of how new alien arrivals negatively influence Guam's unassuming inhabitants.

Guam's invasive species have been showcased to the international community, but almost all of the attention has been devoted to the invasions of the brown tree snake and various insects. Yet the role that plants can have for illuminating how lessons from Guam can benefit the world's invasion biology community is of paramount importance. Recently, Dr. Thomas Marler has been responding to the need to add plant-focused research to the invasion biology literature.

For example, *Cycas micronesica* was the most abundant tree in Guam's forests in 2002, but mortality following the invasion of the Asian cycad scale in 2003 and the cycad blue butterfly in 2005 was so rapid and so widespread that the International Union for Conservation of Nature listed the tree as endangered in 2006. Organisms that influence ecosystem-level properties because of their sheer number are called foundation species. There may be no other historical example of how a vibrant foundation species such as *Cycas micronesica* in an island setting was damaged by invasive species in a manner that generated endangered status only three years after the invasion events.

Against this context, Guam emerges as an alluring case study of global relevance. The island possesses archetypal examples of unbridled invasions by non-native species, habitat destruction, forest fragmentation, and over-exploitation of natural resources. Guam may thus serve as a lens through which the future of many other small islands may be seen.

But the clarity of that lens and how far it allows other islands to see into the future is dependent on informative research that illuminates the destructive forces with precision and defines the contextual implications. Indeed, the United States National Invasive Species Council recently published their urgent priority actions, which included the fostering of scientific, technical, and programmatic innovation necessary to prevent and mitigate the impact of invasive species. Through its mission, the WPTRC is ideally positioned to serve as the generator of the research that is a prerequisite for invasion biologists in other islands to learn from Guam's environmental degradation.

One of the outcomes of Marler's recent research revealed that the persistent presence of the invasive tangantangan tree (*Leucaena leucocephala*) exerts profound changes in soil chemistry. Invasion of this legume tree alters the process called mineralization, such that stored carbon and nitrogen decline. Presence of this alien woody tree can actually transform habitat traits that control ecosystem function, and these transformations persist even if the alien tree is removed. The findings indicate that removal of alien trees such as tangantangan from Guam's forests during restoration efforts will not be enough to return the habitats to healthy "native" conditions.

In a context of worsening worldwide invasions, Guam is already succumbing to invasion meltdowns characteristic of the predicted future of other insular settings. Therefore, Marler's research revealing the impacts of an invader plant on ecosystem function serves as a window into the future of many other locations worldwide.

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Funded by USDA NIFA Hatch and United States Department of Defense

Our role in terrestrial plant conservation

The orange fruits of Guam's threatened *Tabernaemontana rotensis* trees are striking.

The United States Endangered Species Act (ESA) requires that the best available science be employed to drive conservation decisions to curb extinctions and preserve biodiversity. Unfortunately, the ESA does not go into detail on how to enact this requirement. As a result, conservation

professionals in some regions like the Mariana Islands have exhibited an unserious response to the mandate, revealing few examples of the empirical research that is required to construct the foundation of knowledge to enable the best available science. For example, a federal plan to recover Guam's endangered *Serianthes nelsonii* was published in 1994 and explicitly called for more research as one of the actions necessary to meet the recovery criteria. For the next two decades, only one publication based on verifiable experimental methods appeared in a science journal. If those two decades of conservation of *Serianthes nelsonii* are used as a sentinel for predicting efficacy of future conservation programs for other Mariana Island species, a need for re-imagining the approach becomes clear.

Dr. Thomas Marler has begun to address this historical void in research with journal publications that propel forward conservation knowledge for Guam's native trees. Model species that were included in recent publications were *Cycas micronesica, Elaeocarpus joga, Intsia bijuga, Serianthes nelsonii,* and *Tabernaemontana rotensis*. These charismatic trees are succumbing to the numerous threats with declining populations. Three of them are formally listed for protection under the ESA.

The recent conservation articles published by the WPTRC illuminate how conservation efforts may improve if each conservation professional respects which component of the knowledge-action framework that their institutional mission supports. WPTRC's mission is "excellence in research…" so our contribution to conservation demands a clear focus on research. This will enable a greater foundation of empirical information that moves conservation attempts beyond casual and anecdotal approaches. Conservation decisions based on anecdotal information and personal opinions are highly risky. Lack of evidence-based information to support decision-making jeopardizes conservation investments and leads to inefficient use of public resources. The ability to use quality data for improving conservation actions is fundamentally dependent on publication of experimental results in established science journals.

