COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS
DEPARTMENT OF LANDS AND NATURAL RESOURCES

ACTION PLAN
For
Oryctes rhinoceros
2018 – 2023

OFFICE OF THE GOVERNOR

CNMI LEGISLATURE

USDA AFFILIATED AGENCIES

DEPARTMENT OF LANDS AND NATURAL RESOURCES

REVIEWED BY:

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INTRODUCTION

The Northern Mariana Islands, officially the Commonwealth of the Northern Mariana Islands (CNMI; Chamorro: *Sankattan Siha Na Islas Mariånas*), is one of the five inhabited U.S. island territories (the other four are Guam, Puerto Rico, the U.S. Virgin Islands and American Samoa). It is one of two territories with "Commonwealth" status; the other is Puerto Rico. It consists of fifteen islands in the western Pacific Ocean, about three-quarters of the way from Hawaii to the Philippines. The United States Census Bureau reports the total land area of all islands as 183.5 square miles (475.26 km^2). As of the 2010 census, the Northern Mariana Islands had a population of 53,883, of whom over 90% live on the island of Saipan. Of the 14 other islands, only two – Tinian and Rota – are permanently inhabited. (http://en.wikipedia.org/wiki/Northern_Mariana_Islands)

Because of island's geographic isolation, its limited and fragile natural resources lacks diversity and pest resistancy in terms of fending itself from newly introduced invasive and detrimental species. Newly introduced species of plants, insects or pathogen from other countries, tends to multiply significantly due to the islands ideal condition. Any new introduction almost guarantees the absent of its natural enemies, which makes it even harder to control if not detected and dealt with immediately.

Currently there are numerous species of plants, insects, animals, and pathogens within the CNMI that can be classified as pests. Species with the greatest potential for damage are those introduced with the absent of their biological enemies.

At the same time, there is always the risk of new introductions, as contact with other areas via shipping, airplanes, and tourism increases. Ongoing work by the Quarantine staff has remained constant in focusing most of its attention in the imports of agricultural goods via ports of entries, where pests are most likely be introduced. Currently, the Department of Lands and Natural Resources *(DLNR)* continues to monitor and inspect cargos for listed species on table I and II (page 5 and 6), and others as listed in the http://www.hear.org/pier/, and the USDA APHIS websites.

Threat of invasive species exists on neighboring island (Guam and Rota), whereas introduction is just a matter of when and how. Recently, Coconut Rhinoceros beetle (*Oryctes rhinoceros*) was discovered on the island of Rota and were being addressed by DLNR team. The Little Fire Ant (*Wasmannia auropunctata*) still remain on Guam as well as the Great banded hornet (*Vespa tropica)*. These species are currently on the island of Guam, just 90 km away from Rota and 218 km away from the Saipan.

DLNR will working closely with Entomologist and Pathologist from the University of Guam -Agriculture and Life Science and the Director of Invasive Species also in Guam, to assist in addressing detrimental species in the CNMI. These professionals must provide an agreement letter stating their willingness to assist in identifying discovered pests in and throughout the CNMI's Forests, Urban Forest and throughout its Farmers and Ranchers private property respectfully.

For a number of years, dealing with pest problems in the Commonwealth has been handled as each problem is encountered. Attempts to minimize insect and disease problems have included monitoring and eradication via chemical and biological control methods have been deployed. Strict quarantine measures have requested annually, but due to budget constrain, staffing and workload are currently insufficient to address these point of entries.

Federal programs has been applied and designed specifically to assist the DLNR in meeting its need to monitor and control pests, and to promote a healthier and a more manageable practices. The program's goals identifies, monitoring and preventive, if necessary, controlling existing detrimental pests that threatens the CNMI's Ecosystem. The term "pests" includes insects, diseases, plants, and animals that have a detrimental effect on the condition of forest resources.

Impart of the DLNR's mission is to avail feasible technology assistance to land-managers, farmers and ranchers that are committed to the protection, restoration, maintenance, enhancement and/or conservation of the islands fragile resources. The strategic direction is to ensure that such benefits were shared accordingly and that all issues are recorded and taken affirmative action to protect, preserve, conserve, sustain and enhance the three pillars of agricultural practices and ecosystems.

DLNR will continue to administer programs along with the advisement from the Commonwealth Invasive Species Council, throughout each funded year. The Council is made up of resource professionals, state and federal agency, program managers, private landowners, and private businesses.

PURPOSE:

The purpose of the this Strategic Plan is to develop an acceptable and more feasible approach towards prevention, detection and eradication of Oryctes rhinoceros and other pest that threatens our fragile and limited natural resources, while maintaining cultural and traditional practices, promoting economic development, and to edify land managers and landowners the values of our fragile land resources.

This plan will also serve as a Standard Operating Procedure (SOP) in ensuring suitable and acceptable approach towards eradication of Oryctes rhinoceros and other introduced non-native pest species. The methodology will be practical and achievable in an acceptable time period. The outcome will undeniably protect and enhancement of wildlife habitat, recovery of native or indigenous tree species, and more will be realized.

VISION:

DLNR's vision is to have a thriving and healthy flora and fauna, while sustaining the island fragile ecosystem. With healthy ecosystem, regeneration of native plant species, diversified tree stands, cleaner water table, balanced synergy amongst all living and non-living organism.

MISSION STATEMENT:

The mission of DLNR is to protect its natural resources from harmful pest while applying sound management practices. Provide the best pest management services in the CNMI in which we serve in the most professional and safe manner. We will accomplish this by providing the best quality of work with the finest employees the Department can provide. Enhance economic benefits through marketing and public awareness, and protect crops and livestock from harm and enhance public benefits through the use of natural resources.

CURRENT SITUATION:

A newly discovered and confirmed pest known as Oryctes rhinoceros (Coconut rhinoceros beetle) was the discovered on Rota in October 2017. These pest is known to have detrimental impact on coconut palms (Cocos nucifera). Coconut (*Cocos nucifera*) is a member of the family Arecaceae (palm family).

Coconuts are known for their versatility ranging from food to cosmetics. They form a regular part of the diets of many people in the tropics and subtropics. Coconuts are distinct from other fruits for their large quantity of water (also called "juice"), and when immature, may be harvested for their potable coconut water. When mature, they can be used as seed nuts or processed for oil, charcoal from the hard shell, and coir from the fibrous husk. When dried, the coconut flesh is called copra. The oil and milk derived from it are commonly used in cooking and frying, as well as in soaps and cosmetics. The husks and leaves can be used as material to make a variety of products for furnishing and decorating. The coconut also has cultural and religious significance throughout the pacific islands.

