CHAPTER 28

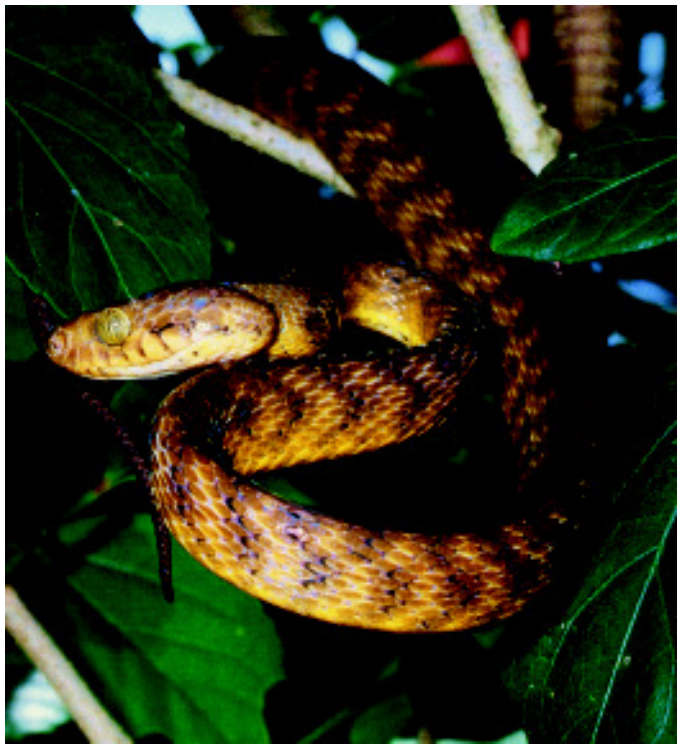
PREVENTING AND CONTROLLING BROWN TREESNAKE INTRODUCTIONS

28. 1. INTRODUCTION

28. 1. 1. The Disappearance of Guam's' Birds

In the late 1970's and into the 1980's a mysterious thing was happening to Guam's native bird populations. They were disappearing. Species after species were suddenly gone. Curiously the smallest birds disappeared first with the larger species being the last to go.

By the mid-1980's, Guam's forests were eerily silent. Loss of habitat; pesticide use; unknown diseases; introduced predators; all were suggested as being possible causes. A young biologist named Julie Savidge eventually proved conclusively that an introduced snake, the **brown treesnake** (*Boiga irregularis*), was the sole culprit in this ecological disaster.



The brown treesnake - architect of environmental devastation

28. 1. 2. How the Snake was Implicated

Before Savidge began focusing her research on the snake itself, no one knew how many snakes were on Guam and what their impact was. Most Guam residents rarely see snakes as the brown treesnake is **arboreal** and **nocturnal**.

These habits keep the actual populations well hidden. After some research was done quantifying population levels, people began to realize that there were indeed a great many snakes on Guam. More than enough to totally decimate forest bird populations.

Still, further proof was needed to say with certainty that disease was not causing the loss of the birds. Snake proof cages were built and birds were kept in the jungles to see if they would contract any type of sickness. None ever did. California quail (*Callipepla californica*), an already introduced game bird to Guam, were put out in cages. Half of the cages were built to allow the entry of snakes and the other half were snake proof (the control group).

Any trap that allowed snake entry was empty within several days. Quail in snake proof cages remained alive. By 1986 it was gener-

ally accepted that for the first time in recorded history an introduced snake had almost completely wiped out the avifauna from an island ecosystem.

28. 1. 3. How the Snake Arrived on Guam

The brown treesnake arrived on Guam sometime after World War II, in the late 1940's - early 1950's, on military cargo. While the snake's native range includes Northeast Australia, New Guinea and surrounding islands, these particular brown treesnakes, it is now thought, originated from the island of Manus near New Guinea. During this time, large amounts of construction materials and equipment for bases were being transported from there by the U.S. military.

How many snakes were transported to Guam and how often this happened is simply not known. By the mid-to-late 1950's snakes were being sighted or killed near the Guam port, by Orote Peninsula.