About 10% of the world's 8,000+ tree species are currently threatened with extinction, so Guam's threatened tree species are an integral part of a global crisis. Marler's publications have shown that the WPTRC can be a luminary in the field of conservation science if we just demonstrate discipline to restrict our role to knowledge production in conformity with our mission. Recognizing the need for quality research archived in science journals will help conservation decision-makers and practitioners to move beyond the historical barriers that have inhibited past conservation efforts in the Mariana Islands.

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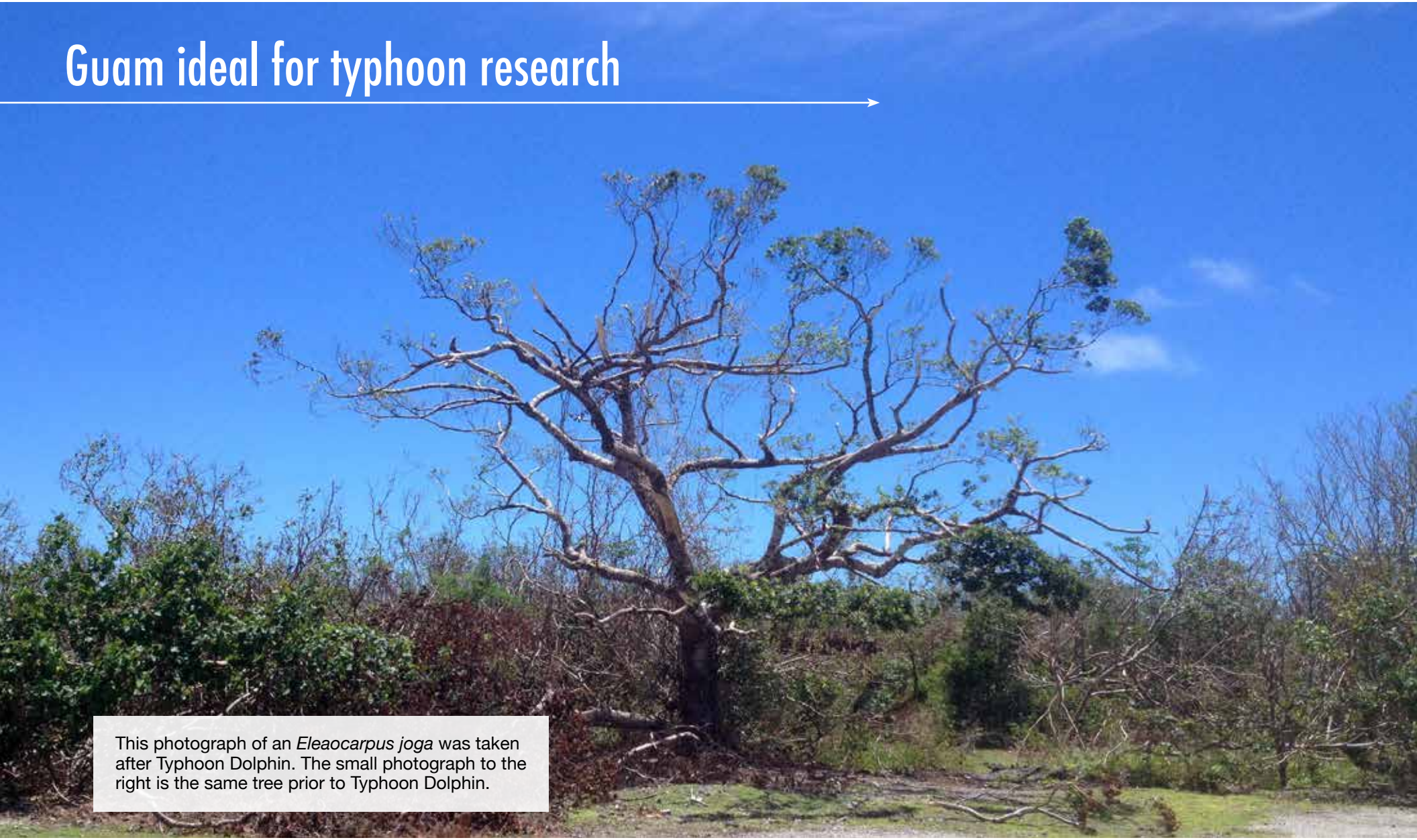
Funded by United States Department of Defense

Guam ideal for typhoon research



This photograph of an *Eleaocarpus joga* was taken after Typhoon Dolphin. The small photograph to the right is the same tree prior to Typhoon Dolphin.