The beetles however, have a short life span according to the study. But their impact is great and with limited time frame, can destroy plantation of coconuts, and other Arecaceae family. Its current impacts are being felt on Guam, whereas most of not all coconut have sustained bore into the crown or tops of the tree damaging growing tissues, feeding on the tree sap. These damages causes low yield, no yield and mortality to any affected trees. The beetle is also known to feed on economically important commercial crops such as bananas, sugarcane, papayas, sisal, pineapples, and date palms.

Adult females deposit eggs inside dead palms, decaying plant material, soil with high organic matter content, and, occasionally, wooden structures (Manjeri et al. 2014). In approximately 11 days, eggs hatch into larvae which begin feeding on surrounding organic material. Eleven to 15 weeks later, the larvae will have grown up to 16 times larger and have stopped eating, after which they enter the pupal stage and are immobile for approximately six weeks (Hickley 1973). Upon emerging, adults fly to a new tree, feed, and mate, sometimes mating just after their first feeding.

Adults spend most of their time feeding on fresh leaves. Adult females live up to nine months, over which period they can lay up to 100 eggs. Thus adult progeny may be present with the mother and the population consists of overlapping generations (Manjeri et al. 2014).

Multiple overlapping generations are common under favorable conditions, e.g. when no diapause is needed. Since coconuts occur in regions where there is no cold season and a minimal dry season, the beetles can be active and reproductive throughout the year

As with many beetles, adults and larvae have different feeding preferences. In the case of *Oryctes rhinoceros*, damage to plants is caused by adults (especially young adults) and not larvae, which feed on already rotting material (Giblin-Davis 2001).

Larvae live in decaying material including: *Cocos nucifera*, *Artocarpus* sp. (breadfruit), *Calophyllum inophyllum* (Alexandrian laurel), *Mangifera* sp. (mango), and *Pandanus* sp. (Gressitt 1953).

Adults are a major pest of *Cocos nucifera* (coconut palm) and *Elaeis guineensis* (African oil palm) (Giblin-Davis 2001) but are a minor pest of many other palms and plant species. By feeding on healthy leaves, *Oryctes rhinoceros* causes physical damage, which can stunt growth and lead to secondary infections from bacteria or fungi (Hinckley 1973).

Minor host plant species include:

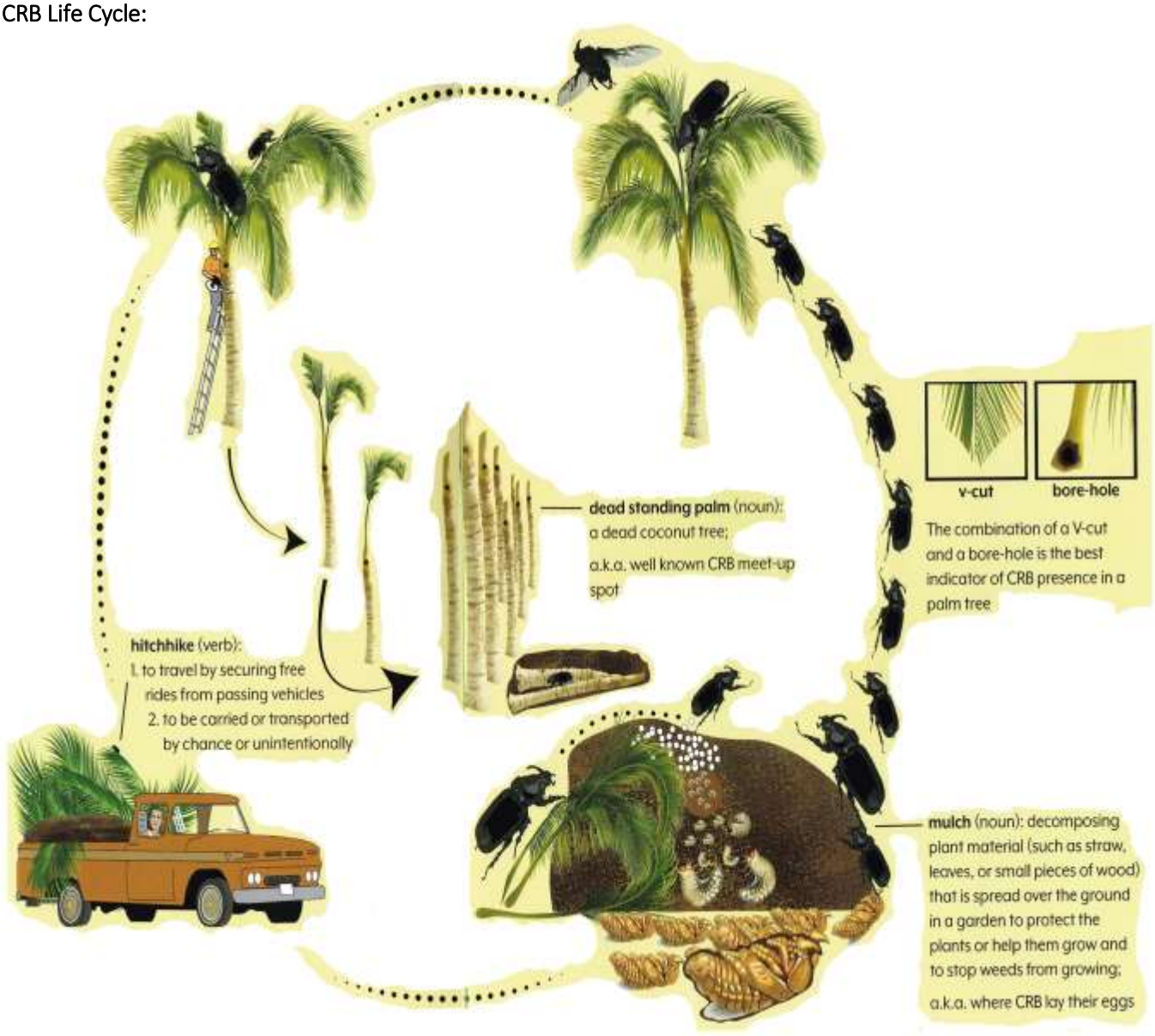
Acanthophoenix rubra (barbel palm)	*Corypha umbraculifera* (talipot palm)	*Pandanus tectorius* (Tahitian screwpine)
Agave sisalana (sisal agave)	*Corypha utan* (buri palm)	*Phoenix dactylifera* (date palm)
Agave americana (American agave)	*Cyathea* sp. (tree fern)	*Phoenix sylvestris* (wild date palm)
Aiphanes horrida (ruffle palm)	*Dictyosperma album* (red palm)	*Pinanga* sp.
Ananas comosus (pineapple)	*Dypsis pinnatifrons*	*Pinanga insignis*
Areca sp. (areca palm)	*Heterospathe elata* var. palauensis	*Pritchardia pacifica* (Fiji fan palm)
Areca catechu (betel-nut palm)	*Hydriastele palauensis*	*Raphia farinifera* (raffia palm)
Arenga sp. (arenga palm)	*Hyophorbe lagenicaulis* (bottle palm)	*Raphia vinifera* (bamboo palm)
Arenga pinnata (sugar palm)	*Latania* sp.	*Roystonea regia* (royal palm)
Borassus sp. (borassus palm)	*Livistona chinensis* (Chinese fan palm)	*Saccharum* sp. (sugarcane)
Borassus flabellifer (palmyra palm)	*Metroxylon amicarum* (Caroline ivory-nut palm)	*Syagrus romanzoffiana* (queen palm)
Caryota urens (fish-tail palm)	*Metroxylon sagu* (sago palm)	*Thrinax* sp. (thatch palm)
Casuarina equisetifolia (Australian pine)	*Musa* sp. (banana)	*Verschaffeltia splendida* (Seychelles stilt palm)
Clinostigma samoense	*Normanbya* sp.	*Wodyetia bifurcata* (foxtail palm)
Colocasia sp. (taro)	*Nypa fruticans* (nipa palm)	
Corypha sp. (gebang palm)	*Oncosperma* sp.	