The brown treesnake arrived on Guam sometime after World War II in the late 1940's - early 1950's on military cargo.

The snake population apparently advanced in a wave-like pattern over the island. It depleted the food source in one area and then moved to the next. In the mid-1960's after a decade of slow growth and spread, snake numbers dramatically increased.

The exact reasons for this are yet a mystery, but it is known that several other introduced species (shrews and small skinks) made it to Guam at this time. These potential food sources could have fueled a rising snake population. Other instances have shown that the existence of one or more exotic species makes it that much easier for colonization by another exotic.

By the mid-1980's, the snake had finally reached the extreme northern end of Guam at Ritidian Point. By this time snake researchers were doing population studies on the snake.

The scientists found that a recently colonized area could have incredibly dense snake populations approaching 100 per hectare (100 meters x 100 meters). After food resources were depleted, the snake populations would decline, though not disappear.

28. 1. 4. The Present Snake Situation on Guam - Fluctuations Between the Snakes and the Prey Base in Local Populations

Presently, it appears that snake populations on Guam fluctuate in response to fluctuations in the prey base. Simply put, snakes reduce the prey base so this leads to fewer snakes in that particular area.

After a period of time with fewer snakes, the prey base increases, which then leads to an increase in snakes and the cycle continues. This is a classic scenario seen in other predator-prey relationships where prey numbers determine predator numbers and not the other way around.

28. 1. 5. The Future of the Snake on Guam - Will Probably be There for Some Time

So the possibility of the snake eating itself out of house and home, and then itself dying out, is not very likely. In all likelihood without outside intervention, the snake will continue to flourish on Guam for the foreseeable future.

28. 2. THE EFFECTS OF THE SNAKE ON GUAM

28. 2. 1. Ecological Effects

The most obvious and well-publicized effects are the depletion and extirpation of bird populations. Nine species of forest bird are now gone from Guam. The Micronesian kingfisher (*Halcyon cinnamomina*) now exists only in zoos on the United States mainland.

Several introduced bird species, notably black drongos and sparrows, persist in urban areas. A small population of Guam rails is being intentionally introduced on the CNMI Island of Rota as part of a recovery effort.

There are several reasons why the snake has caused such a drastic decline in native bird populations.

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28. 2. 2. Snake Densities are Extraordinarily High

There are just a lot of snakes there. Pre-snake bird densities on Guam have been estimated at 26 birds per hectare. As mentioned, snake densities on Guam can approach 100 snakes per hectare. This is more than enough snakes to quickly wipe out a bird population.

Julie Savidge's experiments with quail-baited snake traps in the trees showed that a roosting bird was almost guaranteed to be attacked by a snake.

28. 2. 3. Prey Naiveté

Guam's forest birds, not having evolved in the presence of a nighttime arboreal predator, had not developed any nesting or defensive behaviors to effectively deal with the brown treesnake. This is why island organisms are often quickly decimated by introduced predators.

Small rodent populations have also been drastically reduced. While the decline of rats, mice and shrews (all introduced species and generally considered to be pests) does not represent a great loss to the people of Guam, the effects of the snake on fruit bat populations does.

Brown treesnakes have proved to be remarkably adept at eating juvenile bats that have been left alone on the roost by the mother. Guam's last remaining bat colony has problems with reproducing itself because of this.

The anole, an introduced species from the Southern U.S., has also been virtually eliminated on Guam.

Since juvenile brown treesnakes eat nothing but lizards, they have had a profound effect upon these communities on Guam. The large Island gecko (*Gehyra oceanica*), common on many man-made structures, has all but been eliminated.

The anole (*Anolis carolinensis*), an introduced species from the Southern U.S., has also been virtually eliminated on Guam. This is of special note in that, as mentioned, letting in one introduced species can contribute to a successful colonization of another, which can then have grave effects.

The main difference between the snakes' native range and the Mariana Islands is the difference in lizard populations. The lizard populations on our islands are much greater than those in Australia or New Guinea.