Botanist Benjamin Stone once proposed the term "typhoon forests" as a descriptor for Guam's forest habitats. His observations of the "monotonous regularity" of typhoons in shaping the appearance of Guam's forests were at the root of his proposal. The universal term for what we call a typhoon is tropical cyclone. Many coastal regions such as the eastern coastline of the continental United States are subjected to these intense storms, and every effort to study their interactions with coastal vegetation is of great importance to the entire world. As a result, Dr. Thomas Marler has recently published several studies of habitat-level responses to typhoons in Guam and the Philippines. "Justifying typhoon research is a no-brainer for any biologist in the Western Pacific," said Marler. "We live and work in the most active tropical cyclone region in the world."

The May 2015 passage of Typhoon Dolphin offered an opportunity to study the responses of Guam's *Cycas micronesica* population to the typhoon, then compare those outcomes to Marler's prior publications following Typhoon Paka in December 1997 and Typhoon Chaba in August 2004. The 2015 typhoon occurrence was the first time that Guam's *Cycas micronesica* population was challenged by a typhoon since the invasion of several herbivorous insects that have threatened the plant. Based on Marler's past research that used winching techniques to reveal the biomechanical integrity of this plant's stems had been compromised by the alien insect infestations, an increase in stem breakage was predicted for Typhoon Dolphin damage in comparison to the earlier typhoons. The results confirmed this prediction, with catastrophic stem damage during the 2015 typhoon greatly exceeding that during earlier typhoons.

Marler and his coauthors, John "Bart" Lawrence and Gil Cruz, used the Typhoon Dolphin study to reveal how an invasive species can lead to damage of a native tree species in surprising ways. Guam's *Cycas micronesica* population evolved with the chronic pressure of typhoons. This native tree was highly resistant to damage during past typhoons, then revealed rapid recovery following those typhoons. But after several years of damage by the invasive insects, the natural ability of this tree to take what typhoons dish out was compromised such that the May 2015 typhoon event led to an unprecedented 23% catastrophic damage in some exposed habitats.

Access as a resident scientist to the many opportunities for studying vegetation recovery following a typhoon is not the only justification for typhoon research on Guam. Predictions surrounding global climate change also offer substantiation. Predictive models exist about future frequency of tropical cyclones and suggest that highly intense tropical cyclones will occur with greater frequency as a result of climate change. This confers on Guam forests an essence of what coastal forests elsewhere might increasingly come to look like as severe tropical cyclones appear with greater frequency worldwide in the future. Marler's recent typhoon publications have revealed how a greater emphasis on Mariana Island typhoon research can position the WPTRC in the vanguard of tropical cyclone knowledge production.

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Funded by USDA NIFA Hatch and United States Department of Defense

We can step up

Dr. Thomas Marler and Paris Marler inspect leaves of *Cycas nongnoochiae* plants in central Thailand habitat. This and other cycad species comprise the most threatened plant group worldwide.

Ensuring Guam's research is communicated in established science journals guarantees the greatest utility of the knowledge worldwide. As international experts, journal editors and reviewers are the unbiased gatekeepers that ensure quality science is communicated. Journal articles

require authors to include experimental and statistical details such that users of the information can conclude for themselves the sufficiency in research quality. Journal articles are readily located and accessed by users through routine use of search engines. And journal articles are locked in a safe archive of knowledge such that future users can find the information in 2 years, 20 years, even 200 years. When research results are only communicated in project reports to funding agencies, the information goes into what scientists call the dark files, never to emerge in a manner that benefits university stakeholders.

Linking knowledge producers with knowledge users requires a connection that is sometimes called knowledge mediation. Scientists who synthesize knowledge on a subject by crafting literature reviews or meta-analyses are key players in this mediation. These mediators can find all of Guam's research results only if local scientists respect the need to publish in established journals.

Thomas Marler's laboratory recently coordinated the compilation of two review endeavors to assimilate current and historical issues of importance to international cycad biology and conservation. The first review undertaking teased apart cycad data from the Red List of threatened species published by the International Union for Conservation of Nature. Geographic and phylogenetic trends were uncovered and the outcome confirmed the acute threatened status of this group of plants. The Red List includes types of threats that are endangering each species, and for most of the world's locations these threats were habitat loss and wild-harvest of plants for human use.

"Guam's cycad species was revealed as the only contemporary species that reached endangered status as a result of invasive insect herbivore damage," said Marler. "This underscored the importance of fully studying the demise of the Guam cycad to showcase it as the pioneer example of how cycad species from other regions may become more threatened as invasions become more prevalent in the future."

