

DRAFT Environmental Assessment

**Targeted Aerial Application of Acetaminophen
for Brown Treesnake Control on Guam**

Preparer and Lead Agency:

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Wildlife Services
233 Pangelinan Way
Barrigada Heights, GU 96913

TABLE OF CONTENTS

Page

List of Acronyms and Abbreviations Used in this Document.....	4
CHAPTER 1: PURPOSE AND NEED FOR ACTION.....	5
1.1 Introduction.....	5
1.2 Purpose	6
1.3 Need for Action	6
1.3.1 Proposed Action.....	6
1.3.2 Acetaminophen Baiting Technology.....	7
1.4 Biology.....	7
1.5 Location and Scope of Analysis.....	9
1.5.1 Location and Human Use.....	9
1.5.2 Scope.....	11
1.6 Related Environmental Documents	11
1.7 Authority and Compliance	12
1.7.1 Authority of Federal and State agencies in invasive species management.....	12
1.7.2 Compliance with Federal Laws and Court Orders.....	13
1.7.3 Territory of Guam laws.....	14
CHAPTER 2: DESCRIPTION OF ALTERNATIVES.....	15
2.1 Alternative 1 – Targeted aerial application of oral toxicants for controlling brown treesnake populations in and around the Habitat Management Unit (HMU) on Andersen Air Force Base (Preferred Action).....	15
2.2 Alternative 2 – Targeted aerial application of oral toxicants for controlling brown treesnake populations on Orote Point, Guam	16
2.3 Alternative 3 - Use of methods other than toxicants to achieve large scale BTS control.....	18
2.4 Alternative 4 - No Action Alternative.....	18
2.5 Alternatives Considered but Not Assessed In Detail.....	19
2.5.1 Development of an Alternative Toxicant.....	19
CHAPTER 3: ISSUES IMPORTANT TO THE ANALYSIS OF IMPACTS.....	19
3.1 Issues Driving the Analysis	19
3.2 Issues Not Analyzed in Detail with Rationale	19
CHAPTER 4: ENVIRONMENTAL CONSEQUENCES.....	20
4.1 Alternative 1 - Targeted aerial application of oral toxicants for controlling brown treesnake populations in and around the HMU on Andersen Air Force Base (Preferred Action).....	20
4.1.1 Effectiveness	20
4.1.2 Impact on Non-target Animals	21
4.1.3 Impact on Human Health and Safety.....	24
4.1.4 Impact on Watersheds and Water Quality.....	25
4.2 Alternative 2 - Targeted aerial application of oral toxicants for controlling brown treesnake populations on Orote Point, Guam	26
4.2.1 Effectiveness	26
4.2.2 Impacts on Non-target Animals	26
4.2.3 Impacts on Human Health and Safety.....	26
4.2.4 Impacts on Watersheds and Water Quality.....	27
4.3 Alternative 3 - Use of methods other than toxicants to achieve large scale BTS control.....	27

4.3.1 Effectiveness	27
4.3.2 Impacts on Non-target Animals.....	28
4.3.3 Impacts on Human Health and Safety	28
4.3.4 Impacts on Watersheds and Water Quality.....	28
4.4 Alternative 4 – No Action Alternative.....	28
4.4.1 Effectiveness	28
4.4.2 Impacts on Non-target Animals	28
4.4.3 Impacts on Human Health and Safety	28
4.4.4 Impacts on Watersheds and Water Quality.....	28
4.5 Cumulative Impacts.....	28
4.6 Monitoring.....	29
4.7 Conclusions.....	29
CHAPTER 5: PREPARERS AND PERSONS CONSULTED.....	31
CHAPTER 6: REFERENCES.....	34
APPENDICES.....	
A Agency Correspondence.....	39
B ESTCP Proposal.....	43
C ESTCP Site Change Proposal.....	54
D WS Directive 2.401, Pesticide Use	57
E EPA Label for Acetaminophen.....	61
F Public Comments.....	64

DRAFT

LIST OF ACRONYMS AND ABBREVIATIONS

<u>APHIS</u>	<u>Animal and Plant Health Inspection Service</u>
<u>BO</u>	<u>Biological Opinion</u>
<u>BTS</u>	<u>Brown Treesnake</u>
<u>CFR</u>	<u>Code of Federal Regulations</u>
<u>CZMA</u>	<u>Coastal Zone Management Act</u>
<u>DAWR</u>	<u>Division of Aquatic and Wildlife Resources, Guam Department of Agriculture</u>
<u>DNM</u>	<u>Dead Neonatal Mouse</u>
<u>DOD</u>	<u>Department of Defense</u>
<u>EA</u>	<u>Environmental Assessment</u>
<u>EIS</u>	<u>Environmental Impact Statement</u>
<u>EO</u>	<u>Executive Order</u>
<u>ERP</u>	<u>Emergency Response Plan</u>
<u>ESA</u>	<u>Endangered Species Act</u>
<u>ESTCP</u>	<u>Environmental Security Technology Certification Program</u>
<u>FIFRA</u>	<u>Federal Insecticide, Fungicide and Rodenticide Act</u>
<u>GDOA</u>	<u>Guam Department of Agriculture</u>
<u>GDAWR</u>	<u>Guam Division of Aquatic and Wildlife Resources</u>
<u>GEPA</u>	<u>Guam Environmental Protection Agency</u>
<u>HMU</u>	<u>Habitat Management Unit</u>
<u>NEPA</u>	<u>National Environmental Policy Act</u>
<u>NHPA</u>	<u>National Historic Preservation Act</u>
<u>NWRC</u>	<u>National Wildlife Research Center</u>
<u>T&E</u>	<u>Threatened and Endangered</u>
<u>USDA</u>	<u>United States Department of Agriculture</u>
<u>USEPA</u>	<u>United States Environmental Protection Agency</u>
<u>USFWS</u>	<u>United States Fish and Wildlife Service</u>
<u>WS</u>	<u>Wildlife Services</u>

1.0 PURPOSE AND NEED FOR ACTION

1.1 INTRODUCTION

The brown treesnake (*Boiga irregularis*; BTS) was inadvertently introduced to Guam in the mid-1940s to early 1950s, probably via post World War II cargo shipments (Rodda et al. 1992). Since its introduction, the snake has colonized the entire island, at densities of up to 80 snakes per hectare of forest. The BTS has caused the extirpation of most of Guam's native terrestrial vertebrates, including native forest birds, bats, and lizards, and it threatens the future existence of others (Savidge 1987, Engbring and Fritts 1988, Rodda and Fritts 1992, Wiles et al. 1995). In addition to the more prominent adverse ecological impacts attributed to the snake, it has become an agricultural nuisance by feeding on young poultry and other livestock (e.g. rabbits, pigs, dogs), and threatens human health and safety (McCoid 1991, Fritts and Rodda 1998). There have been numerous documented incidents wherein the mildly venomous snakes have bitten or chewed on the extremities of infants or children, in some cases causing respiratory arrest and life threatening incidents (Fritts et al. 1990, Fritts and McCoid 1999). The snakes have also been implicated in numerous power outages throughout Guam causing millions of dollars in structural damages and lost revenue (Fritts et al. 1987, Fritts and Chizar 1999).

Federal, state, and territorial governments have committed substantial resources to combating the problems created by the BTS on Guam. These efforts include prevention of BTS dispersal from Guam and mitigating the day-to-day impacts of BTS populations on the island (Engeman and Vice 2001, Vice and Pitzler 2002). The need for intensive control of BTS on Guam and the continued development of better control technology is immediate and ongoing.

The potential spread of the brown treesnake from Guam via cargo movements is a serious concern due to Guam's importance as a trans-Pacific shipping hub, and the delicate environments of islands receiving cargo (Fritts et al. 1999, Brown Treesnake Control Committee 2008, Perry and Vice 2009). These concerns have been substantiated by confirmed brown treesnake sightings in diverse locations such as Hawaii, Commonwealth of the Northern Mariana Islands (CNMI), Federated States of Micronesia (FSM), Marshall Islands, Okinawa, Diego Garcia, Wake Islands, and the southern United States (McCoid et al. 1994, Fritts et al. 1999). Despite these sightings, there is limited evidence supporting that brown treesnakes have established breeding populations at any of these locations. Based upon the frequency of sightings, some experts believe BTS may exist on Saipan (Colvin et al. 2005, Brown Treesnake Control Committee 2008).

The primary objectives of the WS BTS program in Guam are to prevent the inadvertent spread of the snake to other locations and to reduce the negative impacts BTS have on Guam's economic and ecological resources (Engeman and Vice 2001, Vice and Pitzler 2002). To prevent the spread of the brown treesnake, and the potential damage that could result, the Wildlife Services (WS) program of the U.S. Department of Agriculture entered into cooperative agreements with the Government of Guam's Department of Agriculture (GDOA) and the U.S. Department of Defense (DOD) in April 1993 and July 1993, respectively. Subsequently, WS has entered into additional cooperative agreements to further the protection of Guam's natural and economic resources from damages caused by BTS.

To achieve these goals, a variety of control tools and strategies are employed, including the use of specially-designed BTS traps, oral toxicants, hand capture, snake-detector dogs, and public education (Engeman and Vice 2001, Vice and Pitzler 2002). Each of these methods are effective at controlling segments of Guam's BTS population, but are of limited application for

controlling populations in large, unbroken forest blocks typical of the undeveloped landscapes in northern and southern Guam, and therefore will not effectively control BTS populations across the island (Engeman et al. 1998, Rodda et al. 1999a, Rodda et al. 2002). Current methods development efforts are, in part, focused upon the need for additional control tools that can be applied to larger landscapes on Guam (Colvin et al. 2005, Brown Treesnake Technical Committee 2008).

1.2 PURPOSE

The purpose of the proposed action is to further develop the aerial delivery of oral toxicants used in controlling BTS populations on Guam, to facilitate population suppression in larger, undeveloped landscapes across the island.

1.3 NEED FOR ACTION

In 2003, the United States Environmental Protection Agency (USEPA) authorized a label for the use of acetaminophen as an oral toxicant for controlling BTS populations on Guam (EPA Registration Number 56228-34). Application of acetaminophen can be made either by ground-based operations using bait stations or aerially, via fixed-wing airplane or helicopter. The technology necessary for ground-based application of oral toxicants is well established; aerial delivery has not yet been conducted on an operational scale, as there are continued needs for refinement of the technology and methodology.

The U.S. Department of Defense, Environmental Security Technology Certification Program (ESTCP) has supported a proposal from WS to engage in a project aimed at furthering the development of aerial toxicant bait application for controlling BTS. Appendix B and Appendix C contain more detail regarding the specific research proposal.

1.3.1 Proposed Action

To further the development of aerial delivery of oral toxicants for controlling BTS, the USDA, WS, National Wildlife Research Center (NWRC) and the Guam WS operational program are proposing an approximately 16-month long joint research-operational aerial toxicant project on northern Guam. The proposed project would occur on the Habitat Management Unit (HMU) within the Munitions Storage Area of Andersen Air Force Base and adjoining DoD property. Two blocks of forest, totaling 110 hectares, would be exposed to intermittent application of toxicants via a commercially-leased helicopter, with 55 hectares of adjacent property serving as a control (or baseline) site. The HMU is surrounded by a barrier which blocks immigration by BTS; the second forest block is not surrounded by a barrier, and therefore is open to BTS immigration and emigration.

Specific results expected from the ESTCP project include: the development of a functional navigational system needed to ensure even landscape-level coverage of baits; refinement of the delivery process for applying baits via a helicopter; an understanding of the population-level impacts bait application will have on a contained and uncontained BTS population; and improved processes for ensuring bait flaggers are effectively suspended from forest canopies. The potential benefits from this effort will greatly increase the capacity of operational BTS control programs, subsequently reducing the impacts of snakes on Guam and the risk of BTS dispersal from Guam (Savarie et al. 2001). However, the addition of aerially-delivered oral toxicants to existing control programs is not expected to facilitate complete BTS eradication from Guam.

1.3.2 Acetaminophen Baiting Technology

Extensive research and evaluation was required to develop and register acetaminophen as an oral toxicant for BTS (Brooks et al. 1998, Savarie and Bruggers 1999, Savarie et al. 2000, Johnston et al. 2002). Acetaminophen is a commonly used human analgesic, available over-the-counter, with limited risks in the proposed use pattern. Laboratory and field testing determined that 80 mg of acetaminophen (the equivalent of a human children's dose) is lethal to BTS (Johnston et al. 2002). Through further evaluation, a suitable matrix to hold the toxicant, a dead neonate mouse (DNM), was found to be attractive and palatable to BTS (Savarie et al. 2001, Shivik et al. 2002). Substantial information regarding environmental and human risk has been published (Bessems and Vermeulen 2001, Johnston et al. 2002, Larson et al. 2005). In 2003, acetaminophen was registered by the United States Environmental Protection Agency for use in controlling BTS on Guam (EPA Registration Number 56228-34). Use of acetaminophen under this label is regulated by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

The application of acetaminophen baits for controlling BTS is accomplished via aerial or ground-based delivery, which are both proven technologies used for rodent control. However, the aerial and bait station delivery techniques for BTS are unique and innovative for the following reasons: 1) acetaminophen is a safe oral toxin and is the first toxin ever to be developed for snake control; and, 2) inanimate baits (DNM) are used to deliver the toxicant to snakes (Shivik and Clark 1997). In both circumstances, a single 80 mg acetaminophen tablet is inserted orally into a DNM. Ground-based applications are made using bait stations, generally a 5.1 cm x 30.5 cm length of PVC pipe, suspended horizontally approximately 1.5 m above the ground, from vegetation, fences, or a rebar frame.

For aerial application, DNM treated with an 80 mg tablet of acetaminophen are individually attached to double-ended marking flags (a 1.2 meter long paper streamer folded accordion-style, attached to cardboard on each end; see Figure 1) with the DNM attached to the outside of the small cardboard. The double-ended cardboard streamers form a loop in the air and entangle the treated dead neonatal mice in the canopy where they can be consumed by BTS while remaining less available to scavengers such as coconut crabs (*Birgus latro*), hermit crabs (*Coenobita* spp.), cane toads (*Bufo marinus*), and monitor lizards (*Varanus indicus*). The streamers are 100% biodegradable, consisting of thin forest green tissue paper material and cardboard. During dry periods, streamers may persist in the forest canopy for a week or more; when heavy rains occur, streamers degrade more quickly, often within a day of application (WS, NWRC unpublished data). DNM baits that are not consumed by BTS are typically degraded within 3-4 days of application.

Bait application, whether aerial or via bait stations, is limited to no more than 36 baits/ha per application, per EPA label. Multiple field evaluations have concluded that acetaminophen baits, when applied to forested environments on Guam, are effective at controlling BTS populations (Savarie et al. 2001, Clark 2003) and present minimal risk to non-target organisms. Both bait station and aerial broadcast field evaluation trials of acetaminophen-treated baits on 6 ha forest plots resulted in 80%-90% reduction of BTS within 4-5 weeks (Savarie et al. 2001, Clark 2003).

1.4 BIOLOGY

Like other members of its genus, the BTS is an arboreal, nocturnal, slender snake with grooved venom-conducting teeth at the rear of the upper jaw. The species can attain a relatively large size, facilitating predation on a broad range of vertebrates (Rodda et al. 1999b). The average length of brown treesnakes on Guam is about 1.0 m, with a maximum length of approximately 3.1 m (Rodda and Savidge 2007).



Figure 1. Image showing paper streamer used in applying acetaminophen baits for controlling brown treesnakes. DNM bait is attached to the cardboard on the left side of the image.

The BTS's natural distribution extends from Sulawesi in Indonesia east through New Guinea to the Solomon Islands and south along the northern and eastern rims of Australia. Brown treesnakes have been established on Guam, the southernmost island in the Mariana Islands, since the late 1940's or early 1950's. The population reached peak densities of 50-100 snakes per hectare at differing times, depending upon when a given area was colonized (Rodda et al. 1992). While native vertebrate populations have dwindled or disappeared, introduced prey populations (primarily rodents, shrews, geckos and skinks) continue to support large populations of snakes (Rodda and Fritts 1992, Campbell 1996). Recent estimates of snake densities are 10-25 individuals per hectare, although population levels appear to be highly variable, depending upon prey availability (Rodda and Savidge 2007, Gragg et al. 2007).

The BTS is highly adaptable and not limited to specific habitats, forest strata, or seasons. The BTS is an opportunistic predator, consuming both active and inactive prey (e.g., geckos and their eggs), carrion and almost all live terrestrial vertebrates (amphibians, reptiles, birds, and mammals) of a suitable size. In the wild, the snake has been observed consuming meals approximately 70 percent of its body mass (Rodda et al. 1999b). Food also appears to be an important factor limiting survival and reproductive output of newly mature females on Guam (Rodda and Savidge 2007).