Because of this, there is very little juvenile mortality of brown treesnakes on Guam. In effect, all juvenile snakes reach adulthood to breed. This is a major reason for such high snake densities, not the lack of a specialized snake-eating predator.

In ecology, one learns that all things in nature are interconnected and that changing one aspect of the environment can have unforeseen consequences.

Guam has seen an increase in spiders and insects, such as melon flies, which have densities on Guam that are 10 times what they are in the CNMI. The reason? There are no birds to prey on them.

Birds are also major seed dispersers for many plants. It is quite likely that Guam will experience changes in its plant communities as a result of the snake. It has already been noted that flame trees (*Delonix regia*) on Guam are being defoliated by an introduced caterpillar as there are no birds to prey upon it.

Each year on Guam, brown treesnakes cause many electrical power outages.

28. 2. 4. Economic and Health Impacts

Each year on Guam, brown treesnakes cause many electrical power outages. The snakes, while foraging for food, climb power poles — short circuiting power lines. They also crawl into transformers and into power generators, causing this equipment to break down.

Millions of dollars are lost each year in maintenance, repairs and loss of production from inoperable electrical equipment such as downed computers.

In addition to this, there have been cases of infants being attacked in their sleep and having reactions to the venom. At the time of this book's writing, no fatalities have occurred, but most infants require hospitalization and several cases have been quite serious.

28. 3. BROWN TREESNAKE BASIC BIOLOGY

28. 3. 1. Classification and Morphology

The brown treesnake, *Boiga irregularis*, belongs to the snake ***Family Colubridae***. The genus *Boiga* contains about 25 species. Several are in Africa but the majority are native to Asia and Southeast Asia. The brown treesnake is a native of Australia, New Guinea and the islands surrounding New Guinea.

The distinguishing characteristics for the brown treesnake are the elliptical pupils (like a cats' eye), the rear fangs, the big head in relation to the body, and the brownish or greenish color. Sometimes faint bands can be seen on the body. The coloration and the bands can be somewhat variable throughout its native range.

The snakes are about 18 inches long after hatching. Adults are generally 4 to 5 feet long and as big around as an adult humans' thumb. On Guam, snakes in excess of 9 feet have been captured.

As mentioned, juveniles up to about 3 feet in length eat lizards exclusively. Adults switch over to warm-blooded prey such as rats, mice, shrews, birds, and bird eggs.

28. 3. 2. Venom and its Delivery System

Venom is delivered into the prey animal by repeated action of the enlarged rear teeth/fangs. The fangs have a groove and the venom runs through the groove into the wound.

Scientists have differing opinions on the role of the snake's venom. How well the venom subdues a prey animal, or if it is more of a digestive aid, is not really known. Larger snakes will use constriction to subdue larger prey.

28. 3. 3. Reproduction and Growth

Reproduction is poorly known. Scientists believe that females can lay up to 14 eggs per clutch. On Guam, the snakes can probably breed year round. It is not known if females can lay more than one clutch per year.

The eggs hatch in 90 days. The snakes are approximately 3 years old when they first reproduce.

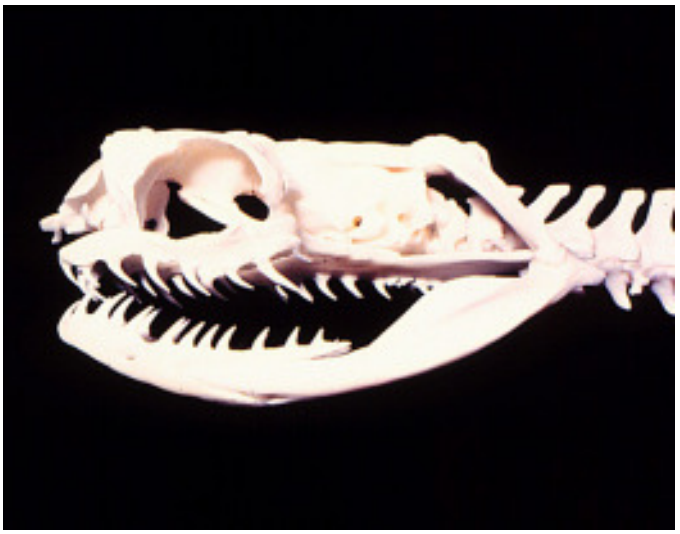
28. 4. HISTORY OF SNAKE SIGHTINGS HERE IN OUR CNMI