Management and Control

Detection can be difficult due to the beetle's nocturnal activity and residence within trees. Visual signs such as holes bored at the base of leaves and V-shaped feeding damage help locate this beetle. Recently, acoustic detection was used to find *Oryctes rhinoceros* in live and dead palms on Guam (Mankin and Moore 2010). Once detected, management and control are required to mitigate the economic impact of a beetle infestation.

Typical V-shaped damage to coconut leaves by *Oryctes rhinoceros*. Photograph by Ben Quichocho, USDA-APHIS.

CRB Life Cycle:



Detection & Inspection

Look for large jet-black beetles up to 40 mm long with prominent horns. Look for tunnels in the crown of coconut palms with frass - often more than one per palm. Look for the V-shape damaged fronds. Use a hooked wire inserted into the tunnel to remove the beetle.

Management

Research into management of *Oryctes* started in the Pacific islands in the 1960s. Today, the key agent is a virus (*Oryctes rhinoceros nudivirus* - OrNV) originally from Malaysia and, more lately, a fungus, *Metarhizium anisopliae,* from the Philippines. Apply control measures if 3-5 beetles occur per ha up to 2 years after planting, and 15-20 beetles per ha thereafter.

QUARANTINE

Vigilance is needed at seaports and airports against hitchhiking beetles. Inspect regularly coconut palms growing nearby for frass and leaf symptoms. This is particularly important as a new form of the beetle has been found in recent years, and is now present in Guam, Palau, Papua New Guinea, and Solomon Islands. The damage it causes is similar that that done by the beetle that already exists in the Pacific and elsewhere, but it is not susceptible to OrNV. Also, it is thought to be more aggressive and invasive. The FAO/IBPGR *Technical Guidelines for the Safe Movement of Coconut Germplasm* should be followed when imports of coconuts are made (http://www.bioversityinternational.org/e-library/publications/detail/coconut/).

NATURAL ENEMIES

There are many general predators (pigs, rats, ants and other insects) and scoliid wasp parasites (e.g., *Scolia ruficornis*). The nudivirus infects larvae and adults. It was released in Fiji, Samoa and Tonga in the late '60s and early '70s. Adult beetles are dipped in a suspension of ground, infected grubs, and then released to infect grubs in breeding sites, and adults in feeding tunnels. In Guam, spores of *Metarhizium anisopliae* (imported from the Philippines) are dusted onto beetles, which then contaminate larvae (Photo 10), and other beetles in breeding sites.

CULTURAL CONTROL

- Destroy fallen dead palms (split, allow to dry and burn); compost dead leaves and grass; and turn manure and sawdust heaps regularly and remove the grubs. Treat compost and manure with *Metarhizium* or insecticides. Note, in Samoa, the cutting of recently dead trunks has been questioned as a policy: the standing dead palms are (i) a valuable source of *Oryctes rhinoceros nudivirus*, and (ii) can be processed for fence posts, and other uses.
- Catch adults by covering breeding sites - heaps of fronds or other organic matter - with gill nets (Photo 11); the beetles get caught in the gill net when entering or leaving the breeding site. A method developed at the University of Guam.
- Grow a legume ground cover (e.g., *Pueraria phaseoloides*) over logs or stumps, and other potential breeding sites that cannot be destroyed.
- Use a hooked wire to extract and destroy adult beetles feeding in the crowns of palms.

CHEMICAL CONTROL

Chemical control is uneconomical because of the low value of coconuts per unit area; additionally, it is impractical to apply insecticides except to young palms. If insecticides are needed, use synthetic pyrethroids. Traps with the attractant ethyl 4-methyloctanoate have been used to monitor populations and to give economic control in some countries. Use one trap per 2 ha.

AUTHOR Grahame Jackson
Information from Waterhouse DF, Norris KR (1987) *Biological Control Pacific Prospects*. Inkata Press. Photos 5-8 Mark Schmaedick, Land Grant Program, American Samoa Community College. Photos 2,3,4,9&11 Joel Miles, Bureau of Agriculture, Republic of Palau. Photo 10 Fred Brooks, University of Hawaii at Manoa.
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However, most of the discovered and recorded pests' are invasive weeds that out-compete native plant species throughout the Marianas archipelagos. These pests have found means to adapt at an alarming rate thus capable in multiplying without limitation due to the absence of its natural enemies. Disturbed areas become vulnerable at most places, whereas the removal of tree canopies allows other faster weed species to overcome.

These introduced species vary from a shrubby plant to climbing vines, brought by island residents or reoccurring visitors. Although at times, interjected by our Quarantine inspectors, such plant species were not listed in the database to be noxious or threat to the island's ecosystem, thus were released and tagged as agricultural goods. This deficiency opens the ability for many plant species to be introduced from neighboring countries without difficulties.