Little is known about the reproductive habits of the brown treesnake, as gravid females and eggs are infrequently found, and mating has never been observed in the wild on Guam (Rodda and Savidge 2007, Savidge et al. 2007). In Australia, reproduction is highly seasonal, whereas reproduction on Guam is year-round (Savidge et al. 2007). This lack of seasonal reproduction may be due to the minimal variation in Guam's annual temperature. Two other species of *Boiga* have been shown to reproduce after long periods (up to 6 years) of isolation, suggesting either

long-term sperm storage or asexual reproduction; however neither has been confirmed on Guam (Savidge et al. 2007). Table 1 presents an overview of life history and ecology of the BTS.

Table 1. Life History Information on the Brown Treesnake¹.

Family	Colubridae
Scientific name	<i>Boiga irregularis</i>
Native range	eastern Indonesia, Papua New Guinea, Solomon Islands, northern and eastern Australia
Non-native range	Guam and Saipan
Diet	Birds and their eggs, lizards, frogs, small mammals
Mature total length	1.5 m (female); 2.1 m (male)
Mature snout-vent-length	910-1,025 mm (female); 940-1,030 mm (male)
Hatchling snout-vent-length	375 mm
Mature weight	230 g (female); 523 g (male)
Maximum weight	3.5 kg
Hatchling weight	5 g
Reproductive strategy	Oviparous (egg-laying)
Reproductive timing	Breeding occurs year-round on Guam
Clutch size	4.3 eggs (mean, range 2-11 eggs)
Population density	10-25 snakes/hectare
Life span in captivity	>15 years
Home range	Up to 100 hectares
Population limiting factors	Food availability

¹ Table adapted from Brown Treesnake Technical Committee (2008)

1.5 LOCATION AND SCOPE OF ANALYSIS

1.5.1 Location and Human Use

The geographic location of proposed activities is Guam, in the Mariana Islands. Potential sites for the proposed project include the HMU within the Munitions Storage Area, Andersen Air Force Base in northern Guam and Orote Point, Naval Base Guam, in southwestern Guam (Figure 2). The scope of analysis is specific to the two potential project sites, and any potential off-site effects. This analysis includes approximately 110 hectares of forest that would be exposed to aerial toxicant application and an additional 55 hectares of forest that would serve as a reference site (with no toxicant application) at the HMU site. The Orote site consists of 107 hectares of toxicant treated forest and 68 hectares of forest that would serve as a reference site.



Figure 2. Aerial image of Guam, showing the proposed locations for BTS toxicant projects, outlined in red. The Orote Point site is located on the left side of the image, and the HMU site on the top of the image.

The HMU site consists of secondary limestone forest and mixed introduced forest, with non-native plants dominating the perimeters of the plot (Liu and Fisher 2005). The HMU site is located over Guam's northern aquifer, and is characterized by shallow limestone soils. The Orote Point site is also characterized by shallow limestone soil, and is not located over the island's northern aquifer. The primary vegetative cover on the Orote Point site consists of non-native *Leucaena leucocephala*, with intermixed mixed scrub forest (Liu and Fisher 2005), as described by Mueller-Dombois and Forsberg (1998).

Both sites are predominantly unbroken forest, with limited human use of the forest interior. Existing roadways and non-residential facilities are found immediately adjacent to the perimeters of each plot, and residences are located adjacent to the proposed HMU reference plot. Terrestrial wildlife found at both sites includes rats (*Rattus* spp.), hermit crabs, coconut crabs, monitor lizards, skinks, and geckos. Feral cats (*Felis catus*) and feral dogs (*Canis familiaris*) are found around both proposed sites, generally along forest perimeters and roadsides. Limited numbers of Eurasian tree sparrows (*Passer montanus*), yellow bitterns (*Ixobrychus sinensis*), Philippine turtle doves (*Streptopelia bitorquata*), black francolin (*Francolinus francolinus*) and black drongos (*Dicrurus macrocerus*) are present in and around each site. At the HMU site, federally endangered Mariana crows (*Corvus kubaryi*) and Mariana fruit bats (*Pteropus mariannus*) are infrequently observed. As well, Philippine deer (*Cervus mariannus*) and feral pigs (*Sus scrofa*) are commonly found in and around HMU.

1.5.2 Scope

This EA analyzes the impacts of aerial application of toxicants for BTS control in HMU and Orote Point. It also analyzes the impact of using existing management methods to achieve proposed objectives and a No Action Alternative.

1.6 RELATED ENVIRONMENTAL DOCUMENTS

ADC Programmatic Environmental Impact Statement (EIS)

WS (formerly called Animal Damage Control (ADC)) issued a Final EIS on the national WS program (USDA 1997, revised). Pertinent and current information available in the EIS has been incorporated by reference into this EA.

Brown Treesnake Control Activities on Guam Environmental Assessment (EA)

WS issued a Finding of No Significant Impact for BTS control activities on Guam (USDA 1996). Information on BTS control methods mentioned in the aforementioned EA has been incorporated into this EA.

Native Forest Birds of Guam and Rota of the Commonwealth of the Northern Mariana Islands Recovery Plan

The United States Fish and Wildlife Service issued a final recovery plan which included the establishment of multiple populations of several endangered native forest birds across Guam. Control of the BTS may assist with recovery efforts for several listed species.

FONSI and Environmental Assessment for the Beddown of Training and Support Initiatives at Northwest Field, Andersen Air Force Base, Guam.

The Department of the Air Force, Pacific Air Forces, issued a Finding of No Significant Impact regarding a proposed Beddown on Northwest Field, Andersen Air Force Base (Air Force 2006). An action component of the Northwest Field Beddown Environmental Assessment included the establishment and management of the Habitat Management Unit on Andersen Air Force Base. The HMU, a 55 hectare block of native limestone forest, is intended to support native wildlife recovery efforts on Guam. The HMU is surrounded by a chain link fence, fitted with a BTS exclusionary barrier, which also serves to exclude introduced ungulates.

Biological Opinion on the Establishment and Operation of an Intelligence, Surveillance, Reconnaissance, and Strike Capability Project on Andersen Air Force Base, Guam.

The United States Fish and Wildlife Service issued a Biological Opinion (BO) in 2006 regarding a proposed activity by the United States Air Force on Andersen Air Force Base, Guam. An

action component of the ISR/Strike Capability BO included Air Force support of research into the development of oral toxicant technology for BTS control.

1.7 AUTHORITY AND COMPLIANCE

Based on agency relationships, missions, and legislative mandates, WS is the lead agency and decision maker for this EA, and therefore responsible for the EA's scope, content, and outcome.

1.7.1 Authority of Federal and State Agencies in Invasive Species Management

Wildlife Services

The WS program is the Federal agency authorized to manage wildlife that threaten natural resources, agriculture and human health and safety. The primary statutory authority for the APHIS-WS program is the Act of March 2, 1931, as amended (7 U.S.C. 426-426c; 46 Stat. 1468).

The Secretary of Agriculture is authorized and directed to conduct such investigations, experiments, and tests as he may deem necessary in order to determine, demonstrate, and promulgate the best methods of eradication, suppression, or bringing under control on national forests and other areas of the public domain as well as on State, Territory or privately owned lands of . . . brown tree snakes and other animals injurious to agriculture, horticulture, forestry, animal husbandry, wild game animals, furbearing animals, and birds...animals; and to conduct campaigns for the destruction or control of such animals...Section 1013 of Public Law 102-237, which amended the Act in 1991, also requires the Secretary to initiate a program to prevent the inadvertent introduction of the brown tree snake into Hawaii from Guam. The Secretary also is required, to the extent practicable, to take action to prevent the inadvertent introduction of the brown tree snake into other areas of the U.S. from Guam.

WS is subject to the Endangered Species Act (ESA) which requires Federal agencies to use their authorities to conserve threatened and endangered (T&E) species.

U.S. Fish and Wildlife Service

Regulations listing species found to be injurious under the Lacey Act are in 50 CFR, part 16. The USFWS is charged with implementation and enforcement of the ESA of 1973, as amended and with developing recovery plans for listed species. The USFWS also makes recommendations to avoid or minimize take of T&E species, as required under Section 7 of the Endangered Species Act.

U.S. Department of Defense

Both proposed project sites are located on property owned and managed by the U.S. Department of Defense (DoD). Regulations that facilitate DoD involvement in the control and management of invasive species include the Sikes Act (16 USC 670a-670o, 74 Stat. 1052), as amended. Public Law 108-136, the National Defense Authorization Act of 2004, enacted on November 24, 2003, amended Section 101 of the Sikes Act to authorize the DoD to incorporate provisions for invasive species management into Integrated Natural Resource Management Plan's for military installations in Guam.

Guam Division of Aquatic and Wildlife Resources

The Division of Aquatic and Wildlife Resources (DAWR), Guam Department of Agriculture is responsible for the management of all aquatic and terrestrial resources for the people of the Territory of Guam.

Guam Environmental Protection Agency

The Guam Environmental Protection Agency is responsible for enforcing local environmental compliance requirements, including the Guam Pesticides Act.

1.7.2 Compliance with Federal Laws and Executive Orders

Several Federal laws regulate, authorize, or otherwise affect wildlife damage management. WS complies with these laws, and consults and cooperates with other agencies as appropriate. The following Federal laws and executive orders were considered in this EA and with the public review process.

National Environmental Policy Act

NEPA requires that Federal actions be evaluated for environmental impacts, that these impacts be considered by the decision maker(s) prior to implementation, and that the public be informed. This EA has been prepared in compliance with NEPA (42 USC Section 4231, et seq.); the President's Council on Environmental Quality Regulations, 40 CFR Section 1500 – 1508, APHIS NEPA Implementing Regulations (7 CFR 372), and WS NEPA policy.

Invasive Species (Executive Order 13112)

The Invasive Species Executive Order (EO) directs Federal agencies to use their programs and authorities to prevent the spread or to control populations of invasive species that cause economic or environmental harm, or harm to human health.

Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) was enacted on October 27, 1972, to encourage coastal states, Great Lake States, and United States territories and commonwealths to develop comprehensive programs to manage and balance competing uses of and impacts to coastal resources. Federal consistency is the CZMA requirement where federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone must be consistent to the maximum extent practicable with the enforceable policies of a coastal state's federally approved coastal management program.

Endangered Species Act

It is Federal policy, under the ESA, that all Federal agencies shall seek to conserve endangered and threatened species and shall utilize their authorities in furtherance of the purposes of the ESA (Sec.2(c)). Section 7 consultations with the USFWS are conducted to use the expertise of the USFWS to ensure that "any action authorized, funded, or carried out by such an agency . . . is not likely to jeopardize the continued existence of any endangered or threatened species. Each agency shall use the best scientific and commercial data available" (Sec. 7(a)(2)). WS has consulted with the USFWS on project effects on the Mariana crow and Mariana fruit bat. Results of that consultation are discussed under the effects of the proposed action.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

FIFRA requires the registration, classification, and regulation of all pesticides used in the United States. The Environmental Protection Agency (EPA) is responsible for implementing and enforcing FIFRA. All chemical methods integrated into any selected program as implemented by APHIS-WS or other cooperating agencies must be registered with and regulated by the EPA (FIFRA Section 3) and the Guam Department of Agriculture (GDOA), and used in compliance with labeling procedures and requirements. The proposed action would be conducted under Section 3.

Impacts on Minority and Low Income Persons or Populations (Environmental Justice and Executive Order 12898)

EO 12898 requires Federal agencies to make Environmental Justice part of their mission, and to identify and address disproportionately high and adverse human health and environmental effects of Federal programs, policies and activities on minority and low income persons or populations. All of WS activities are evaluated for their impact on the human environment and compliance with EO 12898 to ensure Environmental Justice. The proposed action is not anticipated to result in any adverse or disproportionate environmental impacts to minority and low-income persons or populations.

National Historic Preservation Act (NHPA) of 1966, as amended (6 U.S.C. 470 et seq.)

The NHPA requires: 1) federal agencies to evaluate the effects of any federal undertaking on cultural resources, 2) consult with the State Historic Preservation Office regarding the value and management of specific cultural, archaeological and historic resources, and 3) consult with appropriate American Indian tribes or Native Hawaiians to determine whether they have concerns for traditional cultural properties in areas of these federal undertakings. Activities described under the proposed action would not cause major ground disturbance and therefore are not undertakings as defined by the NHPA.

Protection of Children from Environmental Health and Safety Risks (EO 13045)

Children may suffer disproportionately from environmental health and safety risks, including their developmental physical and mental status, for many reasons. EO 13045 stipulates that each Federal agency shall make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks. This EA demonstrates that humans are highly unlikely to be affected by the proposed activities.

1.7.3 Territory of Guam Laws

Endangered Species Act of Guam

The Endangered Species Act of Guam provides authorization for the protection and conservation of resident endangered or threatened species. The Act authorizes the Guam Department of Agriculture to annually promulgate a list of endangered species and to conduct research and management actions in cooperation with federal or other local agencies for the conservation, protection and enhancement of listed species. The Guam Department of Agriculture, Division of Aquatic and Wildlife Resources (DAWR) is authorized to issue permits for actions that lead to the enhancement, conservation and survival of listed species. Both Mariana crow and Mariana fruit bat are listed under the Endangered Species Act of Guam. WS has consulted with Guam DAWR on project effects to both of these species. Results of that consultation are discussed under the effects of the proposed action.

Guam Pesticides Act

Amended under P.L. 29-26, the Guam Pesticides Act authorizes the Guam Environmental Protection Agency (GEPA) to regulate the importation, production, sale, distribution, use and application of pesticides used on Guam that are registered with the U.S. EPA. The Act also authorizes GEPA to implement and enforce such regulations. All actions initiated by the proposed activities would be in compliance with the Guam Pesticides Act.

2.0 DESCRIPTION OF ALTERNATIVES

2.1 ALTERNATIVE 1 – Targeted aerial application of oral toxicants for controlling brown treesnake populations in and around the HMU on Andersen Air Force Base (Preferred Action).

The HMU site consists of two-55 ha plots (HMU Drop Site and Munitions Storage Area [MSA] Drop Site) where toxicant baits would be applied, plus a third plot (Reference Site) that would serve as a source of baseline data on BTS abundance (Figure 3). The HMU Drop Site is surrounded by a chain link fence, fitted with a BTS exclusionary barrier. The MSA Drop Site, adjacent to the HMU Drop Site, is unbounded; this scenario would facilitate a direct comparison of the efficacy of toxicant bait application in areas with and without local BTS population immigration. Aerial application of baits would be made using a commercially leased helicopter, flying at approximately 30 m above ground level. Baits would be deployed from the helicopter via two personnel inside, at a rate of 36 baits per ha per application. Under this alternative, bait would be applied no closer than 2.2 km from the nearest marine environment.

The sites would be treated for 12 months, with no more than 30 aerial bait applications proposed. For the first 2 months, aerial bait applications would be made every two weeks. During this time, 20 treated DNM, with attached radio transmitters, would be included with the treated DNM, to assess bait take and entanglement in the canopy. Radioed baits would be tracked immediately following bait application, and recovered either following consumption by a BTS or after the DNM bait is no longer viable. After the rate of bait take is 20% or less, as determined from monitoring stations and treated DNM fitted with radio transmitters, aerial delivery would be suspended. When bait-take is 30% or greater, as determined from monitoring stations, aerial applications would restart, at bi-weekly intervals until bait-take drops to 20% or less, again as determined from monitoring stations. If monitoring indicates “hot spots” of snake activity, bait stations with treated DNM may be applied in these areas. Depending upon monitoring results, aerial baiting would continue bi-weekly, to maintain the snake bait-take activity below 20%. The maximum rate of application per baiting would be 2.88 g of acetaminophen per ha of forest, with the total number of baits applied not exceeding 3960 baits per application. At 80 mg acetaminophen per bait, a maximum total of 9.504 kg of acetaminophen would be applied over the 30 possible applications during the project.

Snake and rodent abundance would be monitored pre-treatment and during the 16 months of aerial treatment. Snake activity would be monitored using monitoring stations baited with untreated DNM. Monitoring stations would be hung about 1.5 m high in vegetation at 20 m intervals. A minimum of 6 bait station transects (n= 11 stations/transect), randomly selected from the pre-selected transects on the drop site would be monitored daily for 2 days for consumption (bait take) of DNM. Bait take of non-toxic DNM would be monitored pre-treatment. During aerial treatment, transects would be monitored at bi-weekly intervals to assess BTS activity via non-toxic bait take. Transect cutting and maintenance would require limited pruning of vegetation, given the sparse understory in the HMU and MSA plots. All pruning would be completed by hand, using loppers to create a minimal path that allows access without creating large open lanes in the forest. No mature trees or bushes would be removed. Pruning of native vegetation would only be done when necessary to allow access.

Procedures for monitoring rodent (rat) activity would be similar to snake bait stations, except standard rodent live capture traps would be used. Rodents would be released at the capture site. A reference site that does not receive treated bait would also be monitored for snake and rodent activity using the above described procedures.



Figure 3. Map showing the proposed HMU project site, including the HMU plot and MSA plot, and the reference site located across Route 3A.