The second review delved into historical trends from the literature generated from the series of international cycad conferences that were conducted over the past 30 years. These trends were then compared with cycad publications found in the science literature back to 1800. The results revealed the fact that the University of Guam has emerged as a world leader in cycad research, with Marler's laboratory team collectively publishing more than 60 cycad articles over the past 10 years as a result of WPTRC research.

According to coauthor April Cascasan, the advent and proliferation of the internet to house and disseminate global and historical scientific research publications has broken down the logistical and access barriers that historically marginalized remote insular locations like Guam. "Conducting the research that supported this project as an undergraduate student at the University of Guam taught me that there is no reason for Guam scientists to refrain from authoring formal literature reviews that have international relevance," said Cascasan. These WPTRC activities indicate Guam scientists need not feel confined by the mantra ***think global, act local***. Indeed, when it comes to contributing to the literature, we can ***think global, act global***.

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Funded by USDA NIFA Hatch

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Native plants in tissue culture

Elen Ziobro (left) and Rosalie Kikuchi (right) examinethe endangered orchid species *Bulbophyllum guamense* at the GPEPP lab.

The Guam Plant Extinction Prevention Program (GPEPP) aims to prevent the extinction of Guam's rare plant species though various methods. GPEPP has established a plant tissue culture laboratory to help our conservation efforts.

The main activities in the plant tissue culture laboratory are the germination of orchid species and the micro-propagation of rare plants from small pieces of the plants. It is a propagation technique in which either small seeds, embryos or vegetative propagules are sown on a medium in vitro under aseptic conditions. The media contain various concentrations of nutrients and vitamins, depending on the type of plant being propagated. Growth hormones, such as auxins and cytokinins, are sometimes added in the medium, and their concentrations affect how the propagules develop.

This seed germination technique has been used to successfully propagate several rare orchid seeds, such as *Bulbophyllum guamense, Dendrobium guamense*, and *Tuberolabium guamense*. Seeds of the common but native orchids, *Luisa teretifolia* and *Taeniophyllum mariannense*, have also been germinated. For the vegetative propagation, GPEPP's priority is on propagating the rare *Serianthes nelsonii*. There is only one *Serianthes nelsonii* mature tree surviving in the wild. GPEPP Is having success with rescuing the embryos from seeds and from using shoot tips. The tissues are

Bulbophyllum guamense orchid in its natural environment above, and in tissue culture below.

sterilized and grown in the lab in containers with sterile growing media. Tissue culture is a powerful technique that makes it possible to produce large quantities of disease-free and pest-free plants that will help reestablish Guam's native forests.

Funded by USDA NIFA McIntire-Stennis and US Fish & Wildlife Service

Serianthes nelsonii in flower above and below in tissue culture.

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Diagnostic workshop uncovers the presence of citrus canker on Guam

Dr. Raghuwinder Singh (on the left in orange), head of the Louisiana State Extension Diagnostic Center, conducts a Plant Diagnostic Training on Guam at the invitation of Dr. Robert Schlub.

It often takes a fresh set of eyes to see the whole picture, this is exactly what Dr. Robert Schlub had in mind when he invited Dr. Raghuwinder Singh, head of the Louisiana State Extension Plant Diagnostic Center, to assist him in conducting a four-day Plant Diagnostic Training in May 2016. Assisting Drs. Singh and Schlub were Extension Agent Jesse Bamba and WPTRC researchers Drs. James McConnell and Andrea Blas.

Over the course of the training, agricultural professionals from Guam and the Northern Mariana Islands received classroom instruction, which was reinforced with plant disease specimen collection field trips and laboratory exercises. The training emphasized diagnoses based on field symptoms and those revealed through the use of a hand-lens. It was during one of the field trips, Dr. Singh brought to the attention of the attendees, including Dr. Schlub and the other extension associates, of the presence of Citrus Canker on Guam, a very serious worldwide bacterial disease of citrus caused by *Xanthomonas axonopodis* pv. Citri.

Dr. Singh had become an expert on the Citrus Canker disease while taking steps in Louisiana to reduce the impact of a resurgence of this disease. Dr. Singh says, the symptoms to look for include raised brown spots on leaves and fruits that are surrounded by an oily, water-soaked area and a yellow ring. Due to the bacterium's ease of transmission, Dr. Singh emphasized the use of a hand sanitizer after touching diseased tissue. The citrus canker bacterium can also be spread from tree to tree by wind-driven rain and by contaminated tools and equipment. The transporting of infected fruit, plants or part of plants is responsible for long distance movement of the disease and is likely how it came to Guam.