Another avenue of accidental introductions are through the ports of entries (Airport and Seaports). These pathways limits DLNR to fully implement preventive measures due to limited access and jurisdiction for search and seizure. A good example is the search of cargos and containers that passes interisland (Saipan, Rota, Tinian and Northern Islands), or through any U.S. countries and Territories.

DIFINITION OF INAVASIVE SPECIES: *(https://www.google.com/?gws_rd=ssl#q=what+is+invasive+species)*

> "What is Invasive Species? An **invasive species** is defined as an organism (plant, animal, fungus, or bacterium) that is not native and has negative effects on the economy, the environment, or health. Not all introduced **species** are **invasive**. **Invasive** plants and animals are the second greatest threat to biodiversity after habitat loss."

IMPACT OF INVASIVE SPECIES IN CNMI:

Invasive species in CNMI are real issues that have adverse influenced on the health and sustainability of our fragile land ecosystem and its bionetwork. Such undesirable effect proofs to be expensive and costly in mitigating its impact. Invasive species also threaten the bio-security of the CNMI through various means. Such threat imposes impact on natural resources, burdening the economic growth, tourism and the health of the CNMI people.

This impacts agricultural goods, because of the priority will shift from production of crops to mitigation of damages. Another negative effect of pests on agriculture in particular is the growth of CNMI's economy in general. Pests have caused losses in virtually unlimited number of crops. A swarm of pests could ruin a whole season's worth of planting and careful cultivation, leading to financial loss.

It comes as no surprise that pesticides and pest control management strategies are given much importance by farmers. However, this negative impact goes beyond agriculture. Pests also affect plants and trees of interest to our cultural and traditional reliance. Forest habitats that provide alternative hosts or preys may also harbor pests, thereby increasing the vulnerability of such environment that relays on bionetwork's symbiotic relationship.

The ecology also suffers from the invasion of pests. Particularly pests that prey on native fauna, decreasing or rendering extinction of their hosts and upsetting the balance of ecology. Pests also destroy the habitat of other organisms as well as natural resources, leading to reduction in water quality, increase in soil erosion and degradation of land, and destruction of native plants that provide food and shelter to native species or those endemic to the place.

Another way that these vermin can harm the ecology is through their competition with native animals for food and shelter. To a certain extent, pests can even poison native animals and pass on diseases, leading to the decline of certain animal and plant species. The worst ecological scenario that can be imagined with regards to pests is the decreased number of native species, the degradation of their natural habitats and food, and their extinction. In general, it is of no doubt that pests are nuisances and detrimental in their own right, and should not be taken lightly or else the havoc they wreak would be unprecedented.

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CNMI's current top terrestrial Invasive Alien/Non-native Species Lists: This list are set by priorities

Table I - Plant Species:

Scientific Name Common Name	Common Name English	Common Name Chamorro	Habitat	Current Management Plan
Coccinia grandis	Scarlet gourd / Ivy Gourd	Pipi'non maka	Vine	C
Mikania scandens	Mile a minute	Mala'it	Vine	N
Lantana camara	Lantana	Lantana	Shrub	C
Mucuna prurien	Sea bean	Akang'kang dan'kulu	Vine	N
Antigonon leptopus	Mexican creeper / Chain of love	Ka'dena	Vine	N
Spathodea companulata	African tulip	Flores guafi	Tree	C
Mimosa diplotricha	Giant mimosa / wit-a-bit	Subet'biun chosa	Shrub	N
Chromolaena odorata	Bitter bush	Masigsig	Shrub	C
Operculina ventricosa	Paper rose / Wood rose	Ala'lag	Vine	N
Biden pilosa	Beggars tick / Guam daisy	Flores Guahan	Shrub	N

Column that describes the current management such as: **((P))** prevention/education (not yet here); **((E))** eradication (just arrived or just discovered, **((S))** small populations); **((C))** control (management to contain or reduce but not eliminate); **((N))** no management at this time (lack of resources, or too extensive)

Table II - Invasive Terrestrial Non-Plant Species:

Scientific Name Common Name	Common Name English	Common Name Chamorro	Habitat	Current Management Plan
Oryctes rhinoceros	Coconut Rhino Beetle	Gaga Niyok	Insect	P
Wasmannia auropuntata	Little Fire Ant	Odot aga'ga (Di'kiki)	Insect	P
Vespa tropica	Great banded hornet	Sasatan	Insect	P
Darna pallivitta	Nettle caterpillar	Ulu gangochi	Caterpillar	N
Solenopsis invicta	Red imported Fire-ant	Odot aga'ga	Insect	N
Puccinia psidii	Eucalyptus rust	Ga'ga Tina'ke	Fungus	N
Quadrastichus erythrinae	Erythrina gall wasp	Sasa'tan Gaogao	Insect	N
Aulacaspis yasumatsui	Asian cycad scale	Ga'ga fading	Insect	C
Veronicella cubensis	Cuban slug	Ta'gula	Slug	C
Phellinus noxious	Black sock / Brown root rot	Chot'nut atbot	Fungus	N

Column that describes the current management such as: **((P))** prevention/education (not yet here); **((E))** eradication (just arrived or just discovered, **((S))** small populations); **((C))** control (management to contain or reduce but not eliminate); **((N))** no management at this time (lack of resources, or too extensive)

Key elements in approaching Invasive Species: (http://www.invasivespeciesinfo.gov/council/actionb.shtml)

1. Prevention: The first-line of defense and, over the long term, the most cost-effective strategy against invasive species is preventing them from becoming established. Prevention is two-pronged because some species are intentionally introduced for a specific purpose, whereas others arrive unintentionally as "hitchhikers" on a commodity, conveyance, or person.

2. Detection: Preventing the introduction of invasive species is the first line of defense against invasions. However, even the best prevention efforts will not stop all invasive species introductions. Early detection and rapid response (ED&RR) efforts increase the likelihood that invasions will be addressed successfully while populations are still localized and population levels are not beyond that which can be contained and eradicated. Once populations are widely established, all that might be possible is the partial mitigation of negative impacts. In addition, the costs associated with ED&RR efforts are typically far less than those of long-term invasive species management programs.

3. Control and Management: Control and management objectives may include: eradication within a local area, population suppression, limiting dispersal, reducing impacts, and other diverse objectives. Control and management of invasive species populations is accomplished using an integrated pest management (IPM) approach. The IPM approach considers best available scientific information, updated target population monitoring data, and the environmental effects of control methods in selecting a range of complementary technologies and methods to implement to achieve a desired objective.