Success of the demonstration and technology would be assessed by two standard performance methods conducted pre-aerial treatment and during aerial treatment. The performance methods are: (1) Bait take of non-toxic DNM from monitoring stations (bait take decreases as snake abundance decreases; Savarie et al. 2001), and (2) Monitoring of rodents using live traps with release of rodents at the capture site (rodent abundance increases as snake abundance decreases; Weiwel et al. 2009). Additionally, a subsample of the aerially deployed treated DNM baits would be equipped with radio transmitters to assess bait take and entanglement in the canopy.

2.2 ALTERNATIVE 2 – Targeted aerial application of oral toxicants for controlling brown treesnake populations on Orote Point, Guam.

The Orote Point project site consists of three forest plots, totaling 107 ha, plus an adjacent 68 ha reference site (Figure 4). Aerial application of baits would be made using a rented commercial helicopter, flying at approximately 30 m above ground level. Baits would be



Figure 4. Map showing proposed project site on Orote Point, Guam.

deployed from the helicopter via two personnel inside, at 36 baits per ha per application. Under this alternative, bait application would be made within 25 m of tidal environments.

The site would be treated for 12 months, with no more than 30 aerial bait applications proposed. For the first 2 months, aerial bait applications would be made every two weeks. During this time, 20 treated DNM, with attached radio transmitters, would be included with the treated DNM, to assess bait take and entanglement in the canopy. After the rate of bait take is 20% or less, as determined from monitoring stations and treated DNM fitted with radio transmitters, aerial delivery would be suspended. When bait-take is 30% or greater, as determined from monitoring stations, aerial applications would restart, at bi-weekly intervals until bait-take drops to 20% or less, again as determined from monitoring stations. If monitoring indicates “hot spots” of snake

activity, bait stations with treated DNM may be applied in these areas. Depending upon monitoring results, aerial baiting would continue bi-weekly, to maintain the snake bait-take activity below 20%. The maximum rate of application per baiting would be 2.88 g of acetaminophen per ha of forest, with the total number of baits applied would not exceed 3852 baits per application. At 80 mg per bait, a maximum total of 9.2448 kg of acetaminophen would be applied over the 30 possible applications during the project.

Snake and rodent abundance would be monitored pre-treatment and during the 16 months of aerial treatment. Snake activity would be monitored using stations baited with untreated DNM. Monitoring stations would be hung about 1.5 m high in vegetation at 30 m intervals. A minimum of 12 monitoring station transects (n= 10 stations/transect), randomly selected from the pre-selected transects, would be monitored daily for 2 days for consumption (bait take) of DNM. Bait take of DNM would be monitored pre-treatment. During aerial treatment, transects would be monitored at bi-weekly intervals to assess BTS activity via non-toxic bait take. Because of its small size, only 2-3 transects for monitoring purposes would be established on Orote Island. Transect establishment and maintenance at the Orote Point site would require some intensive cutting of non-native forest, as the proposed plots are heavily forested with substantial understory.

Procedures for monitoring rodent (rat) activity would be similar to snake bait stations, except standard rodent live capture traps would be used. Rodents would be released at the capture site. A reference site that does not receive treated bait would also be monitored for snake and rodent activity using the above described procedures.

Success of the demonstration and technology would be assessed by two standard performance methods conducted pre-aerial treatment, and during aerial treatment. The performance methods are: (1) Bait take of DNM from bait stations (bait take decreases as snake abundance decreases; Savarie et al. 2001), and (2) Monitoring of rodents using live traps with release of rodents at the capture site (rodent abundance increases as snake abundance decreases; Weiwel et al. 2009). Additionally, a subsample of the aerielly deployed treated DNM baits would be equipped with radio transmitters to assess bait take and entanglement in the canopy.

2.3 ALTERNATIVE 3 – Use of methods other than toxicants to achieve large scale BTS control

Control tools currently available for operationally managing BTS populations include specially-designed traps, hand capture, oral toxicants, dog detection and barriers that block BTS movement. In combination, these methods are capable of substantially reducing, and potentially eliminating BTS populations from small, barrier-bounded plots of forest on Guam (Rodda et al. 1992, Campbell 1999, Engeman et al. 2000). Under this alternative, Wildlife Services would implement a control program that integrates all available control methods except the delivery of oral toxicants. The proposed project would be implemented in HMU on the Munitions Storage Area at Andersen Air Force Base, Guam.

2.4 ALTERNATIVE 4 – No Action Alternative

Under this alternative, WS, as the lead Federal agency, would not take any action to control BTS using any control means in either proposed project site.

2.5 Alternatives Considered but Not Assessed in Detail

2.5.1 Development and use of alternative toxicant

The identification, development, and registration of a novel toxicant for managing invasive vertebrate species is costly, time consuming, and often unsuccessful. During the initial investigations to develop a BTS oral toxicant, numerous candidate compounds were evaluated for potential use (Brooks et al. 1998, Savarie and Bruggers 1999, Johnston et al. 2001). Acetaminophen, which is now fully registered by the USEPA for use in controlling BTS on Guam, has a proven record of efficacy, as well as limited environmental and human risks. Therefore, this EA will not complete any further analysis of alternative BTS toxicant development.

3.0 ISSUES IMPORTANT TO THE ANALYSIS OF IMPACTS

3.1 Issues Driving the Analysis

The following issues are used to drive the analysis in Chapter 4, Environmental Consequences. Each major issue will be evaluated under each alternative and the direct, indirect and cumulative impacts will be estimated where applicable. Through interagency consultation and scoping, the following issues were identified as requiring consideration in the decision making process for this EA to help compare the impacts of the various alternatives management strategies.

- 1) How effective might the various alternatives be in controlling BTS, and how do they compare in meeting the objectives of the proposal? Relative program efficacy is used in addition to the environmental issues to help the public and decision maker compare the merits of the alternatives and determined which alternative would be most likely to meet the objectives of the proposal.
- 2) Could the proposal affect threatened and endangered species, other sensitive species, and/or other non-target animals?
- 3) What effects would aerial application of acetaminophen have on health and human safety?
- 4) What effects would aerial application of acetaminophen have on watersheds and water quality?

3.2 Issues Not Analyzed in Detail, with Rationale

The actions discussed in this EA involve no construction or physical alteration of the environment, therefore the following resource values are either not affected, or are not expected to be significantly affected by any of the alternatives analyzed: soils, vegetation, geology, minerals, flood plains, aesthetic values, and prime and unique farmlands. There are no significant irreversible or irretrievable commitments of resources. These resources will not be analyzed further.

The Guam Department of Parks and Recreation's Historical Preservation Office has expressed a concern that DNM baits, dead BTS, and flaggers could be deposited on historical artifacts contained within the proposed project sites and subsequently cause damages to artifacts. It is possible that all three scenarios could occur within the scope of the proposed project; however,

in each circumstance, the potential for adverse effects on historical resources is not significant. First, unconsumed DNM baits (and the contained acetaminophen) quickly degrade, with virtually no matter remaining following 5 days in Guam's environment. Bacterial decomposition and consumption by invertebrates eliminates the entire bait over this time. Secondly, BTS are exceptionally abundant in the forests of Guam, and are continually subjected to other sources of mortality. Although the proposed project will likely increase mortality rates for BTS, the environmental persistence of dead BTS is very short. Decomposition and scavenging would result in rapid removal of BTS carcasses from the environment. Thirdly, flaggers are constructed of organic paper and cardboard products, which degrade more readily than most plant material already existing in the forest environments of Guam. The materials are non-toxic and non-corrosive in nature; therefore, there is little risk of causing damage to historical resources during their brief existence in the environment. As a consequence, no further analysis will be conducted.

4.0 ENVIRONMENTAL CONSEQUENCES

Chapter 4 provides information needed for making informed decisions on the BTS operational objectives identified in Chapter 1 and alternatives described in Chapter 2. This chapter uses the issues identified in Chapter 3 as the evaluation criteria. Each of the issues will be analyzed for its environmental consequences under each alternative. Each identified major issue will be evaluated under each alternative and the direct, indirect and cumulative impacts will be estimated where applicable. NEPA describes the elements that determine whether or not an impact is "significant." Significance is dependent upon the context and intensity of the impact. The following factors were considered to evaluate the significance of the impacts on the human environment that relate to context and intensity (adapted from USDA 1997, revised for this proposal).

- 1) The magnitude of the impact (size, number, or relative amount of impact) (intensity);
- 2) The duration and frequency of the impact (temporary, seasonal impact, year round or ongoing) (intensity);
- 3) The likelihood of the impact (intensity);
- 4) The geographic extent; how widespread the program impact might be (intensity); and,
- 5) The legal status of a species that may be affected by the action (context).

4.1 ALTERNATIVE 1 – Targeted aerial application of oral toxicants for controlling brown treesnake populations in and around the HMU on Andersen Air Force Base (Preferred Action).

4.1.1 Effectiveness

The field application of acetaminophen for controlling BTS has been proven to be successful at reducing localized populations of the snake (Savarie et al. 2001). However, the methodologies for large scale application of toxicants via aircraft have not been developed nor extensively tested. Under this alternative, substantial improvements to existing technology are expected. As well, the pairing of the two drop sites (one with a BTS barrier and one without a BTS barrier) will greatly increase the understanding of BTS population dynamics as they relate to control and subsequent re-invasion. Therefore, the probability of effectiveness under this alternative is very high. A secondary benefit of the proposed action is the removal of BTS populations from an important conservation site on northern Guam.

4.1.2 Impacts on Non-target Animals

Impacts to non-target species under this alternative are classified as toxicant impacts, disturbance, and direct mortality from aircraft operations. Each type of potential impact will be analyzed separately below.

Toxicant impacts

Two critically endangered species, the Mariana crow and the Mariana fruit bat, are known to use HMU and surrounding forests on Northwest Field. Currently, there is one known crow left in the wild, inhabiting Northwest Field, and possibly 20-30 bats scattered throughout Guam (Guam DAWR unpub. data). This section will review potential risks of toxicants to both endangered species that are present in the proposed project site, as well as other possible non-target species that could be at risk.

The risk to a given organism from a toxicant is a function of the probability of exposure and relative toxicity. If either variable is zero, the risk is zero. If both variables are greater than zero, there is inherently some risk associated with the toxicant. Exposure can be either through direct toxicant consumption (primary) or through consumption of other organisms exposed to the toxicant (secondary). There are several broad approaches available to mitigate for risk, by reducing the probability of exposure or using a toxicant with low inherent risk. The proposed toxicant application program would implement actions that incorporate some considerations for both approaches. For example, Mariana fruit bats are not carnivorous, and would not be exposed to acetaminophen via ingestion of DNM baits, and therefore their risk of primary toxicant mortality is zero.

Considered a relatively safe compound, acetaminophen still has the potential to impact non-target wildlife species. Johnston et al. (2002) assessed the risks for both primary and secondary poisoning of non-target wildlife associated with acetaminophen use in controlling BTS populations on Guam. Table 2, adapted from Johnston et al. (2002), summarizes LD₅₀ doses for non-target species possibly at risk from acetaminophen baiting (LD₅₀ is the dose at which 50% of those organisms exposed to a chemical are expected to suffer mortality) and associated hazard quotients. Hazard quotients greater than 0.5 exceed the US EPA's acute hazard threshold; the values reported are independent of measures to reduce toxicant ingestion. As well, the table provides an estimate of the number of acetaminophen baits a given species would need to consume in order to reach an LD-50 dose.

Avery et al. (2004) used fish crows (*Corvus ossifragus*) as a surrogate for endangered Mariana crows in assessing risk of acetaminophen. When force-fed (2) 80 mg acetaminophen DNM baits, 5 of 5 birds regurgitated the baits, and a single bird died within a few hours of consuming the baits. In a separate experiment, 5 crows offered the same baits *ad lib* all consumed the DNM but picked around the acetaminophen tablet and did not ingest the tablet; no birds died as a result of the feeding. Wild crows have been observed catching and eating rodents and rodent pups on Guam, and typically do not swallow the animal whole, opting instead to tear the animal into smaller pieces prior to consumption (J. Quitugua, Guam DAWR pers. comm.). As well, crows often hold larger food items in the back of the mouth, before moving to a secure perch where the food is brought up and subsequently torn into smaller pieces (S. Medina, Guam DAWR pers. comm.). During an early field trial with acetaminophen-laden DNM, WS field staff made at least three observations of wild crows pulling DNM baits from toxicant delivery tubes

Table 2. Primary and secondary hazards to non-target wildlife associated with acetaminophen baits for controlling BTS.

Species	LD ₅₀ Acute Toxicity Estimate (mg/kg)	Primary Hazard				Secondary Hazard	
		Acetaminophen dose (µg/g)	Hazard Quotient ^a	Mean body weight	Estimated # baits to reach LD- 50 dose	Acetaminophen dose (µg/g)	Hazard Quotient ^a
House mouse (<i>Mus musculus</i>)	338	2400	7.12	0.04 kg	1	132.2	0.39
Norway rat (<i>Rattus norvegicus</i>)	1944	1600	0.80	0.45 kg	30	88.1	0.05
Domestic dog (<i>Canis familiaris</i>)	>2000	960	<0.48	11.4 kg	>500	52.9	<0.03
Domestic cat (<i>Felis catus</i>)	361	1005	2.78	2.7 kg	12.25	61.7	0.17
Pig (<i>Sus scrofa</i>)	>1000	800	<0.80	22.7 kg	>500	44.1	<0.04
Fish crow (<i>Corvus ossifragus</i>)	560	1280	<2.29	0.4 kg	2	70.5	<0.10

^a Hazard quotient = Acute Toxicity Estimate/Acetaminophen Dose

and moving to a nearby perch, where the baits were (assumed) swallowed whole (Sugihara 2004). Intensive monitoring of crows that ate acetaminophen baits, through radio telemetry and direct observations, indicated no mortality or sub-lethal effects (Sugihara 2004). It is unknown if the birds were consuming the DNM baits whole, or moving to another location to tear the baits into smaller pieces. The crows involved in those observations were part of a released cohort that had been provided DNM in their captive diet, as well as their supplemental feeding following their release (S. Medina, Guam DAWR pers. comm). Following the observations of direct acetaminophen bait consumption by released crows, Guam DAWR ceased the use of DNM in captive crow diets. The single remaining wild crow was not provided DNM as part of its captive diet.

Aerially applied acetaminophen baits would be available to Mariana crows for approximately 3 days (if not immediately ingested by BTS), and the surrogate species work suggests that ingestion of as few as 2 baits could cause mortality in the birds. Therefore, WS has consulted with USFWS and a Biological Opinion (BO) is pending. Based on preliminary discussions and written communications (Appendix A), USFWS, WS and Guam DAWR have agreed to cooperatively implement conservation measures to reduce project related risks to the last remaining Mariana crow. These measures are expected to be specified in the USFWS BO. The preferred approach includes working collaboratively with Guam DAWR, under a its permit, to capture the crow and retain the bird in the Guam DAWR captive rearing facility for the duration of the project, for use in captive breeding efforts. Methods to capture the bird may include the use of mist nets, platform snares or other entangling traps, and supplement feeding. Because there is only a single crow on Guam, the project would not reduce the biological potential for the species survival on Guam.

If the crow does not successfully breed during its first year in captivity, the following list summarizes potential follow-up actions, in order of USFWS preference:

- a. Translocate and release the crow on Rota.
- b. Retain the crow in captivity at Guam DAWR for further breeding attempts.
- c. Release the crow on the fee-simple portion of the Guam National Wildlife Refuge.
- d. Let the crow remain in captivity as an educational display at the Guam National Wildlife Refuge.
- e. Translocate the crow to a mainland zoo.

If efforts to capture the birds are unsuccessful, WS would work with Guam DAWR to monitor crow activity, and modify bait application schedules to avoid application when the bird is using the project area. Current monitoring efforts supported by Andersen AFB provide regular data on where the crow resides, which will facilitate daily decision making regarding bait application. As well, WS will work with Guam DAWR to develop and implement supplemental feeding of the crow, to reduce the potential attractiveness of acetaminophen baits to foraging birds. A feeding site will be established near the former hack site, where the crow was initially released, a site the bird still frequents. Supplemental feed consist of the diet which the crow was fed while in captivity, including fresh fruit, dog food, and other components determined by Guam DAWR staff. Appendix A contains the Informal Consultation response letter from USFWS, including a broader discussion of measures to protect the Mariana crow. Based on discussions with the USFWS, we anticipated that the USFWS BO will conclude that implementation of these measures will preclude jeopardy to the Mariana crow and may provide benefit to the species. The proposed action will incorporate any additional ESA compliance measures that may be included in the BO, therefore, any decision resulting from this EA will conform to all FWS final requirements to avoid jeopardy to the Mariana crow.