The bacterium enters and infects tissue through wounds and natural openings in leaves and fruits. Dr. Singh mentioned that all citrus varieties are more or less susceptible to the disease: grapefruit, trifoliate oranges, Mexican/Key limes, navel oranges, sour oranges, sweet oranges, lemons, Satsuma oranges, tangerines, Mandarin oranges, king oranges and kumquats.

Dr. Raghuwinder Singh discusses citrus tree health with local farmer Ernie Wusstig.

This collaborative effort of WPTRC and the Louisiana State Extension Plant Diagnostic Center has strengthened the diagnostic capabilities of agriculture professionals in Guam and the Northern Marianas.

Funded by USDA WSARE

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Forages for improved health and production of goats

Allowing goats to graze for food in their pastures is a common way of feeding these livestock on Guam, but insufficient nutritional content in the local flora can result in poor health.

As part of a Western SARE Professional Plus Producer Research and Education grant, Dr. Manuel Duguies studied best practicies to improve the health of goats on Guam by providing more nutritious forages.

Plant materials from pasture areas around the island were sampled and analyzed for their nutritional content. These results, along with observations about the health of the goats that foraged in these pastures, revealed a strong need for improved forage vegetation for goats on Guam.

Next, Dr. Duguies ran feeding trials on ten varieties of nutritious forage materials accessible on Guam, including banana leaves, mulberry (*Morus sp.*), tangantangan (*Leucaena leucocephala)*, *Moringa sp.*, and a variety of grasses. At the end of the trials, the forages were ranked in order of the goats' preferences, and the goats were all in greatly improved health. These results prove that better growth and production performance of goats on Guam and in the region can be achieved through a full ration of forage.

Some of the most nutritious and palatable forages that are already common on Guam include tangantangan with 24% crude protein content (cp), mulberry with 16.9% cp, and *Moringa sp.* with 18.8% cp. These recommended forage materials grow very well on the island and produce large biomass. These plants can be planted around the farm and raised to a height of up to four feet for easier harvesting of off-shoots to be fed to the goats. Mulberry and *Moringa sp.* can be used as 100% of the goats' daily ration without any negative effects to their health.

*Leucaena leucocephala (*tangantangan) is a nutritious forage found easily on Guam.

*Morus sp. (*mulberry) grows well on Guam and is a recommended forage material for goats.

Goats that are provided with a large quantity and variety of forages will be the healthiest and happiest. Armed with the results of this research, farmers on Guam now have the tools to provide their animals with the most nutritious, palatable, and easy-to-grow local feed.

Funded by USDA WSARE

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WPTRC scientists part of special meeting to find biological solutions for CRB in Pacific

During the XXVth International Congress of Entomology (ICE) in Orlando, Florida (September 25-30, 2016), the largest gathering of its kind ever held, scientists met in a special symposium to find answers to the problem of invasive scarab beetles, damaging species that are spreading around the globe.

The meeting was timely, with reports a new, highly damaging biotype of the coconut rhinoceros beetle recently established in a number of Pacific islands, including Guam, Hawai'i, Palau, Papua New Guinea, Solomon Islands. Also, reports of the ornamental and turf damaging Japanese beetle established for the first time on the European continent in Italy. The scientists were concerned that increasing international transport and new races of pests are challenging our quarantine systems and will result in severe and ongoing damage once they break through.

A new biotype of the coconut rhinoceros beetle poses a special threat. The pest has invaded Guam, where entomologist Dr. Aubrey Moore predicts that if effective control measures cannot be found, the pest will kill more than 50% of the palms on the island. The damaging beetle was found to belong to a new biotype by AgResearch New Zealand scientist, Dr. Sean Marshall, and has since been found causing heavy damage on a number of other Pacific islands. The beetle has established a beachhead in Hawai'i, where Project Operations Manager Darcy Oishi is running a multi-million dollar program to contain and eradicate the pest.

Representative of the Pacific Community, Dr. Maclean Vaqalo, said the real threat is to the small countries and atolls of the Pacific where the coconut is the "tree of life" providing essential food and shelter to the people. If nothing is done to help the small island states in the Pacific to contain the pest it will simply re-invade the cleared areas and may even reach the American continents.

In addition to the symposium, a special meeting was called by Phil Andreozzi and Dr. Ron Weeks of the U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS) to take advantage of the presence of the assembled scientists to develop a plan to address the problem of the coconut rhinoceros beetle in the Pacific.

The expert team began work on an operational framework and established working groups to increase awareness of the problem, plan emergency responses, enhance biosecurity, and look for long-term biological solutions. Participants were pleased with the meeting and the opportunity offered by ICE to start to address the problem in a coordinated fashion to overcome this severe threat as soon as possible.