The first documented snake sighting on Saipan was on June 16, 1986. Since then, at the time of this book's writing, there have been 74 reliable snake sightings and 15 captures of live snakes. 13 of these snakes were brown treesnakes, one was a harmless species from the Philippines and one was from the United States.

Snake sightings and captures on Saipan have been clustered not only around the ports of entry, but also in scattered areas around the island. Snakes are presumably being transported around the island on cargo that is allowed to clear the port without an adequate quarantine.

On Rota, two dead brown treesnakes were found on a container in 1991. Tinian had one snake sighting in 1990, four in one month in 1995, and four during a two-month period in 2003.

From the above evidence, it can be concluded that there are some snakes on Saipan, and that Rota and Tinian are probably still snake free, or with just a few individuals. It is still too early to say whether or not Saipan has a breeding population of brown treesnakes.



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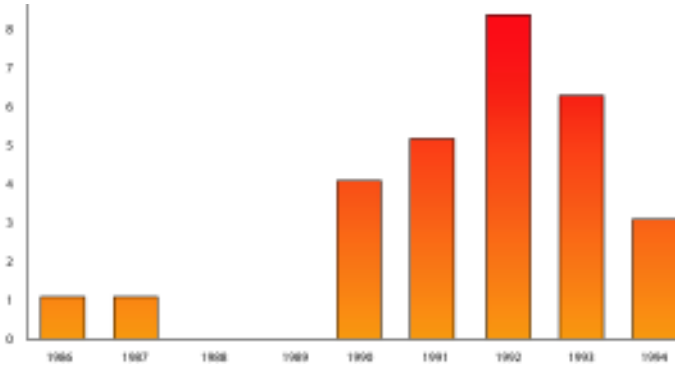

From 1986-1994 there were 29 reliable snake sightings in the CNMI. From 1994 to the time of this book's writing, an additional 45 snakes have been observed.

28. 5. WHY BROWN TREESNAKES ARE PRONE TO BEING TRANSPORTED

28. 5. 1. High Numbers of Snakes

There are several reasons why brown treesnakes are more prone to being transported in cargo than other snake species. First, there are simply a lot of snakes on Guam.

With snake densities on Guam being so high, the odds of a snake coming into contact with cargo are greatly increased. Snake densities are so high that the chances of a snake coming in contact with outgoing cargo are much greater than for any other snake species in any other area.

28. 5. 2. High Degree of Movement by Guam Snakes

Radio telemetry studies show that the snakes on Guam constantly move at night in their search for food. Scientists believe it is because the snakes on Guam are living with a depleted food base that they constantly move and forage. Snakes living in an area with an abundant food source do not have to move as much to find a meal. Because of this high degree of movement, the odds are increased that a snake will encounter cargo.

28. 5. 3. The Behavior of the Snake Itself

As mentioned, brown treesnakes are nocturnal, and as such seek small dark places in which to hide during the day. Many types of cargo (e.g. PVC pipes) offer just such a refuge.

Brown treesnakes are nocturnal, and as such, seek small dark places in which to hide during the day.

Cargo types that are considered high risk for the transport of brown treesnakes would be defined as anything stored outside next to the jungle with small holes and nooks in which to hide. This includes most construction material, used appliances, personal vehicles, heavy machinery, PVC pipe, shoring jacks, and playground equipment, to name just a few.

28. 5. 4. Cumulative Effect

These three factors, high snake densities, high degree of movement by the snakes, and daytime refuge-seeking behavior, work together. They make the snake situation on Guam and the subsequent transfer of snakes away from Guam totally unique in all the world.

These factors make the transportation of brown treesnakes from Guam to other islands in the Pacific, not just a likelihood, but merely a matter of time.