Other possible non-target species that may directly ingest toxicant baits or consume dead BTS (secondary hazard) include feral pigs, feral cats, feral dogs, coconut crabs, hermit crabs, monitor lizards, and cane toads. Table 2 summarizes the overall risk to several of these species; most at risk from acetaminophen baits appear to be feral cats (Finco et al. 1975). However, even though cats are susceptible to acetaminophen toxicity, an analysis of the overall risk suggests a single cat, weighing 2.78 kg (6 lbs), would need to consume more than 12 baits in a single feeding to attain an LD₅₀ dose. Given the proposed aerial delivery methodology, where 80% of applied baits typically hang up in the forest canopy (Savarie et al. 2007), the probability of a single cat consuming baits at this rate is unlikely. During the development of acetaminophen as a BTS toxicant, extensive video monitoring of both untreated DNM and BTS carcasses placed in forested environments revealed very limited non-target vertebrate take, despite the local presence of Mariana crows, feral dogs, cats, pigs, and rodents. Both coconut crabs and hermit crabs have been observed consuming acetaminophen baits and BTS carcasses (P. Savarie, pers. comm.). When offered acetaminophen-laden DNM in captivity, crabs eat the DNM, but do not ingest the acetaminophen tablet (Johnston et al. 2002, P. Savarie, pers. comm.). As well, coconut crabs fed BTS carcasses that had been killed by acetaminophen ingestion did not exhibit any lethal or sublethal impacts (P. Savarie pers. comm.). Mathies et al. (2011) evaluated the accessibility and acceptance of DNM and toxicant bait stations to coconut crabs and commensal rodents. Both had difficulty accessing the DNM if placed in appropriate bait station configurations. The aerial application of bait would also render most DNM inaccessible to terrestrial crabs by holding the baits in the canopy.

From 2001 – 2010, WS and NWRC tracked the fate of 1,349 radio implanted DNM, applied both aerially and via bait stations to forested environments around Guam (WS, unpub. data). Of those baits, 346 baits were consumed by BTS, 34 were found consumed by terrestrial crabs, 11

were consumed by cane toads, and 5 were consumed by monitor lizards. These totals indicate the risk to most non-target species is not high, as most baits were either consumed by BTS or not consumed by any other species. The rate of BTS consumption of baits in the proposed action is predicted to be higher than in previous applications, as BTS populations on Northwest Field may be higher than many other parts of Guam where prior acetaminophen trials have been completed (WS unpub. data). In the HMU site, most non-target species that may consume bait are abundant and/or non-native.

Risks from secondary poisoning appear even less likely than primary poisoning, as acetaminophen residues in BTS carcasses are low and quickly degrade (Johnston et al. 2002, Primus et al. 2004). Other possible non-target species found in the HMU environment are unlikely to consume baits, either due to their dietary preferences (Philippine sambar deer, Mariana fruit bat, Philippine turtle dove) or habitat requirements that differ from the immediate forested environment in HMU (black francolin, yellow bittern). The risks to these species are negligible.

Disturbance

The remaining crow is well known to field personnel working in northern Guam, as the bird was hand-reared in captivity prior to its release into the wild; the bird frequently investigates field personnel and does not appear to be bothered by human presence (J. Quitugua, pers. comm.). Human activity can negatively impact bats, through disturbance from roosting and feeding sites (Wiles et al. 1995). Bats are infrequently observed roosting in HMU, and have been observed transiting through the area (GDAWR unpub. data). It is possible field personnel tracking baits following application could disturb a roosting bat inside the project site. As well, low level helicopter flights have the potential to disturb roosting or transiting bats. The proposed action includes measures to minimize the risk of disturbance and the potential for take: 1) scheduling of flights later in the morning to minimize the chance of encountering bats; 2) regular monitoring for bat activity; and, 3) ceasing operations if a bat is observed in the area. The USFWS has concurred that with the inclusion of these minimizing measures, disturbance to Mariana fruit bats would be unlikely, and the proposed actions would not be likely to adversely affect this species.

Direct mortality

Under this alternative, helicopter operations would be conducted about 30 m above ground level; this altitude could potentially result in collisions between the aircraft and bats or crows. The air speed of the helicopter when applying bait would be approximately 20 knots; at this speed, both crows and bats remain potentially at risk from collisions. The use of a fixed-wing aircraft would require higher air speeds, and subsequently could increase the probability of collisions. Crows are more agile flyers, and generally spend their time at or below forest canopy level, likely creating less collision risk than for bats. Possible minimization measures to reduce the risk of collisions with bats includes the same options as those listed under the Disturbance section above. As well, the operators of the commercial helicopter proposed for use have substantial experience flying low altitude operations in the Northern Mariana Islands, and have developed strong f to operate in such conditions without impacting bats (E. Campbell, USFWS, pers. comm.). Furthermore, analysis of wildlife strike data from Andersen Air Force Base has indicated only a single record of a fruit bat hitting an aircraft (Morton 1996). The USFWS has concurred that with the inclusion of these minimizing measures, direct mortality to Mariana fruit bats would be unlikely, and the proposed actions would not be likely to adversely affect this species.

4.1.3 Impacts on Human Health and Safety

Acetaminophen is the most widely used human pharmaceutical in the United States (Bessems et al. 2001, Sellon 2001). When ingested at therapeutic doses (1000 mg/dose and up to 4000 mg/day), it is harmless (Bessems et al. 2001) and is not considered carcinogenic. It is also the most frequently misused pharmaceutical, and can be fatal in extreme overdoses (Bessems et al. 2001). Through misuse, acetaminophen is responsible for a majority of acute liver failures in the western world (Lee 2004, Larsen et al. 2005).

The landscaped proposed for bait application in Alternative 1 is contained inside a secure military facility, and the forest plots that would be targeted for application are contained inside a further secured munitions site. The probability of a person encountering toxicant baits and subsequently ingesting one is extremely low; first, most baits would be suspended from the forest canopy. As well, the toxicant bait matrix is a dead mouse, which most humans would find unpalatable. Even if bait was ingested, the single bait dosage (80 mg) is 2% of a normal adult human daily therapeutic acetaminophen dose of 4000 mg. To ingest more than the recommended daily therapeutic dose, a person would have to consume 50 toxicant baits. This would require a person to find and consume all baits applied to approximately 1.3 ha of heavily forested land, located inside a secure military installation. Based upon this analysis, the probability of primary human exposure to acetaminophen via accidental or intentional ingestion is highly unlikely.

Scavengers, such as coconut crabs and monitor lizards, may ingest dead or dying BTS that have previously consumed acetaminophen baits. Crabs could then be consumed by humans, leading to secondary exposure to acetaminophen. In laboratory trials, acetaminophen residues (concentrations) in coconut crabs that consumed acetaminophen-killed were extremely low (Johnston et al. 2002, Primus et al. 2004). As well, current DoD regulations on the proposed project sites do not allow the harvest of coconut crabs; therefore the risk of secondary exposure to humans is considered very low under this alternative.

Wildlife Services employees who would be involved with handling, packaging or delivering baits would be required to follow all US EPA label restrictions for acetaminophen use. All necessary personal protective equipment would be used during all phases of handling. Therefore, the risk of accidental exposure to project employees would not be significant.

The use of helicopters to make low altitude flights for distributing baits potentially creates risk for residents living near the proposed site, as well as employees working in support of the project. To facilitate appropriate planning associated with flight operations, WS has drafted an Emergency Response Plan (ERP), with the following objectives:

- a. Establishes Flight Plan procedures;
- b. Ensures there is a contact person on the ground for every flight;
- c. Establishes actions to take if an aircraft is overdue or if an aircraft accident occurs;
- d. Ensures the ERP is provided to every employee; and,
- e. Establishes an annual review of the ERP to insure the most current and accurate information is included.

Through the development and implementation of an adequate ERP, WS has established procedural guidelines that will facilitate safe flight operations and reduce the probability of an accident(s) near residential areas. Because most of the proposed project sites are not situated

near residences, the risk of such an accident is low. As well, by following standardized safety procedures, established by the WS Aviation Program and adapted for the proposed project, the risk to WS employees during flight operations is low.

4.1.4 Impacts on Watersheds and Water Quality

Koplin et al. (2002) found acetaminophen to be one of the most common anthropogenic compounds in a survey of 139 freshwater streams across the United States. Acetaminophen appears to have limited persistence in the environment, but is continuously released into watershed, primarily through wastewater. Typical chlorination processes in treating both waste water and drinking water appear to degrade acetaminophen into other compounds (Koplin et al. 2002, Bedner and Maccrehan 2006), that may potentially be more injurious than acetaminophen to people. It is unclear how these derivatives may impact human health, particularly at the exceptionally low doses expected in drinking water.

The total amount of acetaminophen proposed to be applied over a 16 month period on the proposed site is slightly less than 6.4 kg, dispersed across 110 ha of forest. This application volume equates to no more than 316.8 g per application, or 2.88 g applied/ha/application. Most of this acetaminophen would be ingested by BTS, with smaller amounts consumed by non-target, introduced species. Those organisms killed by the toxicant would then either be consumed by other scavengers, or decompose on the forest floor. Johnston et al. (2002) report the highest acetaminophen residue in BTS carcasses was 734.8 µg/g of tissue; the half-life of acetaminophen is roughly 1-4 days, and would quickly degrade in a decomposing animal carcass. Even with the HMU site's location over Guam's northern aquifer, the rapid degradation of both unconsumed acetaminophen and acetaminophen in carcasses would lead to negligible risk of seepage into the aquifer.

4.2 ALTERNATIVE 2 – Targeted aerial application of oral toxicants for controlling brown treesnake populations on Orote Point, Guam.

4.2.1 Effectiveness

The field application of acetaminophen for controlling BTS has been proven to be successful at reducing localized populations of the snake (Savarie et al. 2001). However, the methodologies for large scale application of toxicants via aircraft have not been developed nor tested.

The Orote Point site is subject to frequent closures, often lasting several days, due to enhanced security requirements associated with Kilo Wharf, the site where munitions are regularly loaded on to US Navy vessels. As a consequence, any long-term project conducted on Orote Point would be subjected to frequent, unpredictable work stoppages that would substantially impact project delivery. The proposed plots at the Orote Point site are not enclosed by a BTS barrier, and therefore no comparison of toxicant effectiveness with and without a barrier could be made. Given these constraints, project effectiveness under this alternative would be minimal, as the designed application procedures and monitoring protocols could not be consistently followed.

4.2.2 Impacts on Non-target Animals

The non-target impacts under this alternative would be the same as those described in Section 4.1.2, with the exception of the discussion regarding Mariana crow and Mariana fruit bat. Both of these species are absent from the Orote Point site. Possible impacts to marine life, though unintentional bait application to the near-shore marine environment, are discussed in Sections

4.2.3 and 4.2.4. Otherwise, the impacts to non-targets under this alternative would not be significant.

4.2.3 Impacts on Human Health and Safety

Under this alternative, it is possible that bait applied to the Orote Drop Site could enter the marine environment, and be subsequently consumed by fish and/or other marine organisms, which could, in turn, be consumed by humans. To achieve a therapeutic dose of acetaminophen (1000 mg), a person would have to consume one or more fish that have previously ingested at least 13 baits in succession (assuming there is no degradation of acetaminophen inside the digestive tract of fish or other organisms). Given the magnitude of bait consumption needed to reach this threshold, the risk is low.

Several communication towers are present on the end of Orote Point, which could create a hazard for low flying aircraft. As well, the surface danger zone designated around the small arms firing range on Orote Point may limit flight operations. There are no occupied residences or other facilities located adjacent to the proposed Orote Point site. Therefore, there are potential risks to human health and safety from low level flights, due to the presence of flight obstructions.

Other than the above descriptions, the impacts to human health and safety under this alternative would be the same as those described in Section 4.1.3.

4.2.4 Impacts on Watersheds and Water Quality

Bait application on the Orote Point site would occur in close proximity to marine shoreline environments. The potential for direct application to surface water and shorelines is significant, given the proposed drop site boundaries. Particularly, application the area between Orote Point and Orote Island, as well as the bordering clifflines, would likely result in some bait landing outside the drop sites. Baits hitting surface water could then be ingested by marine fish; there is a paucity of data regarding possible toxicity of acetaminophen to fish, so this analysis cannot quantify what impact may result. In a worst-case scenario, the total number of baits potentially applied to surface water per application is no more than 3960, which equates to 0.3168 kg of acetaminophen. High winds could potentially lead to accidental application of bait to surface water; however, if winds are high enough to create uncontrolled application, flight operations would either cease or would not be initiated. Therefore, although there is potential for accidental application to marine environments, operational management would make this risk low.

Other than the above discussion, the impacts to watersheds and water quality under this alternative would be the same as those discussed in Section 4.1.4.

4.3 ALTERNATIVE 3 – Use of control tools other than toxicants to achieve large scale control

4.3.1 Effectiveness

Current BTS control technology, although effective at reducing BTS populations, have limited applicability to large, unbroken blocks of forest (see Section 1.1 for expanded description of existing BTS control technology) . As a consequence, control on forest plots such as those at HMU or on Orote Point, is limited to the application of traps and hand capture on accessible

forest edges. In more inaccessible terrain, ground-based control is essentially impossible. This approach leaves large numbers of BTS, located in forest interior, unimpacted by control measures.

To address these out-of-reach snakes, management programs would have to develop and maintain, for long term, large grids of access trails, which require constant maintenance and negatively impact forest vegetation. As well, the cost-per-unit effort is substantially higher when there is significant labor input associated with control programs. Therefore, the effectiveness of BTS control under this alternative is low.

4.3.2 Impacts on Non-target Animals

Impacts to non-target and sensitive species using existing BTS control technology are limited. Terrestrial crabs, non-native rodents and Eurasian tree sparrows are occasionally captured in BTS traps. Other species, including endangered birds and bats, are not exposed to capture or mortality by existing control methods. Disturbance to Mariana fruit bats and Mariana crows could occur, but field personnel working along forest plots would be required to avoid areas and times where these species are known to occur. Therefore, under this alternative, non-target impacts would be negligible and there would be no effect on the Mariana crow and Mariana fruit bat.

4.3.3 Impacts on Human Health and Safety

Under this alternative, no chemicals are applied, and therefore there are no impacts to human health and safety via potential toxicants. As well, there is no use of helicopters, and therefore no risks to human health and safety as a result of low level flights.

4.3.4 Impacts on Watersheds and Water Quality

Under this alternative, no chemicals are applied, and therefore there are no impacts to watersheds and water quality.

4.4 ALTERNATIVE 4 – No Action Alternative

4.4.1 Effectiveness

Under the No Action Alternative, BTS control technologies would not improve, and therefore this alternative provides no measure of effectiveness or success.

4.4.2 Impacts on Non-target Animals

Under the No Action Alternative, there would be no impacts to non-target, threatened or endangered, or otherwise sensitive wildlife. Conservation efforts directed at reducing the impacts of BTS predation would not benefit from technological improvements.

4.4.3 Impacts on Human Health and Safety

Under the No Action Alternative, there would be no impacts to human health and safety.

4.4.4 Impacts on Watersheds and Water Quality

Under the No Action Alternative, there would be no impacts to watersheds and water quality.

4.5 CUMULATIVE IMPACTS

Acetaminophen is an exceptionally common household chemical, and is one of the most frequently found anthropogenic chemicals found in wastewater (Stackelberg et al. 2004, Rounds et al. 2009). The proposed application of acetaminophen in this project is limited in terms of quantity and locations, and effects are expected to be temporary due to consumption and degradation. As Section 4.1.4 discusses, the potential for seepage of acetaminophen into the northern Guam aquifer is low and current water treatment processes for drinking water are known to break down acetaminophen into other derivatives, further minimizing the potential impacts of application to ground water. Therefore, the proposed project is not anticipated to contribute in any meaningful way to the cumulative risks of acetaminophen contamination to Guam. Requirements for larger scale control of BTS on Guam may increase in the future, as endangered species recovery and wide-area snake suppression efforts expand. In this scenario, the aerial application of acetaminophen baits is a likely component of management activities. This analysis indicates that continued, wider application of acetaminophen to the terrestrial environments of Guam is unlikely to have any cumulative impacts regarding acetaminophen contamination.

As shown in the analysis, risks to non-target species other than Mariana crow and Mariana fruit bat would be negligible, given the abundance and non-native status of species that may be affected. In the event of larger scale application of acetaminophen (as described above), non-target impacts are expected to remain negligible.

The HMU site is proposed as a key native wildlife recovery site on Guam, and the effective control of BTS within the area will provide benefit to the larger effort of preserving native fauna on the island (U.S. Fish and Wildlife Service 2006).

4.6 MONITORING

The WS program would actively monitor the effects of its programs to determine if the effects fall within projected results. The WS may determine that additional NEPA compliance measures are necessary when program environmental effects are substantially different than projected, or if new environmental issues arise, new information becomes available, the regulatory framework changes, or a new reasonable alternative that should be considered is identified. Any control program resulting from this EA would be monitored in three different ways:

1. Management Information System (MIS). A primary record keeping system established by WS is the MIS. The MIS would estimate the target animals taken, any non-target animals affected, and methods used. Review of the MIS facilitates a determination of whether or not program impacts would fall within levels determined through this EA.