4. Restoration and Rehabilitation: Restoration is an integral component of comprehensive prevention and control programs for invasive species that may keep invasive species from causing greater environmental disturbances. Although restoration efforts have certain elements in common, each invasion and area is unique. Restoration projects need to be based both on general principles and site-specific considerations and analysis. Resource managers need the research community to provide them with information for the development of a wide range of environmentally sound management strategies and tools, including detailed site assessments and information on the inter-relationships of the species involved. These assessments can help identify the key factors that will affect the success of restoration projects. In addition, monitoring programs are needed to track the success of control and restoration efforts and to ensure that the area is not reinvaded.

STRATEGIES:

Building and maintaining capacity:

Invasive species should be addressed successfully through local and federal capacity. This approach will require adequate funding and collaboration between agencies. A vigorous response to building these effort should include these administrative elements along with the identified key elements when dealing with invasive issues:

a) Strengthen national, regional and local level by establishing good communication, participation and action towards dealing with non-native invasive species. This could mean bringing together appropriate agencies, entomologists, pathologists and conservationist or partaking in the Regional Invasive Species discussion to address pest concerns.

b) Maintain and be informed with current events and application of approved scientific approach towards dealing with invasive pest or pest of concerns. This should include state, regional and national level.

c) Designed and Establish a Rapid Response Mechanism when detection of invasive non-native species are present or as soon as they appear. Issues that should be taken into an account:
   (1) Accessible of funds for emergency actions
   (2) Regulatory support for rapid action; and
   (3) Interdepartmental coordination that can quickly identify and give authority to a lead agency (Dept. Lands and Natural Resources).

d) Design or build educational and informational programs on a local and community level. This should include all possible and applicable avenues to reach local communities and agencies, to solicit for their support in address invasive pest throughout CNMI

e) Use appropriate projects that relates to the control of invasive pests with high priority or visibility, as model of scientific base practice.

f) Support the establishment of an entomologist or pathologist position within the Departmental or collaborating agency level.

g) To include all Quarantine and businesses that imports agricultural good following acceptable protocol in the developed Biosecurity Plan.

Promote sharing of Information:

Considerable information about Invasive Species are available globally and electronically. Even so, the information that could alert management agencies to the potential dangers of new introductions are frequently missed or is not widely shared or available to appropriate agencies. These crippled government agencies from taking prompt action. In addition, the lack of appropriate resources and training is another key factor that impede proper action. Information sharing and preparation is therefore essential.

a. Build an informational system that would links into available database on invasive alien species and other source of information. The system should be coordinated by the responsible agencies i.e. DLNR, RISC, NISC, and PILN, to facilitate the sharing of data. It should work on multiple languages and promote wide spread distribution of information to all interested parties using available technologies.
b. Develop an early warning system that would include notification of new and predicted occurrences of invasive species.
c. Establish database of failure and success of different eradication and control methods for invasive species to ensure that all can be learn from the experience. This should also linked into the information database.

Develop Economic Policies and Tools for addressing problems of Invasive alien Species:

Species invasions are a consequence of economic decisions and have economic impacts. However, the costs of invasions are seldom reflected in market prices or market demand. Moreover, while prevention, eradication, control, mitigation and adaptation all yield economic benefits, they are public goods. If left only to the market, the control of invasive species or any communicable human diseases, will be underprovided. Because biological invasions often indicate market failure, an important part of any strategy to manage invasive species are to make markets work for conservation wherever possible, and to provide alternate solutions if markets do not exist and cannot be created. Therefore, appropriate agencies should encourages legislature to incorporate economic principles into their national or state strategies for addressing Invasive Species, these should be built on five main principles:

a. User pays:
   - Make those responsible for the introduction of economically harmful invasive species liable for the costs they impose.
b. Full social cost pricing:
   - Ensure that the prices of goods and services whose production or consumption worsens the damage of invasive reflect their true cost to society.
c. Precautionary principle:
   - Because of the potentially irreversible and high costs of invasive intrusion, base management and policy on the precautionary principle.
d. Protection of the public interest:
   - Since the control of harmful invasive species yields benefits that are a public good, it requires public investment in prevention, eradication, control, mitigation and adaptation.
e. Subsidiarity:
   - Operate policies and management at the lowest level of government that can effectively deal with the problem.

Institute a system of Environmental Risk Analysis (if feasible):

Risk Analysis and Environmental Impact Assessment (EIA) procedures have already been adopted in many countries and mandated by certain international instruments. The challenge now is to apply these to address the prevention, eradication and control of invasive species. This should involve shifting the burden of proof to those individuals proposing the intentional introduction of a potentially invasive species. Risk analysis measures should be used to identify and evaluate the relevant risks of a proposed activity regarding alien species, and determine the appropriate measures that should be adopted. EIA plays an important role in the decisions to undertake specific processes or activities. Decision-makers should ensure the use of strategic and/or project specific EIA in assessing the impact, long-term and short-term, of species introductions. To ensure the effective use of EIA procedure, decision-makers should consider:

a. Reviewing the risk analysis criteria to implement and ensure compatibility of national law with international criteria.

b. Building on work undertaken by the plant and animal protection community to develop a rigorous process of risk analysis in relation to any deliberate introduction of species (not just between countries, but within a country or region as well), including detailed analysis of the balance between benefits and costs. This

assessment would allow more informed decision-making in relation to invasive alien species introduction, control and management.

c. Developing criteria to measure and classify impacts of alien species on natural ecosystems, including detailed protocols for assessing the likelihood of invasion in specific habitats or ecosystems. Where prediction protocols exist for landscapes comprising mosaics of ecosystems, predictions for the most vulnerable system in the landscape should dictate management decisions.

d. Developing tools to factor invasive species into the decision-making processes regarding land use planning and development.

e. Investigating ways in which strategic and project-specific EIA can be applied to unintentional introductions. For instance, assess large engineering projects, such as canals, tunnels and roads that cross biogeographically zones, which might have the effect of mixing previously separated flora and fauna.

Build Public Awareness and Engagement:

Active public engagement is critical to successful invasive species management. This strategy is intended to help states and organizations engage the public successfully and coordinate their efforts for greatest global benefit, leading to an informed public that supports ongoing actions to reduce the threat of invasive species, and key stakeholders who are actively engaged in implementation of invasive species solutions. Attaining these desired outcomes will require:

a. Developing public awareness campaigns to support invasive species management, including sharing information and coordinating messages as appropriate to avoid contradiction and maximize efficiency.
b. Engaging key stakeholders, communities and neighbors in invasive species solutions by linking invasive species strategies wherever, particularly when integrating and developing programs or other established societal priorities.
c. Building the capacity of local communities and groups to implement invasive species management measures where they live.
d. Prepare acceptable national Strategies and Plans
e. Sharing experience in this strategy with other states and organizations through documentation, staff exchanges, and other means of engagements.