28. 6. POSSIBLE ERADICATION METHODS FOR THE BROWN TREE SNAKE

28. 6. 1. Introduction

Eradication means fully getting rid of. This is different from *control*, which means keeping numbers low, manageable, and not a nuisance. Each is different from *interdiction*, which means the act of stopping from coming in at all.

The USGS Biological Resources Division
Researchers of the USGS Biological Resources Division (BRD) have worked for long hours conducting many scientific experiments. They seek to find the best possible eradication, control, and interdiction methods to deal with the brown treesnake menace.

The agency acknowledges it as a serious biological threat, posed to both US and international biological resources. Their research has explored many potential solutions and has already resulted in several proven-effective techniques. These include best trap design, best barrier design, and techniques to effectively target high risk cargo.

The USDA Wildlife Services
The USDA Division of Wildlife Services (WS) has also worked long and hard on the brown treesnake problem on Guam. This Division funds agricultural quarantine worker training and supports other brown treesnake interception techniques.

One of WS's most important, and its highest profile project, is the support it lends to the "sniffer dog" program. This is discussed below.

Another interesting aspect of their work is the valiant efforts they employ to keep the resident brown treesnakes from ever leaving Guam. Cargo is sniffed. Barriers are built. Traps get set and maintained.

The CNMI and all of Micronesia can only say thanks to the ladies and gentlemen of the USGS BRD and the USDA WS. Thanks for helping protect us from this menace.

28. 6. 2. Trapping
According to the CNMI's Herpetologist, the traps currently used work well. They must, however, be baited with a live mouse. Each mouse must be fed and watered every week. The traps also must be spaced every 20 meters to ensure that most of the snakes in the area are caught.

Our currently used snake traps work well, but each must be baited with a live mouse.

These liabilities make large scale trapping programs very labor intensive and costly. It is probably not feasible to eradicate an existing snake population with trapping alone.

28. 6. 3. Poisons
There have been several substances found that are toxic to snakes. However, the problem is getting the snake to eat the poison. Snakes usually will only eat live food, so poison pellets, as are used for rats, will not work.

28. 6. 4. Viruses/Diseases
Why not just introduce AIDS to the snakes, many of our local people say. Viral and bacteriological researchers know that it is not so easy. Most viruses are species-specific. This means that a virus must already be existing in a species' population to affect it.

Experimental work is currently underway at the US National Zoo to identify an effective brown treesnake eradication virus. It has had mixed results so far, but efforts are continuing.

Researchers have found that a snake virus exists that kills one half of the brown treesnakes it infects. The researchers discovered it by corresponding with owners of private reptile collections. The viruses had affected their collections en masse. Viral strains were collected from the blood of sickly snakes.

Again, current research has shown that the virus will kill one half of the brown treesnakes it infects. At the time of this book's writing, the identified virus has not yet been introduced to Guam or to the CNMI.

This is because, in many cases, the population of animals being infected will often develop resistance or immunity to the disease so the population is never fully eradicated. It would only be knocked back a bit, only to recover in the future. There are also numerous legal issues regulated by the U.S. Environmental Protection Agency when one wants to release viruses into the environment.

The best solution to the brown treesnake problem is to not let the snake become established in the CNMI in the first place.

28. 6. 5. Introducing Another Predator

This has been a popular approach in the past for other pests, with every country that has tried it wishing they had not. Quite simply, it does not work, and one ends up with another pest animal that needs eradication.

Mongoose (*Herpestes nyula*) have been introduced in various places for snake control (Caribbean islands, Southern Japanese islands). There the mongoose (despite its reputation) has ended up not eating all of the snakes but eating native birds and lizards, among other things, instead. Furthermore, the brown treesnake climbs trees at night. The mongoose lives on the ground and is active during the day.

The only predator that is known to eat only snakes and nothing else, is the **King Cobra** (*Ophiophagus hannah*) from Southeast Asia. Due to its deadly poison, this is not the sort of animal that we want in the CNMI.