2. NEPA Monitoring and Review. It is WS policy to review all NEPA documents to determine if they are still valid or if substantial changes warrant additional NEPA compliance. WS routinely reports on its findings to the Federal decision maker to ensure that NEPA compliance is up-to-date.

3. Adaptive Management: WS, in collaboration with NWRC and its cooperating agencies would continue to collect information on non-target impacts and program efficacy. New information would be considered against the selected alternative to determine if program changes are

warranted. Substantial program changes may warrant additional NEPA compliance and public involvement.

4.7 CONCLUSIONS

The action proposed by this environmental assessment is the implementation of Alternative 1, which is the preferred alternative. Alternative 1 meets the purpose and need of this environmental assessment by providing the greatest probability of successful project implementation, while presenting limited environmental risks. Alternative 2 provides opportunity to address several key operational issues with aerial delivery, but is too constrained by limits on land access and potential bait application to marine environments. Alternatives 3 and 4 do not meet the need defined in this Environmental Assessment.

Possible impacts under Alternative 1 to the single remaining Mariana crow and Mariana fruit bats were evaluated by the USFWS. The USFWS has concurred with WS' findings that the proposed project would not be likely to adversely affect the federally endangered Mariana fruit bat (Appendix A).

WS has initiated formal consultation with the USFWS under Section 7 of the ESA to ensure that the proposed project would not jeopardize the continued existence of the Mariana crow. This predecisional EA contains measures which WS would be likely to implement to conserve the last remaining Mariana crow on Guam. These measures were recommended by USFWS during interagency discussions and in written communications (Appendix A), are anticipated to be included in the USFWS Biological Opinion which would complete ESA consultation. Because there is only a single crow on Guam, the project would not reduce the biological potential for the species survival on Guam. However, WS has agreed to implement measures that would potentially benefit this species, as outlined in Section 4.1.2, including a cooperative agency effort to capture and place the single male crow in a breeding facility. No WS decisions would be made, and no actions would be taken until the USFWS issues its Biological Opinion (BO) on the proposed project. All WS actions would be in conformance with requirements in the BO to preclude jeopardy to the Mariana crow. Therefore, the proposed action would be revised if necessary to conform to the BO.

No significant negative impacts would be expected from the implementation of this proposal. The proposed action is intended to provide benefit to long term and large scale control of the Brown Treesnake on Guam, which will ultimately assist with conservation of native wildlife and prevention of the inadvertent spread of the snake.

5.0 PREPARERS AND PERSONS CONSULTED

PREPARERS

Daniel S. Vice, Primary Writer

Assistant State Director
U.S. Department of Agriculture
Animal Plant Health Inspection Service
Wildlife Services
HI/GU/Pacific Islands
233 Pangelinan Way
Barrigada, GU 96913

Shannon Hebert, Writer

Environmental Coordinator
U.S. Department of Agriculture
Animal Plant Health Inspection Service
Wildlife Services
PO Box 11046
Portland, OR 97211

PERSONS CONSULTED

Craig S. Clark

Supervisory Wildlife Biologist
U.S. Department of Agriculture
Animal Plant Health Inspection Service
Wildlife Services
HI/GU/Pacific Islands
233 Pangelinan Way
Barrigada, GU 96913

Dr. Peter J. Savarie

Research Wildlife Biologist
U.S. Department of Agriculture
Animal and Plant Health Inspection Services
Wildlife Services, National Wildlife Research Center
4101 LaPorte Ave.
Fort Collins, CO 80521

David T. Lotz

Conservation Resources Chief
Andersen Air Force Base
36 CES/CEVN
Unit 14007
APO AP 96543

Stephen Mosher

Natural Resources Specialist
NAVFAC Marianas
PSC 455, Box 195
FPO AP GU 96540-2937

Dana T. Lujan

Supervisory Wildlife Biologist
U.S. Department of Agriculture
Animal Plant Health Inspection Service
Wildlife Services
HI/GU/Pacific Islands
233 Pangelinan Way
Barrigada, GU 96913

Allen Hambrick

Biologist
U.S. Department of Agriculture
Animal Plant Health Inspection Service
Wildlife Services
HI/GU/Pacific Islands
233 Pangelinan Way
Barrigada, GU 96913

Dr. William C. Pitt

Research Wildlife Biologist
U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Wildlife Services, National Wildlife Research Center
Hilo Field Station
P.O. Box 10880
Hilo, HI 96721

Celestino F. Aguon

Chief, Guam Division of Aquatic and Wildlife Resources
Guam Department of Agriculture
192 Dairy Road
Mangilao, GU 96926

Diane L. Vice

Wildlife Biologist III
Brown Treesnake Program Coordinator
Guam Division of Aquatic and Wildlife Resources
Guam Department of Agriculture
192 Dairy Road
Mangilao, GU 96926

Jeff Quitugua

Wildlife Biologist II
Guam Division of Aquatic and Wildlife Resources
Guam Department of Agriculture
192 Dairy Road
Mangilao, GU 96926

Suzanne Medina

Wildlife Biologist III
Guam Division of Aquatic and Wildlife Resources
Guam Department of Agriculture
192 Dairy Road
Mangilao, GU 96926

Jodi Charrier

Fish & Wildlife Biologist
Pacific Islands Fish and Wildlife Service
300 Ala Moana Boulevard
Room 3-122, Box 50088
Honolulu, Hawaii 96850-5000

Dr. Earl W. Campbell, III

Assistant Field Supervisor
Invasive Species Program
Pacific Island Fish and Wildlife Office
300 Ala Moana Boulevard
Room 3-122, Box 50088
Honolulu, Hawaii 96850-5000

DRAFT

6.0 REFERENCES

- Air Force. 2006. Environmental Assessment: Beddown of Training and Support Initiatives at Northwest Field, Andersen Air Force Base, Guam. Department of the Air Force, Pacific Air Forces, Hickam Air Force Base, HI.
- Avery, M. L. E. A. Tillman, and P. J. Savarie. 2004. Responses of captive fish crows (*Corvus ossifragus*) to acetaminophen baits and bait stations for brown tree snake (*Boiga irregularis*) control on Guam. *Bird Behavior* 16:1-6.
- Bedner, M., and W.A. Maccrehan. 2006. Transformations of acetaminophen by chlorination produces the toxicants 1,4-benzoquinone imine. *Environmental Science & Technology* 40: 516-522.
- Bessems, J. G., and M. Vermeulen. 2001. Paracetamol (acetaminophen)-induced toxicity: Molecular and biochemical mechanisms, analogues and protective approaches. *Critical Reviews in Toxicology* 31:55-138.
- Brooks, J. E., P. J. Savarie, and J. J. Johnston. 1998. The oral and dermal toxicity of selected chemicals to brown tree snakes (*Boiga irregularis*). *Wildlife Research* 25:427-435.
- Brown Treesnake Technical Committee. 2008. Draft Brown Treesnake Control Plan. 39 pp.
- Campbell, E. W. 1996. The effect of brown tree snake (*Boiga irregularis*) predation on the island of Guam's extant lizard assemblages. Thesis (PH. D.); Ohio State University.
- Campbell, E.W., III. 1999. Barriers to movements of the brown treesnake (*Boiga irregularis*). Pages 306-312 in G.H. Rodda, Y. Sawai, D. Chiszar, and H. Tanaka, editors. *Problem snake management: the habu and the brown treesnake*. Cornell Univ. Press, Ithaca, New York.
- Clark, L. 2003. QA-956 Final Report – Efficacy of aerial broadcast baiting in reducing brown treesnake numbers. USDA/National Wildlife Research Center, Fort Collins, CO. 11 p.
- Colvin, B.A., M.W. Fall, L.A. Fitzgerald, and L.L. Loope. 2005. Review of Brown Treesnake Problems and Control Programs: Report of Observations and Recommendations. Prepared for U.S. Department of Interior, Office of Insular Affairs. 53 pp.
- Engbring, J., and T.H. Fritts. 1988. Demise of an insular avifauna: the brown Treesnake on Guam. *Transactions of the Western Section of the Wildlife Society* 24:31-37.
- Engeman, R.M., and D.S. Vice. 2001. Objectives and integrated approaches for the control of brown treesnakes. *Integrated Pest Management Reviews* 6:59-76.
- Engeman, R.M., M.A. Linnell, D.S. Vice, and M.E. Pitzler. 1998. Efficacy of the methods used in an integrated program to deter the spread of brown treesnakes from Guam. *Proceedings of the Australian Vertebrate Pest Conference* 11:435-440.
- Engeman, R. M., D. S. Vice, G. Nelson, and E. Muna. 2000. Brown tree snakes effectively removed from a large plot of land on Guam by perimeter trapping. *International Biodeterioration*

& Biodegradation 45:139-142.

Finco D.R., J.R. Duncan, W.D. Schall, and K.W. Prasse. 1975. Acetaminophen toxicosis in the cat. *Journal of the American Veterinary Medical Association* 166:469–472.

Fritts, T.H., and N.J. Scott. Jr. 1985. The brown Treesnake on Guam: studies of its ecology, control, and threats to other islands. unpub. Rep. to US Fish Wildl. Serv. Reg. 1, Portland, Oregon. 85 pp.

Fritts, T. H., and G. H. Rodda. 1998. The role of introduced species in the degradation of island ecosystems: A case history of Guam. *Annual Review of Ecology and Systematics* 29:113-140.

Fritts, T.H., and D. Chiszar. 1999. Snakes on electrical transmission lines: patterns, causes, and strategies for reducing electrical outages due to snakes. Pages 89-103 in G.H. Rodda, Y. Sawai, D. Chiszar, and H. Tanaka, editors. *Problem snake management: the habu and the brown treesnake*. Cornell Univ. Press, Ithaca, New York.

Fritts, T.H., and M.J. McCoid. 1999. The threat to humans from snakebite by snakes of the genus *Boiga* based on data from Guam and other areas. Pages 116-127 in G.H. Rodda, Y. Sawai, D. Chiszar, and H. Tanaka, editors. *Problem snake management: the habu and the brown treesnake*. Cornell Univ. Press, Ithaca, New York.

Fritts, T.H., M.J. McCoid, and D.M. Gomez. 1999. Dispersal of snakes to extralimital islands: incidents of the brown treesnake, *Boiga irregularis*, dispersing to islands in ships and aircraft. Pages 209-223 in G.H. Rodda, Y. Sawai, D. Chiszar, and H. Tanaka, editors. *Problem snake management: the habu and the brown treesnake*. Cornell Univ. Press, Ithaca, New York.

Fritts, T.H., M.J. McCoid, and R.L. Haddock. 1990. Risks to infants on Guam from bites of the brown Treesnake (*Boiga irregularis*). *American Journal of Tropical Medicine and Hygiene* 42:607-611.

Fritts, T.H., N.J. Scott, Jr., and J.A. Savidge. 1987. Activity of the arboreal brown treesnake (*Boiga irregularis*) on Guam as determined by electrical power outages. *The Snake* 19:51-58.

Gragg, J.E., G.H. Rodda, J.A. Savidge, G.C. White, K. Dean-Bradley, and A.R. Ellingson. 2007. Response of brown treesnakes to reduction of their rodent prey. *Journal of Wildlife Management* 71:2311-2317.

Johnston, J. J., R. E. Mauldin, P. J. Savarie, J. E. Brooks, and T. M. Primus. 2001. Ecotoxicological risks of potential toxicants for brown tree snake control on Guam. *Pesticides and Wildlife*. American Chemical Symposium Series 771, American Chemical Society, Washington D.C. 212-224.

Johnston, J. J., P. J. Savarie, T. M. Primus, J. D. Eisemann, J. C. Hurley, and D. J. Kohler. 2002. Risk assessment of an acetaminophen baiting program for chemical control of brown tree snakes on Guam: evaluation of baits, snake residues, and potential primary and secondary hazards. *Environmental Science & Technology* 36:3827-3833.

Kolpin, D.W., E.T. Furlong, M.T. Meyer, E.M. Thurman, S.D. Zaugg, L.B. Barber, and H.T.

- Buxton. 2002. Pharmaceuticals, Hormones, and Other Organic Waste Water Contaminants in U.S. Streams, 1999-2000: A National Reconnaissance. *Environmental Science & Technology* Vol. 36 No. 6: 1208
- Larson, A.M., J. Polson, and R.J. Fontana. 2005. Acetaminophen-induced acute liver failure: results of a United States multicenter, prospective study. *Hepatology* 42:1364–72.
- Lee, W.M. 2004. Acetaminophen and the U.S. Acute Liver Failure Study Group: lowering the risks of hepatic failure. *Hepatology* 40:6–9
- Liu, Z., and L. Fisher. 2005. Guam vegetation mapping using very high spatial resolution imagery. USDA Forest Service, Forest Health Protection, McClellan, CA. 17 pp.
- Mathies, T., T., R. Scarpino, B. A. Levine, C. Clark, and J. A. Savidge. 2011. Excluding nontarget species from brown tree snake, *Boiga irregularis* (Reptilia: Colubridae), bait stations: experimental tests of station design and placement. *Pacific Science* 65:41-57.
- McCoid, M.J. 1991. Brown Treesnake (*Boiga irregularis*) on Guam: a worst case scenario of an introduced predator. *Micronesica Suppl.* 3:63-69.
- McCoid, M.J., T.H. Fritts, and E.W. Campbell, III. 1994. A brown treesnake (Colubridae: *Boiga irregularis*) sighting in Texas. *Texas Journal of Science* 46:365-368.
- Morton, J. 1996. The effects of aircraft overflights on endangered Mariana crows and Mariana fruit bats at Andersen Air Force Base, Guam. Pearl Harbor: Department of the Navy, Pacific Division, Naval Facilities Engineering Command. 81pp
- Mueller-Dombois, D., and F.R. Forsberg. 1998. *Vegetation of the tropical Pacific islands*. Springer-Verlag, New York, Inc.
- Perry, G., and D. Vice. 2009. Forecasting the Risk of Brown Tree Snake Dispersal from Guam: a Mixed Transport-Establishment Model. *Conservation Biology* 23:992-1000.
- Primus, T. M., D. J. Kohler, C. A. Furcolow, M. J. Goodall, J. J. Johnston, and P. J. Savarie. 2004. Determination of acetaminophen residues in whole body brown treesnakes. *Journal of Liquid Chromatography & Related Technologies* 27:897-909.
- Rodda, G.H., and T.H. Fritts. 1992. The impact of the introduction of the Brown Tree Snake, *Boiga irregularis*, on Guam's lizards. *Journal of Herpetology* 26:166-174.
- Rodda, G.H., and J.A. Savidge. 2007. Biology and impacts of Pacific Island Invasive Species. 2. *Boiga irregularis*, the Brown Tree Snake (Reptilia: Colubridae). *Pacific Science* 61:307-324.
- Rodda, G. H., T.H. Fritts, and P.J. Conry. 1992. Origin and Population Growth of the Brown Tree Snake, *Boiga irregularis*, on Guam. *Pacific Science* 46:46-57.
- Rodda, G.H., T.H. Fritts, and E.W. Campbell III. 1999a. The feasibility of controlling the brown treesnake in small plots. Pages 468-477 in G.H. Rodda, Y. Sawai, D. Chiszar, and H. Tanaka,

editors. Problem snake management: the habu and the brown treesnake. Cornell Univ. Press, Ithaca, New York.

Rodda, G.H., T.H. Fritts, M.J. McCoid, and E.W. Campbell, III. 1999b. An overview of the biology of the brown treesnake (*Boiga irregularis*), a costly introduced pest on Pacific islands. Pages 44-80 in G.H. Rodda, Y. Sawai, D. Chiszar, and H. Tanaka, editors. Problem snake management: the habu and the brown treesnake. Cornell Univ. Press, Ithaca, New York.

Rodda, G.H., T.H. Fritts, E.W. Campbell, III, K. Dean-Bradley, G. Perry, and C.P. Qualls. 2002. Practical concerns in the eradication of island snakes. In: C.R. Veitch and M.N. Clout (eds.). Turning the tide: The eradication of invasive species. Auckland, New Zealand: IUCN SSC Invasive Species Specialist Group. p. 260-265.

Rounds, S.A., M.C. Doyle, P.M. Edwards, and E.T. Furlong. 2009. Reconnaissance of pharmaceutical chemicals in urban streams of the Tualatin River basin, Oregon, 2002: U.S. Geological Survey Scientific Investigations Report 2009-5119, 22 p.

Savarie, P.J., and R.L. Bruggers. 1999. Candidate repellents, oral and dermal toxicants, and fumigants for brown treesnake control. Pages 417-422 in G. H. Rodda, Y. Sawai, D. Chiszar, and H. Tanaka, editors. Problem snake management: the habu and the brown treesnake. Cornell Univ. Press, Ithaca, New York.

Savarie, P. J., D. L. York, J. C. Hurley, and S. Volz. 2000. Testing the dermal and oral toxicity of selected chemicals to brown treesnakes. In: T.P. Salmon and A.C. Crabb, editors. Proceedings: Nineteenth Vertebrate Pest Conference (March 6-9, 2000, San Diego, California) University of California. 139-145.