APPLICABLE GOALS AND OBJECTIVES FOR HEALTHY AGRICULTURAL PROGRAMS:

A. PHYSICAL/ BIOLOGICAL

Goal (01): CONDUCT PEST SURVEY TO DETERMINE IF THERE IS ANY NEW OR UNKNOWN PEST

Objectives: Staff and volunteers will conduct site visits throughout the CNMI with approximately 101 hectares and other hectares within the three major islands (Saipan, Rota and Tinian) for any visible sign of pests or anything unusual from the ordinary. This survey will involve physical inspection along with available traps to determine the present of pest. Such survey will be aligned with the recommendation of an entomologist or plant pathologist.

Goal (02): DECIDE THE BEST APPROACH TO DEAL WITH PARTICULAR PEST AND IMPLEMENT ACTION

Objectives: Program managers and the Department's management team will work with Entomologist and Plant Pathologist to determine the best approach to deal with pest outbreak in the CNMI. This collaboration will be in line with the Memorandum of Agreement between DLNR, UOG and NMC-CREES.

Goal (03): EVALUATE REGIONAL PEST AND THE SUSCEPTIBILITY TO THE CNMI BASE ON INTRODUCTION, SPEED OF SPREAD, AND DAMAGES TO THE CNMI's ECOSYSTEM

Objectives: Program managers, Entomologist and / or Plant Pathologist will do the evaluation. This will be based on methodology approved thru scientific approach as universally understood amongst all pest evaluators. Pest origin will be noted, damages it cause, hosts, spread and life cycle will be recorded for data purposes. These projects will be led by recognized Entomologist and or Plant Pathologist.

Goal (04): DEVELOP INFORMATION BROCHURES OR POSTERS ABOUT EXISTING PESTS IN THE CNMI. USE IT TO INFORM THE PUBLIC SO THAT UNWANTED PESTS CAN EASILY BE RECOGNIZED AND TREATED ACCORDINGLY

Objectives: Program managers along with its Task Force will create and develop informational and educational brochures and posters to convey the importance of pest control. These resources will be shared with all ports of entry and to school students, government, and non-government agencies to share the impact of what detrimental of pest can do in the pristine forest ecosystem. These materials can also be used as mechanism to identify and prevent insects or plants species from entering or from exported as agricultural goods.

Objectives: To ensure that at least one of the Local or program paid staff acquired their Pesticide Applicator Certification prior to using or purchasing any chemical for treatment of invasive species. This is impart a federal (EPA) regulation on the use of restricted pesticide.

Goal (05): BENEFICIAL INSECTS WILL BE PROMOTED TO ENSURE CONTROL OF PEST OUTBREAK AND SPREAD

Objectives: Program managers, Entomologist and Plant Pathologist will promote and aid the spread of beneficial insects to control outbreaks of current pest listed in the CNMI. New pest discovery will be researched for its natural enemies throughout the region. If any biological control has been determined, the process will undergo specificity testing prior to requesting for approval from the USDA –APHIS. However, this approach will only take precedence when chemical treatment is either unavailable or too costly. The process will be shared with the USDA Affiliated agencies and other partners in the program.

Goal (06): DISTRIBUTE AVAILABLE RESILIENT PLANT STOCKS TO FARMERS, RANCHERS AND PRIVATE LANDOWNERS AS PART OF THE RE-PLANTING PROJECTS UNDER THE BEST LAND PRACTICE IN THE CNMI

Objectives: Program managers and staff will avail healthy plant stock to clientele to aid with recovery of devastated farmland. This practice will support the coverage of open spaces disallowing pest species to overtake.

B. SOCIAL

Goal (01): SEEK VOLUNTEERS TO ASSIST IN THE REMOVAL AND DESTRUCTION OF DISCOVERED PESTS

Objectives: Program managers and implementers will seek partnership with NGO's to assist with the removal and destruction of pest on certain project sites. This practice will also bestow the idea of site adoption while attaining group-satisfaction. Methodology will depend on the target specie or site location. A recognized Entomologist and or Plant Pathologists will head methodology of removal.

C. INSTITUTIONAL / EDUCATIONAL

Goal (01): THE DEPARTMENT WILL BE COORDINATED WITH LEARNING INSTITUTIONS TO EDUCATE AND TRAIN LOCAL STAFF ON PEST IDENTIFICATION

Objectives: Program managers, will avail local staff time to attend trainings and workshops to improve its staff skills in support of the Agriculture program implementation. These training and workshops will be related to Agriculture and its purpose towards conservation, preservation, protection and enhancement of its natural resources.

Goal (02): DLNR WILL WORK TOGETHER WITH CNMI INVASIVE SPECIES COUNCIL (CISC) ENSURING PROGRAM IMPLEMENTATIONS ARE CARRIED OUT ANNUALLY ACCORDING TO ITS PROPOSED AND APPROVED PROJECTS

Objectives: Program managers and staff will work with its CISC to complete needed reports every quarter or upon requests. Submission of progress will be noted and reviewed by key players.

Goal (03): DLNR AND ITS ADVISORY COUNCIL WILL WORK WITH VARIOUS GOVERNMENTS AND PRIVATE AGENCIES TO ENSURE PROPER PLANNING GETS IMPLEMENTED WITHIN ANY DEVELOPMENT OR DISCOVERY OF PEST IN THE FOREST

Objectives: Program managers, Entomologist and / or Plant Pathologist will do the evaluation. This will be based on methodology approved thru scientific approach as universally understood amongst all pest evaluators. Pest origin will be noted, damages it cause, hosts, spread and life cycle will be recorded for data purposes. These projects will be led by recognized Entomologist and / or Plant Pathologist.

Goal (04): EDUCATIONAL INFORMATION REGARDING AGRICULTURAL PROGRAMS AND OTHER MANAGEMENT OF CNMI'S NATURAL RESOURCES AND ALL ITS ASPECTS WILL BE MADE AVAILABLE TO ANY PUBLIC AND PRIVATE SCHOOLS, INDIVIDUALS, COMMUNITIES OR INTERESTED GROUPS IN THE CNMI.