Guam was represented at the meeting by University of Guam entomologists Dr. Aubrey Moore and Dr. Ross Miller.

To access abstracts from the symposium concerning coconut rhinoceros beetle, please visit: **https://aubreymoore.github.io/CRB-G-ICE2016/Session26139.html**

Funded by USDA NIFA Hatch

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The effects of varying salinities on shrimp families

Salinity has a profound effect on the food consumption, energy demand, nutrient utilization, and molting and metabolic rates of shrimp. The optimal salinity for juvenile penaeid shrimp, a common commercial species, is fairly high at between 15 to 25 parts per thousand (ppt). However, shrimp can tolerate a large range of salinity, meaning they could grow in brackish water, which may be the only available resource for some aquaculture farms, including many on Guam. A fast-growing strain of shrimp in low salinity water would be very valuable for such aquaculture activities; however, it is not well understood how genetics affect the shrimp's performance in low salinity water compared to shrimp reared in seawater.

Dr. Hui Gong Jiang leads her team of two visiting scholars and three staff members at the CNAS Guam Aquaculture Development and Training Center (GADTC) in the study of the relationship between shrimp genetics and water salinity tolerance.

The team stocked two ponds, initially both filled with seawater, with 200 juvenile shrimp from ten distinct families. One pond remained filled with seawater (32ppt), and the other pond was gradually changed from seawater to freshwater (2ppt) over the course of a week. Forty-five shrimp from each of the families from the two ponds were sampled every two weeks for growth.

At the end of the trials, the team analyzed the final weights and survival rates of the shrimp, and collected tissue samples for gene expression analysis. They then evaluated the differences between the families for potential family-based selection under low salinity conditions.

The results showed significant familial differences in terms of growth, survival, and genetic expression of various biochemical markers. One family exhibited a higher growth rate in the low salinity water than the higher salinity water, among other beneficial responses. This family could be used to breed a line of shrimp specifically for farms with low salinity water. Additionally, two of the other families demonstrated superior performance in both salinities, which may qualify them as good candidates for breeding stock regardless of water salinity. This information is valuable for selective breeding of shrimp in low salinity water environments, as well as useful to both academia and the aquaculture industry in general.

Funded by USDA NIFA Hatch and government of Guam

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Children's Healthy Living

In the U.S., obesity in children is occurring at younger ages than previously observed and is impacting children as early as age two. Being obese or overweight carries substantial health consequences. Children are at risk for serious chronic diseases including type 2 diabetes, heart disease and certain types of cancer. The estimated rate of overweight/ obesity prevalence in the U.S. for children ages 2 to 19 years is approximately 32%; however, a recent study suggests that the rate of obesity and overweight for children of those same ages on Guam is significantly higher than their US counterparts at 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). 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.

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 5 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 collected on the physical activity in a sample of activity logs and Actical accelerometer data from Guam.

How physically active are children on Guam?
Of the 367 children with accelerometer data, 179 (48.8%) children met the U.S. national recommendations for achieving at least 60 minutes of moderate or vigorous activity daily, which is also a CHL behavioral intervention target or goal. There was no significant difference in activity level by village. This information can be found in the following table.

Physical activity from accelerometer	Agat / Santa Rita	Agana Hts / Sinajana	Yona / Talafofo	Yigo
Sedentary activities per day	11.17 hrs	11.5 hrs	11.4 hrs	11.27 hrs
Light activities per day	11.72 hrs	11.4 hrs	11.5 hrs	11.61 hrs
Moderate activities per day	1.06 hrs	0.96 hrs	0.97 hrs	1.07 hrs
Vigorous activities per day	0.08 hrs	0.07 hrs	0.07 hrs	0.08 hrs
Moderate & vigorius activities per day	1.17 hrs	1.03 hrs	1.04 hrs	1.15 hrs

Parents were asked, "On usual weekdays (Monday to Friday), how many hours a day does your child spend watching television and/or videos/DVDs?" Parents were then asked how many hours their child spent playing active and inactive video games on weekdays. They were asked the same questions about the weekend days. The next table reports the screen time (adding the hours for watching TV and DVDs, the hours playing active video games, and the hours playing inactive video games) of children from the different villages on Guam. This information is summarized in a table on the next page.