Savarie, P. J., J. A. Shivik, G. C. White, J. C. Hurley, and L. Clark. 2001. Use of acetaminophen for large-scale control of brown treesnakes. *Journal of Wildlife Management* 65:356-365.

Savarie, P. J., T. C. Mathies, and K. A. Fagerstone. 2007. Flotation materials for aerial delivery of acetaminophen toxic baits to brown treesnakes. In: G.W. Witmer, W.C. Pitt and K.A. Fagerstone, editors. Managing Vertebrate Invasive Species: Proceedings of an International Symposium. USDA/APHIS/WS-NWRC 218-223

Savidge, J.A., F.J. Qualls, and G.H. Rodda. 2007. Reproductive biology of the brown tree snake, *Boiga irregularis* (Reptilia: Colubridae), during colonization of Guam and comparison with that in their native range. *Pacific Science* 61: 191-199.

Savidge, J. A. 1987. Extinction of an island forest avifauna by an introduced snake. *Ecology* 68:660-668.

Sellon, R.K. 2001. Acetaminophen. In: Peterson ME, Talcott PA, eds. *Small Animal Toxicology*. Toronto: W.B.Saunders 388-395.

Shivik, J. A., and L. Clark. 1997. Carrion seeking in brown tree snakes: Importance of olfactory and visual cues. *Journal of Experimental Zoology* 279:549-553.

Shivik, J.A., P.J.Savarie, and L. Clark. 2002. Aerial delivery of baits to brown treesnakes.

Wildlife Society Bulletin 30:1062-1067.

Stackelberg, P.E., E.T. Furlong, M.T. Meyer, S.D. Zaugg, A.K. Henderson, and D.B. Reissman. 2004. Persistence of pharmaceutical compounds and other organic wastewater contaminants in a conventional drinking-water-treatment plant. *Science of the Total Environment* 329:99-113

Sugihara, R. T. 2004. Operational evaluation of toxicant (Acetaminophen) bait stations used in combination with trapping for landscape level control of residual brown treesnake (*Boiga irregularis*) populations on Guam. Job Completion Summary (QA-966). USDA, APHIS, WS, NWRC. Hilo, HI. 3pp.

U.S. Department of Agriculture. 1997. Environmental Assessment for Brown Tree Snake Control Activities on Guam. USDA, APHIS, Wildlife Services, Unit 150, 4700 River Road, Riverdale, MD 20737-1237. 31 pp.

U.S. Fish and Wildlife Service. 2006. Biological Opinion on the Establishment and Operation of an Intelligence, Surveillance, Reconnaissance, and Strike Capability Project on Andersen Air Force Base, Guam. Honolulu, HI. 73 pp.

Vice, D. S., and M. E. Pitzler. 2002. Brown treesnake control: economy of scales. Pages 127-131 in L. Clark ed., *Human conflicts with wildlife: economic considerations*. Fort Collins, CO.

Vice, D.S., M.A. Linnell, and M.E. Pitzler. 1998. Draft summary of Guam's outbound cargo handling process: preventing the spread of the brown Treesnake. US Dept. Agric., Anim. Plant Health Inspect. Serv., Wildlife Serv., Barrigada, Guam. 26 pp.

Wiewel, A. S., A. A. Yackel-Adams, and G. H. Rodda. 2009. Distribution, density, and biomass of small introduced mammals in the southern Mariana Islands. *Pacific Science* 63:205-222.

Wiles, G.J., C.F. Aguon, G.W. Davis, and D.J. Grout. 1995. The status and distribution of endangered animals and plants in northern Guam. *Micronesica* 28:31-49.

APPENDIX A

AGENCY CORRESPONDENCE

DRAFT



United States Department of the Interior



FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2011-I-0270

MAY 13 2011

Mr. Daniel Vice
U.S. Department of Agriculture
Animal Plant Health Inspection Service
Wildlife Services
233 Pangelinan Way
Barrigada, Guam 96913

Subject: Informal Section 7 Consultation for the Aerial Application of Acetaminophen for
Brown Treesnake Control on Guam

Dear Mr. Vice:

The U.S. Fish and Wildlife Service (Service) received your March 21, 2011, joint Draft Environmental Assessment (DEA) and informal section 7 requesting our concurrence that the proposed project will affect, but is not likely to adversely affect the federally endangered Mariana crow (*Corvus kubaryi*) (crow), *Serianthes nelsonii* or the threatened Mariana fruit bat (*Pteropus mariannus*) (fruit bat). The proposed action involves using aerially-delivered oral toxicants to control the invasive brown treesnake (*Boiga irregularis*) (BTS) on 110 hectares (272 acres) of limestone forest in northern Guam. The purpose of the proposed action is to continue the development of improved technology and to provide greater ability to control BTS on Guam.

We discussed the DEA and our preferred alternative during a conference call on April 25, 2011. Therefore, the remainder of this letter will focus on your request for informal consultation and the potential effect of the action to the aforementioned three species. Our delayed response is due to further interagency coordination and internal discussions, and we thank you for your patience. This response is in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Proposed Action

The Habitat Management Unit, where the aerial drop would occur was created as a mitigation measure in the Environmental Impact Statement (EIS) for the Establishment and Operation of an Intelligence, Surveillance Reconnaissance, and Strike Capability (ISR Strike) at Anderson Air Force Base (AAFB), Guam. Active BTS control is one of the primary activities that the Department of Defense committed to inside the Habitat Management Unit. Pursuant to the ISR Strike EIS and Biological Opinion, AAFB committed to provide funding for toxicant use efforts by the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (Wildlife Services). They were also to seek internal Department of Defense funding for

TAKE PRIDE[®]
IN AMERICA 

applied research efforts for BTS control by Wildlife Services-National Wildlife Research Center, including development of aerial broadcast techniques for toxicants. The Habitat Management Unit is surrounded by a snake-proof fence and will allow investigation into the effectiveness of aerial toxicant drops as a tool for landscape-level BTS control and support the creation of a snake enclosure that is intended to be used for re-establishment of native avifauna.

Affected Species

There is currently a small population of Mariana fruit bat in northern Guam. The proposed project action could potentially adversely affect fruit bats flying in the area through collisions with aircraft or noise disturbance. However, flights for the toxicant drops are planned to occur in the late morning when fruit bats are less active. In addition, the only recorded fruit bat strike by an aircraft was in 1982 (Morton 1996). Therefore, given the low density of fruit bats on Guam, and the unlikelihood for a helicopter strike, we concur that the effect of the action to fruit bats would be discountable. Also, due to the distance of the *Serianthes nelsonii* from the action area, and there the proposed action will not have any impact on this one tree, we concur the action is not likely to adversely affect *Serianthes nelsonii*. In summary, we concur the aerial toxicant drop will not adversely affect either the *Serianthes nelsonii* or the fruit bat.

However, we have decided the proposed project has the potential to adversely affect the only existing crow on Guam. We recommend that the following options be considered to reduce impacts to the crow.

1. Wildlife Services will work cooperatively with the Guam Division of Aquatic and Wildlife Resources (DAWR) and Department of Defense to capture the crow and move it to the DAWR captive breeding facility. It is possible that the crow will be able to breed, and thereby contribute to the recovery of this critically endangered species. This measure will require a one-year recovery permit from the Service to DAWR. If the bird does not breed successfully in one year, the Service will review the recovery permit issued to DAWR and support one of the following actions:
 - a. Translocate and release the crow on Rota.
 - b. Let the crow remain in captivity for further breeding attempts.
 - c. Release the crow on the fee-simple portion of the Guam National Wildlife Refuge.
 - d. Let the crow remain in captivity as an educational display at the Guam National Wildlife Refuge.
 - e. Translocate the crow to a mainland zoo.

(The above options are listed in order of Service preference).

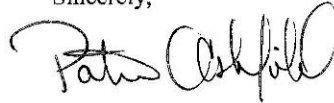
2. Wildlife Services should work cooperatively with DAWR to monitor and provide supplemental feed for the crow in its current habitat. This alternative needs to be considered in case the crow is not caught and must remain in the wild during the drop of the toxicant. We recommend initiating a formal section 7 consultation for the potential "take" of the crow due to ingestion of the toxicant.

Mr. Daniel Vice

3

We anticipate the results of this project will assist in the development of landscape-scale methodologies to control BTS and this level of snake control is needed for the restoration of Guam's native avifauna. We look forward to receiving your updated and detailed project description along with your request for formal consultation for the crow. If you have questions regarding our recommendations, please contact Jodi Charrier, Fish and Wildlife Biologist, (phone: 808-792-9400, fax: 808-792-9581).

Sincerely,



for Loyal Mehrhoff
Field Supervisor

Literature Cited

Morton, J. 1996. The effects of aircraft overflights on endangered Mariana crows and Mariana fruit bats at Andersen Air Force Base, Guam. Pearl Harbor: Department of the Navy, Pacific Division, Naval Facilities Engineering Command. 81pp.

APPENDIX B

ESTCP Target Aerial Toxicant Delivery Project Proposal

1.1 Technical Section Revised Proposal:

1. **Short Descriptive Title:** Aerial Application of Acetaminophen-treated Baits in Cargo Areas for Control of Brown Treesnakes
2. **ESTCP Topic Area:** 5) Control of Non-Native Invasive Species on Department of Defense Lands and Waters
3. **Lead Organization:** USDA/National Wildlife Research Center
4101 LaPorte Ave.
Fort Collins, CO 80521-2154
Project Lead: Peter J. Savarie
4. **Abstract:**
 - a. **Objective:** Infestations of the introduced brown treesnake (*Boiga irregularis*, BTS) have caused catastrophic changes to the avifauna and economy on the island of Guam. Snakes have extirpated all but two (Micronesian starling, *Aplonis opaca* and island swiftlet, *Aerodramus vanikorensis bartschi*) of the 12 native forest birds and caused millions of dollars in damages to the island's electrical power distribution system. An anticipated dramatic increase in the U.S. military presence on Guam will increase the flow of outbound cargo, increasing the risk of snake dispersal. This growth could overtax the present operational control methods (trapping, hand capture of snakes, canine inspection of outbound cargo) for deterring the spread of snakes from Guam to other favorable locations such as Hawaii. Forests adjacent to cargo areas are the source of snakes that can potentially get into cargo. The current control methods reduce snake populations in smaller forest plots and intercept snakes from the forest before they get into cargo areas, but do not appreciably depopulate snakes in larger forest blocks. The overall objective is to deploy toxic baits aerially by helicopter to reduce snake populations in the forests adjacent to cargo facilities to reduce the risk of snake dispersal in cargo.
 - b. **Technology Description:** Thawed dead neonatal mouse baits treated with 80 mg acetaminophen are individually attached to paper flag streamers with cardboard on each end of the paper streamer. The baits and streamers are packaged into an electro-mechanical dispenser and deployed from a helicopter over a prescribed forested drop zone at 36 baits per ha. The double-ended cardboard streamers form a loop in the air and entangle the treated dead neonatal mice in the canopy where they can be consumed by brown treesnakes.
 - c. **Expected Benefits:** The aerial baiting technology will provide the DoD two major benefits for reducing environmental and economic risks caused by BTS. First, it will provide an additional substantial level of defense against snakes getting into outbound cargo by reducing snake populations adjacent to cargo facilities. This will decrease the probability of dispersal of snakes from Guam to vulnerable areas (e.g., Tinian and Hawaii) where there are no protections to prevent the ecological and economic devastation caused by the snake on Guam. Potential economic impact of the BTS to Hawaii has been estimated at over \$600 million annually. Secondly, this technology is unlimited in an operational sense. While initially deployed on DoD properties, the ultimate future goal of application is to all areas on Guam at an annual cost of \$2.1 million. BTS operational control has been ongoing for 15 years and will extend into perpetuity unless island-wide control is initiated because the 3 primary current control methods (trapping, fenceline searches, and detector dogs) are not appropriate for all terrain types. In order to eradicate the BTS from Guam, aerial delivery must be a major component of the effort. Suppressing the level of damage on Guam has the potential to save almost \$2 for every dollar spent on this program, while extending the benefits to Hawaii increases the savings to well over \$250 per dollar spent on the program.
5. **Problem Statement:** The brown treesnake (*Boiga irregularis*, BTS) is a nocturnal, arboreal invasive predator on the island of Guam that was probably introduced after World War II as a passive stowaway in cargo from the Admiralty Islands north of New Guinea. Lacking natural predators on Guam, the population of the brown treesnake exploded, reaching as many as 50-100 snakes per hectare (ha, 1 ha = 2.47 acres) in some areas. Snakes colonized the entire island of Guam (54,100 ha) in about 20-30 years. The brown treesnake has gained the unfortunate distinction of being the only reptile known to have caused the extinction of another vertebrate

species. Ten of 12 native birds have disappeared from the forests on Guam and the impact of the snake has also been devastating to the island's lizards. The snake is mildly venomous and poses a health risk to small children, causes power outages by climbing on and short-circuiting electrical transmission lines, and preys on poultry and domesticated birds. Guam is the focal point of air and ship cargo traffic in the tropical western Pacific and there is the threat that snakes could be inadvertently introduced and establish breeding populations on other snake-free islands in the region. Sightings or captures of brown treesnakes of probable Guam origin have been documented on Oahu in Hawaii, Kwajalein in the Marshall Islands, Pohnpei and Chuuk in the Federated States of Micronesia, Diego Garcia in the Indian Ocean, Okinawa in the Ryukyu Islands of Japan, and Rota, Tinian, and Saipan of the Commonwealth of the Northern Marianas Islands (CNMI), as well as Texas, Oklahoma, and Alaska in the continental United States.

In 1993, the U.S. Department of Agriculture, Wildlife Services, initiated an operational program to deter the spread of snakes from Guam using hand capture from fences during nighttime spotlight searches, trapping, and inspection of cargo with search dogs. Ongoing control efforts in and around Guam's outbound cargo areas continue to capture thousands of snakes annually, and the problem remains critical on all Guam's military installations – in FY2007 alone, 2,603 brown treesnakes were intercepted on Navy installations, and 4,467 on Air Force installations (D. Vice, pers. comm.). The majority of these were intercepted around the Navy wharves and cargo staging sites around Apra Harbor, and around the flight line, warehouses, and cargo staging facilities at Andersen Air Force Base. Adjacent to the cargo areas are forests that are inaccessible for operational control using traps and bait stations. These forests are the likely source of snakes that could disperse off-island through outbound cargo. With the pending increase of U.S. military presence on Guam, there will be increased movement of personnel and household goods, which will increase the potential for dispersal of brown treesnakes through outbound cargo. Of particular concern is the deployment of military personnel and equipment from Guam to the island of Tinian in the CNMI for training exercises and increased traffic through Hawaii. Aerial application of treated baits in these inaccessible forests will reduce snake populations in large areas adjacent to commercial and military warehouses and cargo staging facilities and this will reduce the risk of snake dispersal to at-risk locations such as Tinian and Hawaii.

6. Technology Description:

- a. Technical Objective: The objective is to demonstrate the use of aerial techniques to deploy acetaminophen-treated dead neonatal mouse (DNM) baits to reduce snake populations in forested sites adjacent to Guam DoD cargo facilities before they enter into areas of military transport. Aerial delivery is a technique to depopulate snakes in a large area.
- b. Technology Description: Aerial and bait station delivery are proven technologies used for rodent control. However, the aerial and bait station delivery techniques are unique and innovative to the BTS for the following reasons: 1) acetaminophen is a safe oral toxin and is the first toxin ever to be developed for snake control (U.S. EPA Reg.No. 56228-34); 2) inanimate baits (dead neonatal mice, DNM) are used to deliver the toxin to snakes, which were previously thought to take only live prey; 3) aerial application requires a biodegradable parachute (flotation device) that entangles baits in the forest canopy to keep them off the ground and away from scavengers such as coconut crabs (*Birgus latro*), land hermit crabs (*Coenobita* spp.), and monitor lizards (*Varanus indicus*) that will take the baits before BTS can get to them; and 4) polyvinyl chloride (PVC) tubes are used as bait stations to mitigate entry of all large animals (e.g., crabs) except BTS. Reduction of snake abundance has been validated by bait-take assessment from bait tubes (Attachment 1A) and recovery of snakes that consumed aerially deployed DNM baits equipped with radio transmitters as shown in Attachment 1D.

DNM treated with an 80 mg tablet of acetaminophen are individually attached to double-ender marking flags (a paper streamer folded accordion style attached to cardboard on each end). A single DNM is attached to the smaller piece of cardboard (Figure 1). The double-ender marking flags with attached DNM (i.e., streamers, flag-baits) are loaded into a Model 5 flag dispenser (R-S Sales/Automatic Flagman[®], Lewiston, Idaho). Two dispensers are mounted on a Hughes 500 helicopter (Americopters, Tamuning, Guam). Each dispenser is equipped with a 24-volt solenoid that ejects a streamer out of the dispenser when activated. The streamer forms a loop in the air (Figure 2) that becomes entangled in the forest canopy.