Objectives: Program managers along with CISC will create and develop informational and educational brochures and posters to convey the importance of pest control. These resources will be shared with all ports of entry and to school students, government, and non-government agencies to share the impact of what detrimental of pest can do towards the improvement of CNMI's Agricultural ecosystem. These materials can also be used as mechanism to identify and prevent insects or plants pest species from entering or from exiting the CNMI.

Objectives: To utilizes the CISC Five-Year Strategic Plan, so that the Department and CISC could implement proper program throughout the CNMI. Also, to use as guide for grant submission throughout the five-year funding period.

Objective: To improve existing projects including; Specialty Crop, Arbor planting, Neighborhood Greening/Back-Yard Gardening, Park Planting, School and Businesses Beautification/Gardening, Beach Planting and Church Grounds.

Objective: To maintain an open communication with inter-island agencies and our Federal counterpart. These communication processes would involve Phone, fax, websites and Internet access.

PERFORMANCE MEASURES and Effectiveness:

A superlative performance of Pest Eradication Programs rests on the acceptance of each land managers / owners, their implementation of appropriate land management practices, raising awareness, conservation practice and participation in all aspects of Pest Control Programs throughout the island's landscape. With a successful program implementation, favorable actions and outcomes will be shared with land Managers.

An outstanding performance of preventive measures rests on the acceptance of CNMI's Community and their ability to implement caution and reduction of transporting affected commodities / goods / resources, from one island to the next. All aspects of tree care, pest prevention and pest reduction is the responsibilities of the CNMI People.

CNMI Invasive Species COUNCIL (CISC):

This council oversees and advises all pest control projects and programs being implementable in the CNMI.

Department reps. sitting in the Council	*Role in the Community*
Ray Roberto	CISC Coordinator
Victor Guerrero, Jr.	CNMI Forester (member)
Pamela Sablan	District Conservationist – (NRCS) (member)
Mike Tenorio	Division of Fish and Wildlife (member)
James Manglona	Rota Forester (member)
Gil Borja	Tinian Resident Director (member)

Arnold Route	Entomology Technician NMC – CREES (member)
Appointee	Division of Customs (member)

OUTCOME-SUSTAINABLE ECOSYSTEM:

This plan address the need to create and maintain healthy sustainable forests / island's ecosystem. This healthy ecosystem includes, stable shoreline, wind barriers, coastal runoffs, stable soil, clean water, diverse wildlife and a more defined landscape. In addition, this healthy ecosystem builds pride within the people of the CNMI. The ecological restoration and enhancement aspect of the will continue as encouragement for partnership between the USDA Forest Service, CNMI Government and the CNMI's private landowners and Managers of Natural Resources.

SUMMARY:

This is a general Five-Year Strategic Plan to control the spread and impact of Coconut Rhinoceros Beetles. Its specific activities, projects and tasks will be incorporated into the yearly project proposals, updates in the annual grant application. CISSC Coordinator and its council members will also administer the programs operation.

CISC will also provide additional assistance in the program direction and dissemination throughout each applicable year. Taking all these action into consideration, land managers will finding a cohesive approach when dealing with economic development and conservation practices on our limited fragile ecosystem.





STANDARD OPERATING PROCEDURE FOR PEST COLLECTION AND SURVEY

Introduction:

This is a cooperative effort between the DLNR, CISC, NMC-CREES, USDA - Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ), University of Guam – Agriculture Live Science, Guam's Invasive Species Program and the US State and Private Forest Service (USFS).

It outlines the mission-related goals, objectives, and the anticipated projects and accomplishments as well as the approach for a surveillance program for Targeted Pest (TP) stated on *Table I and II* and other new pests the CNMI.

This Standard Operating Procedure (SOP) will be performed by DLNR and its collaborating agencies, CICS and volunteers. APHIS and NMC-CREES shall be in charged with the collected pest in each sampling sites for proper identification. Early detection of target pest would authorize management with immediate mitigating action to reduce the probability of pest establishment.

I. Purpose of SOP

This SOP defines a consistent surveillance methodology to determine the presence of TP. Implementation and detection procedures will identify an introduction of TP and will allow rapid containment. Control measures shall be implemented as soon as possible, before the pest establishes and causes irreparable damage to the environment, forest ecology and the CNMI's Economy.

II. Processes

a. Surveillance of TP will be conducted on a weekly or bi-weekly time frame at ports of entry (Airport and Sea-Port) throughout CNMI.
    - Surveys shall begin in the month of January 2018 and will continue throughout the agreement period ending when funds become unavailable.
    - Bait stations will be set, collected and reported bi-weeks throughout the implementation period.

b. Specimen collected (if any) will be made using established methodologies, primarily through manual placement of bait stations.
    - Bait:
        i. Compost Pile
        ii. Pheromone traps
        iii. Other attractant if identified

    - Methodology
        i. Traps should be placed around the perimeter of both ports of entry
        ii. Place each traps in different location, preferably in different environment
            - Concrete slab, grassy area, tree stands, pavement, structured buildings, temporary resting spots, etc.
        iii. Placed each baited approximately 1 meter apart at approximately 20 meter intervals in the field near structures that have a high probability of harboring TP.
        iv. After one week, any collected pests should be delivered to an Entomologist for identification
        v. Results shall be recorded and reported to PEST Coordinator and CISC members for entry into NAPIS if needed.

- Data: (see forms)
    i. Who collected and recorded the traps (Name of person)
    ii. Who delivered the samples (Date, Time and person who delivered the samples)
    iii. Where was the samples delivered too (Location samples delivered)
    iv. Who received the samples (Person who received the samples)
    v. All survey data from cooperative agreements involving pest surveys will be entered into the NAPIS database.
        - First record for the State and/or County will be entered within 48 hours of confirmation of identification by a qualified identifier
        - All other required records, both positive and negative survey data, must be entered within two weeks of confirmation.
        - All records are to be entered into the database by the end of each year survey the survey was conducted and samples collected, so these data can be included in the yearly CISC Report to the Governor.

III. EQUIPMENTS and SUPPLIES

a) Collecting materials
    - Ethanol alcohol 70%
    - Bait pail
    - Baits lights
    - Vehicle
    - Vehicle fuel
    - Office supplies

IV. Handling of excess materials and equipments

- Dispose of used containers
- Tightly covered in all areas (indoor and outdoor).
- Clean up spills immediately.
- Wash, rinse, and sanitize recycled containers regularly.
- Store recyclables in clean, pest-proof containers away from sampled areas.
- Store all pheromone and supplies properly
- Keep all pheromone and supplies at least six inches off the floor and six inches away from walls.
- Use FIFO (First In, First Out) inventory rotation, so pests do not have time to settle into these products and breed.
- Clean and sanitize the facility thoroughly and regularly. Careful cleaning eliminates the food supply, destroys insect eggs, and reduces the number of places pests can take shelter.