As we can see, at the time of this book's writing, there really is not an effective method for eradicating a brown treesnake population. Our solution must be to not let the snake become established here in the first place.

28. 7. METHODS FOR BROWN TREESNAKE INTERDICTION

28. 7. 1. Visually Inspect Cargo

One method employed is to have personnel go through cargo containers and break bulk cargo, visually inspecting all potential hiding places. The problem with this is that it is very labor intensive and not very efficient as the snakes can be very difficult to detect.

28. 7. 2. Quarantine Cargo

Another is to quarantine cargo in an area that is enclosed with a snake proof barrier. Personnel then place snake traps on the inside. This allows snakes to move out of the cargo and into a situation with a high probability of capture. Trap capture, however, is not guaranteed and the snakes could re-enter cargo and be transported out of the area.

28. 7. 3. Fumigation

Fumigating cargo with methyl bromide gas using two pounds of methyl bromide gas per 1000 cubic feet of space applied for 4 hours would kill 100% of the snakes in that space.

However, personnel must be trained and certified for methyl bromide use and specialized equipment must be purchased. Therefore, this method cannot be practically used for all cargo. Because methyl bromide is known to deplete the ozone layer in the earth's atmosphere, it is possible that it may soon be taken off of the market.

Dogs can be trained to sniff out snakes in cargo.

28. 7. 4. Inspect Cargo with Specially Trained Dogs

Dogs can be trained to sniff out snakes in cargo. Dogs and handlers must be trained with live snakes. Other smells can throw the dogs off. Dogs must be cared for and handler error is a big contributor to detection failure.

28. 7. 5. Multiple Method Approach

Because no one method is perfect, the ideal interdiction program would utilize 2 or 3 of the above methods in conjunction with each other.

Since a stable secure area is needed to fumigate and inspect cargo via dogs or manually, this area would have a snake barrier with traps. Cargo that was not suitable for methyl bromide would be inspected with dogs and vice versa.

28. 8. BROWN TREESNAKE CONTROL IN OUR COMMONWEALTH

28. 8. 1. Introduction

In 1991, the CNMI initiated a brown treesnake interdiction and control program with the hiring of a **herpetologist** (reptile biologist).

The program had a modest start with small trapping programs and night searches. Since that time the program has expanded on these activities and brought in new technologies and skills for a comprehensive snake interdiction program.

28. 8. 2. Our New Sniffer Dog Program

There are now personnel on Rota, Tinian, and Saipan specifically working on brown treesnake issues. The training of four sniffer dogs and handlers has been completed on Saipan, and one has been trained on Tinian. These dogs have been specially trained to detect brown treesnakes present in Guam cargo.

An effective snake interdiction program can help ensure that our future forests will continue to echo with the songs of our native birds.

As training aids, four live brown treesnakes are housed at the Division of Fish and Wildlife offices. These snakes are sterilized males and have had radio transmitters surgically implanted in them. This is so that in the event of an escape, the snakes can be easily tracked and recaptured.

28. 8. 3. Cargo Quarantine Yards

The Island of Tinian now has a cargo quarantine yard built specifically for snake interdiction. The yard is enclosed by a low wall (1.3 meters high) with an electrified lip on it.

Snakes cannot breach this wall. Snake traps are placed on the inside. High risk cargo is placed inside the yard for up to three nights.

This allows the snakes to exit the cargo and then have a much higher probability of being trapped than just putting traps up in the trees surrounding the port. It is anticipated that Saipan and Rota will have similar barriers in the near future.

28. 8. 4. Interagency Cooperation

CNMI Fish and Wildlife personnel have worked in close conjunction with Federal scientists, Guam biologists, and CNMI agencies such as the Commonwealth Ports Authority, Coastal Resources Management, Emergency Management Operations, and Division of Agriculture-Quarantine. Together they are attempting to develop the tools and regulations needed for an effective snake interdiction program.

These efforts are being carried out to ensure that the CNMI remains snake free. Hopefully, unlike Guam, we can avoid the serious health and economic threats posed by this snake and our future forests will continue to echo with the songs of our native birds.