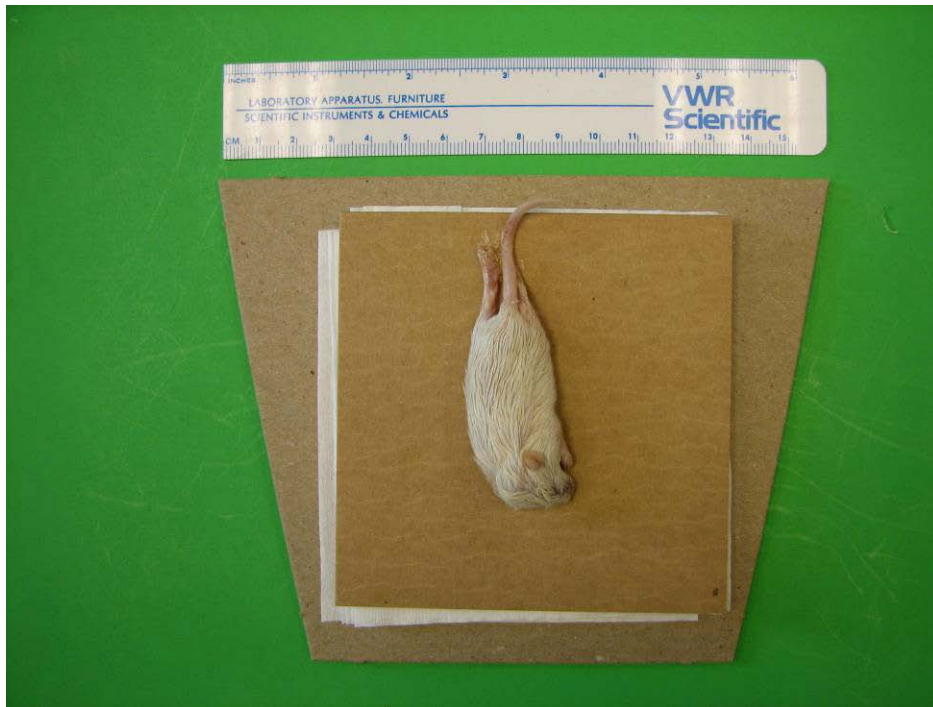


Figure 1. Double-ender marking flag (streamer) with a dead neonatal mouse attached to the small piece of cardboard.

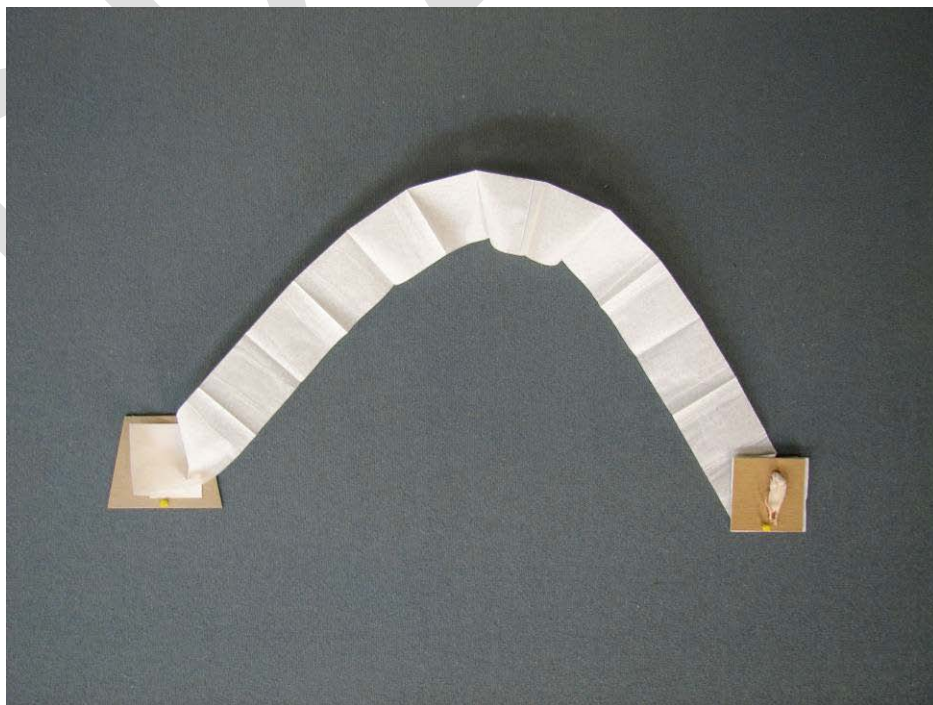


Figure 2. Loop formed by the double-ender marking flag (streamer).

- c. Technology Maturity: From 1995-1998 the DoD Legacy Program provided \$1.104 million to the USDA/National Wildlife Research Center (NWRC), Fort Collins, Colorado, for development of chemical methods to control BTS. The goal of this project was to identify and develop chemical control methods (oral and dermal toxicants, attractants, repellents, and fumigants) that could be used in an integrated program to control and prevent the dispersal of BTS from Guam and reduce or help control snake populations in various island situations (Engeman and Vice 2001). This project was highly successful and included the identification of formulations of pyrethrins as a dermal toxicant (Brooks et al. 1998a, 1998b), natural products as repellents (Clark and Shivik 2002), and acetaminophen as an oral toxicant (Savarie et al. 2000). DoD Legacy funded NWRC \$1.171 million for field evaluation of chemicals, bait matrices, and delivery methods for BTS control from 1999-2003. During this period bait station and aerial broadcast field evaluation trials of acetaminophen-treated baits on 6 ha forest plots resulted in 80%-90% reduction of BTS within 4-5 weeks (Savarie et al. 2001, Clark 2003). Bait station test data are summarized in Attachment 1A and 1B, and aerial delivery test data are summarized in Attachment 1D. Based on these small-scale field trials, acetaminophen was registered in 2003 by U.S. EPA as an oral toxicant in dead neonatal mouse (DNM) baits for BTS control in bait stations and broadcast application by hand, helicopter, and fixed-winged aircraft. Acetaminophen poses minimal risks to non-target feral and wildlife species (Johnston et al. 2002).

From 2001-2007, 7 hand drop aerial delivery studies were conducted on Guam. Two proof-of-concept aerial delivery studies have been conducted. The first, conducted in 2001, deployed non-toxic DNM baits using non-biodegradable plastic streamers and parachutes and demonstrated that baits entangled in the forest canopy were consumed by BTS (Shivik et al. 2002, Attachment 1C). The second aerial delivery study was conducted in 2002 and is the only study using treated DNM. It showed that after 4 drops totaling 900 80 mg acetaminophen-treated DNM on 6 ha of forest, snake activity was reduced by about 80% (Clark 2003, Attachment 1D). A problem with the second aerial delivery was that the corn starch flotation material attached to the DNM dissolved rapidly in the rain and the DNM dropped to the ground. Daily rainstorms are common on Guam and the flotation material must remain intact for 2-3 days before disintegrating. Biodegradable materials are needed to reduce the potential accumulation of litter in the forest. In 2003, 5 biodegradable flotation materials (paper ring, paper cup, excelsior (wood shavings), burlap, and paper food cup) were evaluated (Savarie and Tope 2004). The highest entanglement in the canopy was only 60% (12 of 20) with the paper food cup.

From 2004-2006, NWRC was funded \$180,000 by the U.S. Department of the Interior/Office of Insular Affairs for bait matrix and aerial delivery development. In 2004, a study was conducted on low and high crab abundance sites to determine baits taken by non-target animals. Forty DNM with radios attached to jute mesh and 40 radioed-DNM without jute mesh were deployed. All DNM without jute mesh landed on the ground and 21% of DNM attached to jute mesh landed in the canopy. Comparisons of baits taken between low vs high crab abundance sites was as follows: BTS, 24% vs 0%; crab, 24% vs 67%; monitor lizard, 0% vs 11%; marine toad, 3% vs 0%; ants, 21% vs 14%; unknown, 3% vs 8%; not taken, 26% vs 0% (Savarie et al. 2007). It is evident from these data that a parachute that delivers the majority of the DNM baits to the canopy is needed and that crabs remove mice making them unavailable for BTS.

In 2005, 2 small biodegradable parachutes fabricated from paper towels and Ecofilm[®] (corn derived plastic-like material that decomposes by bacterial degradation) were evaluated, and in 2006, 4 commercial biodegradable paper products including single- and double-ender paper streamer marker flags were tested. Entanglement in the canopy for these 6 products ranged from 67% with paper cups to 95% with the double-ender marker flags (Savarie et al. 2007).

An advantage of the single- and double-ender marker flags is that they can be deployed from an electro-mechanical dispenser mounted on a helicopter. In 2007, the U.S. Navy provided \$250,000 for evaluation of single-ender flags. Untreated DNM attached to single-ender flags (i.e., flag-baits) were deployed from a helicopter by mechanical dispenser and hand on 4 ha of forest at 36 baits per ha. There were a total of 6 drops (3 each by dispenser and hand) and 144 flag-baits, including 28 DNM with radio transmitters, were deployed per drop. Canopy landing of the radioed DNM was 85% (61 of 72) by dispenser and 79% (66 of 84) by hand. An important finding from this study was that DNM body fluids from a flag-bait can be transferred to an adjacent flag-bait causing sticking between the 2 flag-baits. This can cause the dispenser

to jam and the flag baits are not ejected properly from the dispenser. Because of this malfunction, double-ender flag-baits as described in section 6.b. will be used in the present proposal.

d. Technical Approach:

i) Test Site Selection: Testing will be conducted on U.S. Naval Base Guam. The proposed site, not to exceed 100 ha, is on Orote Peninsula and contains an area known as Kilo Wharf used for inbound and outbound munition shipments. This cargo facility has a historical record (≥ 16 months) of the number of snakes captured by WS operations using hand capture and traps. These records will provide pre-treatment baseline data. WS will continue capturing snakes at these cargo facilities during the aerial baiting and throughout the duration of this project. The area of the cargo facility and the adjacent baited forested sites will be defined by GIS/GPS. Several randomly selected transects, separated by at least 40 m within the site, will be used for monitoring snake and rodent activity. When the boundary of the test site is a road, a transect of bait stations containing DNM treated with 80 mg acetaminophen may be placed on the forest perimeter to deter snake immigration into the test site. If the test site boundary goes through contiguous forest, a transect of bait stations with treated mice will be established to deter snake immigration. Bait stations will be hung about 1.5 m high in vegetation spaced at intervals of about 20 m. These bait stations with treated mice will be rebaited and monitored twice weekly. Additionally, there is a 3 ha island about 25-50 m off the eastern side of the peninsula (Orote Island) that will be treated aerially. Historically, this island was a nesting site for seabirds but appears to have been abandoned after snakes colonized the island.

ii) Monitoring Snake and Rodent Activity: Snake and rodent abundance will be monitored pre-treatment, during the 24 months of aerial treatment, and post-treatment. Snake activity will be monitored using bait stations baited with untreated DNM. Bait stations will be hung about 1.5 m high in vegetation at 20 m intervals. A minimum of 5 bait station transects ($n= 10$ bait stations/transect), randomly selected from the pre-selected transects, will be monitored after 2 days for consumption (bait take) of DNM. Bait take of DNM will be conducted pre-treatment. During aerial treatment and post-treatment snake bait station transects will be monitored at 1-4 week intervals. Video camera surveillance may also be used to monitor some bait stations for animal activity. Because of its small size, only 2-3 transects for monitoring purposes will be established on Orote Island.

Procedures for monitoring rodent (rat and mice) activity will be similar to snake bait stations, except standard rodent live capture traps will be used. Rodents will be released at the capture site. A reference site that does not receive treated bait will also be monitored for snake and rodent activity using the above described procedures.

iii) Aerial Delivery with Acetaminophen-Treated DNM Baits: DNM treated with 80 mg acetaminophen attached to paper streamers will be deployed by helicopter at 36 baits/ha. The test site will be treated for 16 months and no more than 37 aerial bait drops will be deployed. For the first 2 months, aerial bait applications will be made every 1-2 weeks and 20 treated DNM with attached radio transmitters will always be included with the treated DNM to assess bait take and entanglement in the canopy. After the rate of bait take is 20% or less as determined from bait station monitoring and radio transmitted treated DNM, aerial delivery will not be implemented again until bait take is 30% or greater, as determined from bait station monitoring. At that time, aerial applications will be made at 1-2 week intervals until bait take is 20% or less as determined from bait station monitoring and radio transmitted DNM. If bait station monitoring indicates "hot spots" of snake activity, bait stations with treated DNM may be applied in these areas.

iv) Data Analyses: Statistical analyses will be conducted on two separate sets of data: 1) Bait take by snakes from bait stations on the aerial delivery acetaminophen-treated site and the reference site will be analyzed using 2-factor ANOVA with site and baiting period as the two factors; and 2) Trap capture of rodents will be analyzed similarly. Descriptive statistics will be applied on another two separate sets of data: 1) The fate (e.g., canopy or ground landings, bait take by snakes, baits not taken) of each of the 20 dead mouse baits with radio transmitters for each of the aerial drops; and 2) number of snakes captured in the adjacent cargo facility, comparing 16 consecutive months of snake live trapping data collected before start of aerial baiting with acetaminophen with data collected over the same months after start of baiting (these data from

Wildlife Services Guam as part of their continuing effort to depopulate snakes in the immediate cargo facility).

- e. **Methodologies:** Success of the demonstration and technology will be assessed by two standard performance methods conducted pre-aerial treatment, during aerial treatment, and post-aerial treatment. The performance methods are: (1) Bait take of DNM from bait stations (bait take decreases as snake abundance decreases), and (2) Monitoring of rodents using live traps with release of rodents at the capture site (rodent abundance increases as snake abundance decreases). Additionally, a subsample of the aerially deployed treated DNM baits will be equipped with radio transmitters to assess bait take and entanglement in the canopy.
 - f. **Technical risks:** Technology has already been applied in small-scale field evaluations with no apparent ecological risks. The only potential risks will be unknown logistical factors that may occur when scaling up the acetaminophen aerial treatment from 6 ha to 100 ha. A large-scale evaluation is needed to mature aerial delivery techniques to ensure its ultimate success.
 - g. **Related efforts:** There are no other similar projects.
7. **Expected DoD Benefit of Technology:** The expected DoD benefit of this technology is unique in that due to the nature of the economic impacts of the BTS, expected benefits of this technology initially are not only site specific but are expanded to benefit the entire island of Guam and other islands such as Hawaii. The total economic impact of the BTS is the summation of the numerous impacts that the snake has had on Guam and additionally the potential impact that the snake can have to surrounding areas (e.g., Tinian and Hawaii) given the translocation of this snake aboard military cargo. The expected DoD benefit must then reflect the benefits of eliminating or reducing snake impacts on Guam and reducing the potential impacts of the snake to surrounding areas.

The BTS population on Guam has created economic impacts in multiple areas including: medical expenses, power outages, potential extinction of many native bird species and impacts to other islands through military translocation of the snake in cargo. Documented BTS bites and subsequent hospitalizations of children are approximately 50 per year and in general, 1 in 1,200 emergency room visits annually are a result of snake bites, causing an annual average loss of \$50,000. In Guam, the BTS causes approximately 1 power outage every 1.8 days resulting in approximately \$4.5 million dollars per year in lost productivity alone and this estimate is conservative because it does not consider repair costs, damage to electrical equipment, and lost revenues for the power company. The BTS has been devastating to Guam's native bird population, having extirpated 10 out of 12 of the native forest birds.

With the anticipated increase of U.S. Navy and Air Force military presence on Guam, there will be increased movement of personnel and household goods which will increase the potential for dispersal of brown treesnakes through outbound cargo. Of particular concern is the deployment of military personnel and equipment from Guam to the island of Tinian in the CNMI for training exercises and Hawaii. Aerial application of treated baits will reduce snake populations in large areas adjacent to commercial and military warehouses and cargo staging facilities and this will reduce the risk of snake dispersal to at-risk locations.

There is an immense biological and economic threat to Hawaii if the BTS becomes established on those islands. The potential economic impact would be much greater than on Guam due to the larger population, diversity of birds, and the greater number of tourists and tourism income entering the island. Therefore, the broader application of the technology may provide a return on investment including a percentage of damage on Hawaii. In 2004, a study was undertaken to estimate the economic impacts likely to occur to the Hawaiian Islands by the translocation of the BTS from the Territory of Guam. There were three general categories of economic impact related to brown tree snake's invasion; medical treatments, electrical outages, and tourism losses. Data gathered on Guam for medical and electrical impacts were used to derive results for Hawaii. Impacts associated with the tourism sector of the economy were projected using an input-output model. Impacts to Hawaii's tourism from the BTS have never before been estimated. In the 2004 study a hypothetical range of decreased tourist numbers

(1% - 10%) was used, resulting in an annual decrease in revenue to the Hawaiian economy of \$137.5 million to \$1.4 billion and 1,339 to 13,000 jobs lost in the local economy. Total damage estimates from all areas of impact ranged from \$622 million to \$2.18 billion annually. The hypothetical decrease in tourism comprised the largest area of impact. In order to more accurately define the range of potential tourist impacts from the BTS, a survey was conducted in Oahu during January 2008.