V. Use of Pesticide

The assigned supervisor should decide if and when pesticides should be used in the facility. Assigned supervisor should be trained to determine the best pesticide for each pest, and how and where to apply it. Supervisors should keep a copy of the corresponding Material Safety Data Sheets (MSDS) on the premises

Pesticide should be:

a. Kept in their original containers.
b. Store in locked cabinets away from food-storage and food-preparation areas.
c. Store (aerosol or pressurized spray cans) in a cool place.
    - Exposure to temperatures higher than 120ºF could cause them to explode
d. Check for local regulations before disposing of pesticides.
    - Many are considered hazardous waste.
e. Dispose of according to manufacturers' directions and local regulations.

****

COLLECTION FORMS LOCATION: _____ DATA NUMBER: _____

Date: _____ Time: _____

Bait Station: _____

Estimated Quantity of pest caught in traps (If applicable)

Lead:	Compost Pile Trap	_____	_____
	Pheromone Trap	_____	_____
	Sign / symptoms	_____	_____

Collector: _____

Receiver: _____

Identifier: _____

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Sever damages to young fronds by adult coconut rhinoceros beetle, *Oryctes rhinoceros*.

Female (left) and male (right) *Oryctes rhinoceros*. In this picture, the head of the female is up while the head of the male is down, displaying an exaggerated difference in horn length.

The grub or larva of a coconut rhinoceros beetle, Oryctes rhinoceros, infected by fungus *Metarhizium*. The green areas are where the fungus is sporulating

Trapping coconut rhinoceros beetle, Oryctes rhinoceros. Breeding sites are heaps for old fronds or other organic matter; they are covered by a gill net, and the beetles get caught in the mesh when entering or leaving the heaps.

Additional Materials, Supplies, Tools and Equipments (Samples) that would assist in dealing with CRB issues:

Figure 1: Machete

Figure 2: Lopper

Cutting tools:

Figure 4: Knives

Figure 3: Pruner

Figure 1: Cherry Picker

Figure 2: 4X4 Truck

Equipment:

Figure 3: Chain Saw

Figure 4: Pruning pole

Figure 1: Gill Net

Figure 3: Gloves

Safety Gears:

Figure 6: Chainsaw Sheen Guard

Figure 5: Chainsaw Face Guard

Figure 4Non-Toxic Lures

Figure 2: Pheromone Lure / without chemical

Lures and Traps:

Figure 1: Bucket trap with lights and lure

Figure 4: Light trapping

Chemical and Biological:

Figure 1: Fungus Metarhizium anisopliae

Figure 2: Ethanol alcohol

Figure 3: Pheromones attractant

Draft Budget Analysis:

Oryctes rhinoceros Control and Management Project Draft Budget Spreadsheet 2018-2020				
Program / Projects	Object Class Categories	Proposed $$ Saipan, Tinian and Northern Islands	Proposed $$ Rota	Total $$ Requesting
I. ADMINISTRATION				
(4) Coordinator / Technician Salary for One Year	Salary	$ 90,000.00	$ 30,000.00	$ 120,000.00
Coordinator / Technician Fringe Benefit for One Year	Fringe Benefits	$ 18,000.00	$ 6,000.00	$ 24,000.00
(4) Technician Salary for One Year	Salary	$ 60,000.00	$ 20,000.00	$ 80,000.00
(4) Technician Fringe Benefit for One Year	Fringe Benefits	$ 12,000.00	$ 4,000.00	$ 16,000.00
subtotal for ADMINISTRATION		$ 180,000.00	$ 60,000.00	$ 240,000.00
II. COMMUNICATION				
Telephone, Fax, Internet Services (DSL), Web Page, Field Radio Services	Other	$ 6,000.00	$ 2,000.00	$ 8,000.00
III. STRATEGIC DIRECTION				
Inter-Island and Off Island Travel & Per Diem	Travel	$ 10,000.00	$ 3,000.00	$ 13,000.00
Utilities and Water	Other	$ 3,000.00	$ 1,000.00	$ 4,000.00
Freight and Handling	Other	$ 1,500.00	$ 500.00	$ 2,000.00
Rental Others	Other	$ 19,800.00	$ 6,600.00	$ 26,400.00
Repair and Maintenance	Other	$ 3,000.00	$ 1,000.00	$ 4,000.00
Machinery Tools and Equipment	Other	$ 6,000.00	$ 2,000.00	$ 8,000.00
Printing and Photocopying	Other	$ 6,000.00	$ 2,000.00	$ 8,000.00
Supplies Operation	Supplies	$ 15,000.00	$ 5,000.00	$ 20,000.00
Fuel & Lubrication	Supplies	$ 6,000.00	$ 2,000.00	$ 8,000.00
TOTAL		$ 256,300.00	$ 85,100.00	$ 341,400.00
Indirect Cost (11.37%)	Indirect Cost	$ 29,141.31	$ 9,675.87	$ 38,817.18
GRAND TOTAL		$ 285,441.31	$ 94,775.87	$ 380,217.18

Photo of other Invasive Terrestrial Non-Plant Species as noted on table II:

Botanical Name	Common Name	Chamorro Name
Wasmannia auropuntata	Little Fire Ant	Odot aga'ga (Di'kiki)

Botanical Name	Common Name	Chamorro Name
Vespa tropica	Great banded hornet	Sasatan

Botanical Name	Common Name	Chamorro Name
Darna pallivitta	Nettle caterpillar	Ulu gangochi

Botanical Name	Common Name	Chamorro Name
Solenopsis invicta	Red imported Fire-ant	Odot aga'ga

Botanical Name	Common Name	Chamorro Name
Puccinia psidii	Eucalyptus rust	Ga'ga Tina'ke

Botanical Name	Common Name	Chamorro Name
Quadrastichus erythrinae	Erythrina gall wasp	Sasa'tan Gaogao

Botanical Name	Common Name	Chamorro Name
Aulacaspis yasumatsui	Asian cycad scale	Ga'ga fading

Botanical Name	Common Name	Chamorro Name
Veronicella cubensis	Cuban slug	Ta'gula

Botanical Name	Common Name	Chamorro Name
Phellinus noxious	Black sock / Brown root rot	Chot'nut atbot

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