→

Children's Healthy Living

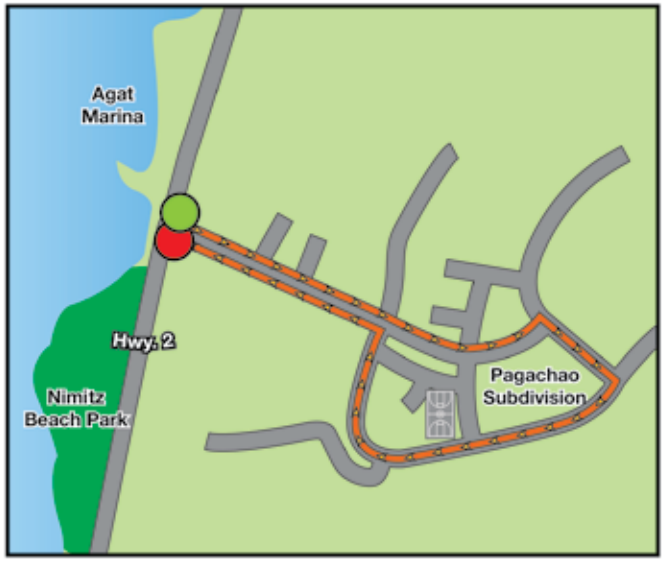
SOUTHERN GUAM WALKING TRAILS

Agat

Distance: 1.0 miles
Difficulty: Medium
Trail Type: Sidewalk

Start at the stop sign at the entrance to Pagachao. Stay on the sidewalk with a slight hill until you reach a T intersection and make a right. Make a right at the next stop sign and you will pass a basketball court. Make a left back to your starting point.

This route is all on paved sidewalks. It is safe with a little incline for a challenge.



UNIVERSITY OF GUAM WALKING TRAILS

UOG Triton Loop

Distance: 1.0 or 1.4 miles
Difficulty: Easy
Trail Type: Sidewalk/ Residential Road

Starting at the Agriculture and Life Sciences Building at the University of Guam, follow the sidewalk around the perimeter of the campus, taking College Lane to head back to University Drive.

When you reach Dean's Circle, you may go straight to walk a distance of one mile, or you may turn right and walk around the loop to increase your distance to 1.4 miles.

Hours per day child watches TV	% of Children Agat / Santa Rita	% of Children Agana Hts/ Sinajana	% of Children Yona/ Talafofo	% of Children Yigo
1/2 hour or less	0.0%	3.94%	4.26%	6.44%
More than 1/2 hour up to 2 hours	11.73%	16.75%	13.48%	11.39%
More than 2 hours up to 4 hours	24.58%	26.60%	33.33%	27.23%
More than 4 hours up to 6 hours	24.02%	24.63%	21.99%	17.33%
More than 6 hours up to 7 hours	39.66%	28.08%	26.95%	37.62%
Total	100%	100%	100%	100%

The national recommendation is that young children should spent 2 hours or less on screen time per day. Only 13.5% of the children from the various villages met this recommendation. Baseline data indicate that the levels of physical activity of young children on Guam have a lot of room for improvement.

The Guam CHL Program is now working with local partners to ensure the long-term sustainability of their efforts. Over the past 5 years, the Guam CHL Program has developed long-term partnerships with the New and Veteran Farmer's Program, SNAP-ed, EFNEP, 4H, the Department of Public Health and Social Service's Non-Communicable Disease (NCD) consortium, Guam Department of Education, and the Mayor's Council of Guam, and many other community partners and sponsors. Through these partnerships we tested many community-based interventions to increase physical activity. Community/ University partnered approaches have proven successful in the implementation and long-term sustainability of our efforts.

Through the "Getting Guam Healthy Incentives Program" (P.L. 32-179), $700,000 was appropriated to the NCD to promote health, wellness, physical activity, and the effective use of social and healthcare services for medicaid-eligible recipients and other disadvantaged populations on Guam through individual, family, and community programs. The NCD Physical Activity Team received funding to implement both the Walk to Wellness Program ($200,000) and the Early Start, Fit for Life Initiative ($300,000), which builds upon earlier CHL activities. The Walk to Wellness Program focuses on increasing daily physical activity throughout the island by improving availability and accessibility in each village. Efforts include short-term solutions such as implementing physical activity, conducting health screening and education, and longer-term environmental changes in identified villages in order to increase overall physical activity levels for all in the community.

Dr. Bob Barber leads the way in the Million Step Village Challenge. The village maps pictured on the left can be found on the CNAS website at: **http://cnas-re.uog.edu/walking-maps/**.

The Early Start, Fit for Life Initiative's goal is to reduce and/or eliminate non-communicable diseases, including common and modifiable risk factors, such as obesity in children, and to promote health, wellness, and physical activity during and after school at Guam

Continued on next page →

Children's Healthy Living

Department of Education (GDOE) in order to provide students with the minimum of 25 minutes of instructional physical education. Key objectives of the program include: a School Program Consultant to ensure program sustainability and build GDOE's capacity to support physical activity in the elementary curriculum; to standardize and enhance the monitoring of the health, wellness, and physical activity of students at the elementary school level through BMI screenings; to provide SPARK training/SPARK curriculum and kits, coordinators and support; and the School Health Intervention Program to create avenues for teachers and local organizations to implement physical fitness and wellness activities both during and after school.

Additional funding has been awarded to Dr. Bob Barber ($126,709) and Dr. Clare Camacho ($71,674 and $144,110) through the Guam Cancer Trust Fund (P.L. 30-80) to conduct cancer preventative interventions in the community. These activities will expand the efforts and reach of both the Walk to Wellness Program and the Early Start Fit for Life Initiative.

With the knowledge of healthier lifestyle choices, obesity can be prevented at an early age. The CHL program has adopted "The Food Friends, Get Movin with Mighty Moves" curriculum for the GDOE pre-k classrooms. This program takes a two-pronged approach to health with both a physical and nutritional component. The program promotes healthy eating behaviors and enhances motor skills. Guam DOE pre-k classrooms have already implemented the physical component, "Get Movin' with Mighty Moves" and will introduce the nutritional component "Fun with New Foods" in January 2017.

To date, the CHL program has made a significant impact on health-related issues in Guam villages and schools through the efforts highlighted above. Their successful affiliation with various agencies, schools and community partners ensures the longevity of their work and will do much to inform their research.

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United States Department of Agriculture

National Institute of Food and Agriculture

WPTRC
RESEARCH FOR GUAM'S FUTURE

THE COCONUT RHINOCEROS BEETLE:

AN INVASIVE SPECIES ON GUAM

College of Natural & Applied Sciences
University of Guam | Unibetsedåt Guåhan

FAST FACTS:

- **Scientific name:** *Oryctes rhinoceros*
- **Discovered on Guam in 2007**
- **Rhino beetles are nocturnal and are most active about an hour after sunset.**
- **Can fly up to two miles at a time.**

FEMALE CRBs:

Smaller horn

Posterior ends usually covered in reddish hairs

MALE CRBs:

Larger horn

Little to no reddish hair on their posterior ends

HOW DID THEY GET HERE?

It is still unknown. However, it is likely that one or more beetles hitch-hiked with imported cargo.

WHAT THEY DO:

Rhino beetles' effects on our coconut trees can be seen all over the island.

They burrow into the crowns of palm trees to feed on the sap, causing the fronds to grow out with distinct v-shaped cuts.

The trees are killed when the beetles destroy the growing tip of the trees in their attempt to feed.

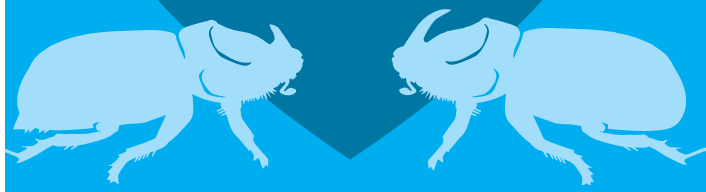
Only adult beetles cause harm to our trees. Juveniles feed on decaying vegetation at breeding sites.

HOW TO HELP:

PRINCIPLES OF COCONUT RHINOCEROS BEETLE (CRB) MANAGEMENT

- **Education:** Learn the facts about CRBs and the proper care of palm trees.
- **Monitoring:** Observe CRB activities and damages in the area.
- **Sanitation:** Maintain the areas' green waste and trees.
- **Trapping:** Use traps to help prevent CRBs from damaging your trees.

Rhino beetles mate and lay their eggs in green waste and decaying matter- keeping your land clear of waste will prevent your yard from becoming a rhino beetle breeding ground!



TYPES OF CRB TRAPS:

1

Tekken Netting

Placing tekken netting over piles of green waste can trap beetles when they try to breed.

2

Barrel Traps

Barrel traps attract beetles with green waste, LED lights, and pheromones, then trap them in netting.

3

Tree Bow Ties

Bow tie traps, constructed of tekken net and stones, are placed directly in coconut trees to trap beetles as they try to feed.

4

DeFence Traps

DeFence traps lure beetles with pheromones and LED lights, then trap them in netting placed on a fence line.

FIND OUT MORE:

To learn more about coconut rhinoceros beetles, including information about how to prepare traps, visit UOG's coconut rhinoceros beetle page at:

www.cnas-re.uog.edu/crb

or call:

(671) 735-2080

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