This survey sought to elicit responses from the major tourists groups (i.e., U.S. West, U.S. East, and Japan) on how they would alter their behavior in response to the presence of the BTS. Survey results indicated that initial estimates of the 2004 study were conservative. The results of this study have not yet been published but show that damage to Hawaii from the presence of the BTS altering the number of tourists alone increase initial loss estimates by \$1 billion.

To estimate the return on investment for this application of technology, we must compare the estimated benefit of application to the cost of the technology. Snakes create an estimated loss of over \$5.55 million dollars annually to the economy of Guam. If the application of the technology is successful and we conservatively estimate a reduction of 5% of the economic damage from the BTS, then the benefit is over \$277,500 in annual savings of damage. Extended over a 5 year time span at an increasing rate (5%, 10%, 15%, 20% and 25%), Guam will benefit by a reduction of approximately \$4.16 million. The total cost of the technology application is \$2.1 million over 3 years. Therefore, for every dollar spent on the application of technology it is returned with \$1.49 in benefits. Incorporating the potential for preventing the movement of the snake to Hawaii would increase this benefit-cost ratio to over 200, or in other words, for every dollar spent on this technology, Hawaii would receive over \$200 in benefits.

8. **Transition Plan:** The U.S. Department of Agriculture (USDA) is authorized to provide assistance to State governments, Federal agencies, and private individuals to control and prevent damage caused by invasive species. USDA/Guam Wildlife Services has extensive work experience with DoD military authorities and has an on-going operational program for deterring BTS dispersal from Guam and trapping to reduce BTS populations and intrusion into small accessible areas such as power stations. The majority of the proposed field work will be conducted by Guam Wildlife Services personnel. They are aware of the technology and there would be no major transition problems in transferring the technology to them. Standard operating procedures, guidelines, and technical reports will be prepared for future implementation. Guam DoD facilities would be the first users of the technology. Since acetaminophen is registered by U.S. EPA for use by U.S. State and Federal governments, the Government of Guam, and the CNMI, there are no known institutional or regulatory barriers that would affect the transition. Approval to apply the technology throughout Guam and CNMI, in localized areas as needed, would have to be obtained from the appropriate military and non-military land resource managers.

9. **Performers:** USDA/Wildlife Services/Guam (logistics/supervision)
233 Pangelinan Way
Barrigada, GU 96913

References

Brooks, J.E., P.J. Savarie, and R.L. Bruggers. 1998a. The toxicity of commercial insecticide aerosol formulations to brown tree snakes. *The Snake* 28:23-27.

Brooks, J.E., P.J. Savarie, and J.J. Johnson. 1998b. The oral and dermal toxicity of selected chemicals to brown treesnakes. *Wildlife Research* 25(4):427-435.

Clark, L., and J. Shivik. 2002. Aerosolized essential oils and individual natural product compounds as brown treesnake repellents. *Pest Management Science* 58:775-783.

Clark, L. 2003. QA-956 Final Report – Efficacy of aerial broadcast baiting in reducing brown treesnake numbers. USDA/National Wildlife Research Center, Fort Collins, CO 11 p.

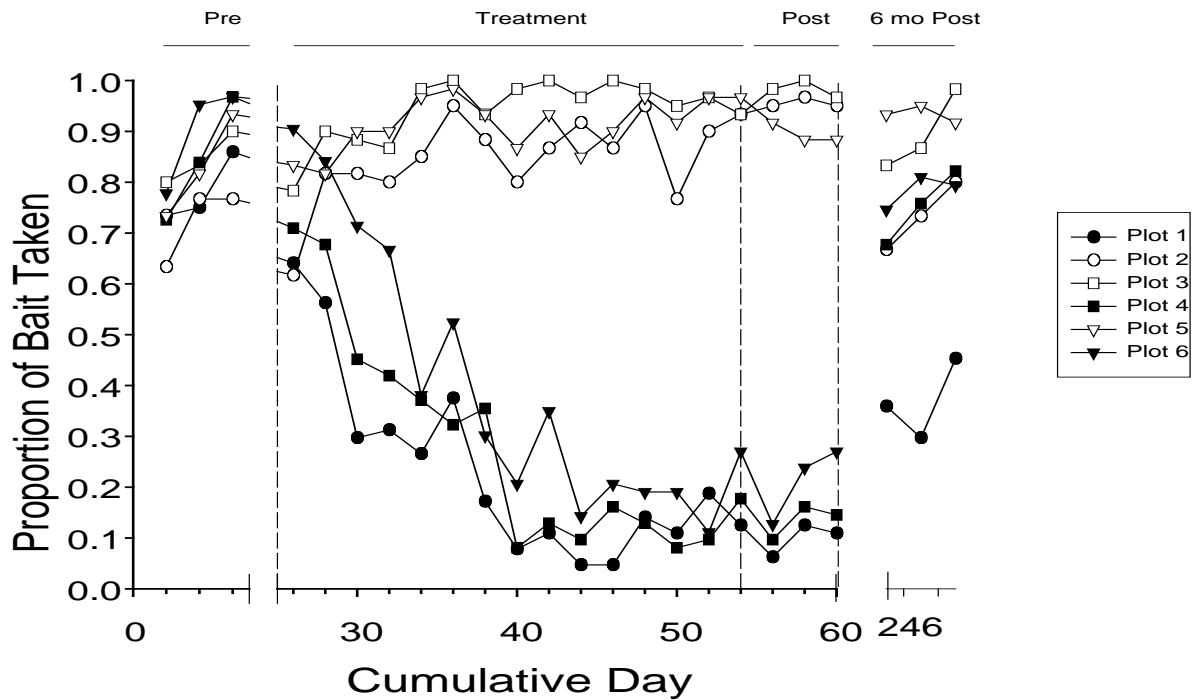
Engeman, R.M., and D.S. Vice. 2001. Objectives and integrated approaches for the control of brown treesnakes. *Integrated Pest Management Reviews* 6:59-76.

- Johnston, J.J., P.J. Savarie, T.M. Primus, J.D. Eisemann, J.C. Hurley, and D.J. Kohler. 2002. Risk assessment of an acetaminophen baiting program for chemical control of brown treesnakes on Guam: evaluation of baits, snake residues, and potential primary and secondary hazards. *Environmental Science and Technology* 36:3827-3833.
- Savarie, P.J., D.L. York, J.C. Hurley, S. Volz, and J.E. Brooks. 2000. Testing the dermal and oral toxicity of selected chemicals to brown treesnakes. *Vertebrate Pest Conference* 19:139-145.
- Savarie, P.J., J.A. Shivik, G.C. White, J.C. Hurley, and L. Clark. 2001. Use of acetaminophen for large-scale control of brown treesnakes. *Journal of Wildlife Management* 65(2):356-365.
- Savarie, P.J., and K. Tope. 2004. Potential flotation devices for aerial delivery of baits to brown treesnakes. *Vertebrate Pest Conference* 21:27-30.
- Savarie, P.J., 2007. Savarie, P.J., T.C. Mathies, and K.A. Fagerstone. 2007. Flotation materials for aerial delivery of acetaminophen toxic baits to brown treesnakes. Pages 218-223 in G.W. Witmer, W.C. Pitt, and K.A. Fagerstone, editors. Managing vertebrate invasive species: proceedings of an international symposium. USDA/APHIS/National Wildlife Research Center, Fort Collins, Colorado, USA.
- Savidge, J.A. 1987. Extinction of an island forest avifauna by an introduced snake. *Ecology* 68:660-668.
- Shivik, J.A., P.J. Savarie, and L. Clark. 2002. Aerial delivery of baits to brown treesnakes. *Wildlife Society Bulletin* 30(4):1062-1067.
- Tobin, M.E., R.T. Sugihara, P.A. Pochop, and M.A. Linnell. 1998. Nightly and seasonal movements of *Boiga irregularis* on Guam. *Journal of Herpetology* 33:660-668.

Attachment 1.

A. Delivery of dead neonatal mouse (DNM) baits by bait stations (Savarie et al. 2001).

Figure 1. Index of BTS populations from the proportion of DNM baits taken as a function of time by BTS on 3 reference plots and 3 treatment plots on Andersen Air Force Base, Guam. No treated baits were offered during the pre-treatment and post-treatment periods. During the treatment period, 80 mg acetaminophen-treated DNM were placed in bait stations (black symbols) and untreated DNM were placed in bait stations on the reference plots (white symbols). During treatment, bait-take remained high on the reference plots and decreased to 10%-20% after 20-30 days on the treated plots indicating a low snake population. A higher 6-month post-treatment bait-take indicates that BTS immigrated back into the treated plots from the surrounding forest, suggesting that larger-scale treatment or a physical barrier is needed to prevent immigration.



Attachment 1 (Continued).

B. BTS population estimates after delivery of 80 mg acetaminophen-treated dead neonatal mouse (DNM) baits by bait stations (Savarie et al. 2001).

Table 1. Population estimates of BTS on 6 study plots (3 untreated reference plots, R, and 3 treated with acetaminophen baits, T,) on Andersen Air Force Base, Guam. Estimates are from model-averaged robust models in program MARK. BTS populations were reduced 27% - 56% on the reference plots and 79% - 88% on the treated plots. The lower post-treatment BTS populations even on the reference plots were most likely due to a carryover effect from movement patterns of snakes (i.e., snakes moved from reference plots to the treatment plots and took treated baits). When adjusted to account for snakes that were initially captured on treatment plots during the pre-baiting period, survival estimates for treatment and reference plots differed considerably. The fact that snakes moved between plots indicates the need for larger-scale control.

Plot	Pre-treatment			Post-treatment		
	N	SE	95% CI	N	SE	95% CI
2-R	52.95	2.73	47.61-58.29	35.08	2.87	29.44-40.71
3-R	65.20	3.08	59.16-71.25	47.71	3.55	40.75-54.67
5-R	76.34	3.39	69.69-82.99	33.93	2.81	28.42-39.44
1-T	51.84	2.69	46.56-57.11	10.95	1.43	8.14-13.75
4-T	79.68	3.48	72.86-86.51	10.95	1.43	8.15-13.75
6-T	113.10	4.35	104.56-121.63	13.08	1.54	10.05-16.10

C. Aerial delivery of untreated dead neonatal mouse (DNM) baits (Shivik et al. 2002).

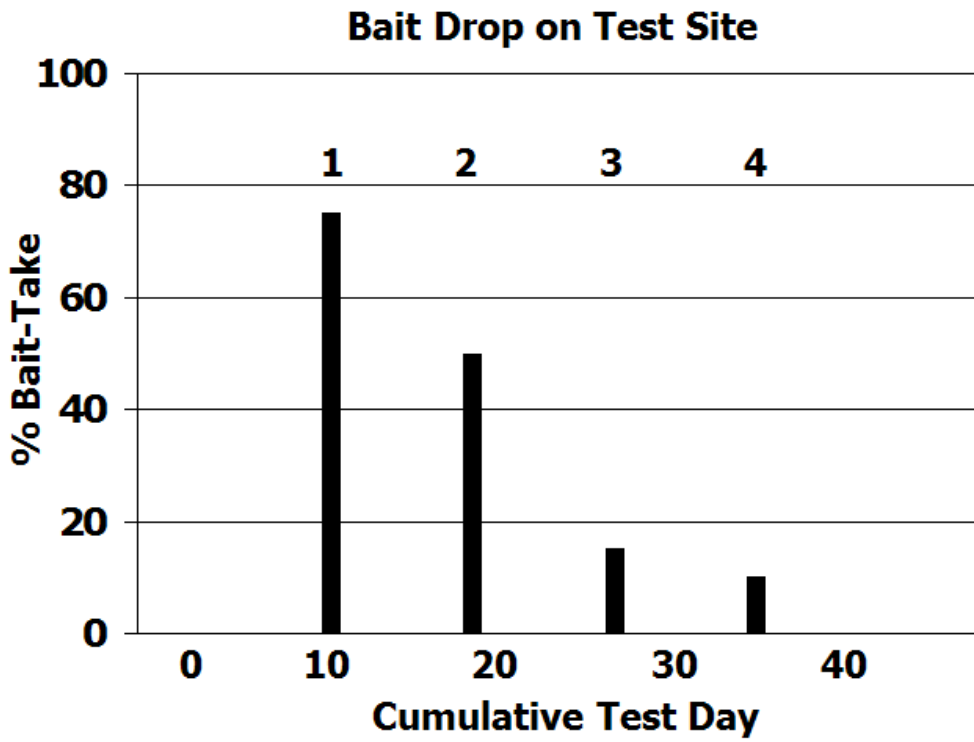
Abstract: An aerial feasibility study was conducted in forests on Andersen Air Force Base, Guam, with untreated DNM inserted with radio transmitters. Immediately after the drop, the location (forest canopy or ground landings) was determined and bait-take was recorded for 1-4 days post-drop. Forty-two (42) percent of baits attached to streamers landed in the canopy and BTS took 32% of these baits. Ninety-two (92) percent of baits attached to parachutes landed in the canopy and BTS took 59%. BTS also took baits that landed on the ground: 1) 27% of the baits with streamers (3 of 11), and 2) 100% of the baits with parachutes (2 of 2).

Attachment 1 (Continued).

D. Aerial delivery of 80 mg acetaminophen-treated dead neonatal mouse (DNM) baits with radio transmitters (Clark 2003).

Figure 1. The percentage of telemetered DNM baits taken by brown treesnakes after 4 aerial drops of 225 treated baits each that included 20 DNM with radio transmitters for each of the 4 drops. The 6 ha test site was located on Northwest Field, Andersen Air Force Base, Guam. Randomly deployed baits, as occurs when aurally deployed, reduced bait take (snake activity) by 80% and 87% after aerial drops 3 and 4, respectively. Based on the telemetry data, BTS were the overwhelming target of the aurally deployed treated baits. Of the 80 telemetered baits dropped, 30 were taken by BTS, 1 was taken by a toad, and 1 was taken by a monitor lizard. Results indicate that all BTS died. Neither the toad nor the monitor lizard, which are introduced species, showed any evidence of ill effects from

ingesting the treated baits.



APPENDIX C

ESTCP SITE CHANGE PROPOSAL

DRAFT

ESTCP Project SI-0925 – Aerial Application of Acetaminophen-treated Baits for Control of Brown Treesnakes - Site Change on Guam

The original study area on Navy property was Orote Peninsula in southern Guam that included a 100 hectare (ha, about 2.5 acres) drop test site, bounded by the ocean and roads, about 6 km from the 100 ha reference site that was bounded by forest. This test site includes Kilo Wharf where munitions are staged before being loaded. When live ordnance is on the wharf, the helicopter would be grounded, and access to the aerial drop site by research personnel would be restricted. There is no way of foreseeing those instances and planning for them, and they would have been disruptive for the study.

The new study area is on northern Guam and consists of three 55-ha sites within 1 km of each other (Attachment 1). The two aerial drop sites are on Air Force property and the reference site is on Navy property. The Habitat Management Unit (HMU) drop site will be enclosed by a continuous wire mesh snake barrier fence that prevents snake immigration, but not emigration. The Munitions Storage Area (MSA) drop site is unfenced and is bounded by forest on three sides and a road on the fourth side. The Reference Site (curved on the south east end) is 75% bounded by forest and 25% by a road. The inference about snake control between the HMU (fenced) and MSA (unfenced) is that snake control will be easier on the HMU because there will be no immigration.

Aerial application of 36 treated baits per ha according to the EPA label has not changed between the originally proposed 100 ha test site and the two new 55-ha test sites. The study design on the Orote site had five independent, randomly selected transects; each containing 10 bait stations with untreated dead



Attachment 1

neonatal mice (DNM) to monitor snake activity, and 10 rodent live traps to monitor rodent activity. The two new test sites (HMU, MSA) will each have six transects, each containing 11 bait stations and 11 rodent live traps.

Below is a summary comparing statistical analyses for the original and new aerial drop sites:

1. Both designs are subjected to the same general analyses, two-factor factorial analysis of variance (ANOVA).
2. For both designs, the transects observed within each site at each time period are the experimental units.
3. There are two fundamental differences between the original design and the new one. First, the new design has three treatments (reference, fenced drop, and unfenced drop). The original experimental design only had two treatments (reference and unfenced drop). The second design difference is that the new design has 6 transects observed within each treatment at each time period. The original design had only 5 transects observed within each treatment at each time period.
4. The sample size of transects observed is substantially greater for the new design than in the original design. For example, assume that observations will be made at 8 time periods. Thus, for the new design there will be 3 treatments x 8 periods x 6 transects per treatment-period = 144 total transects observed. In the original design there

would have been only 2 treatments x 8 periods x 5 transects per treatment-period = 80 total transects observed.

5. Most important for statistical sensitivity for detecting differences, the number of degrees of freedom for the error term is substantially larger in the new design than for the original design (there is one error term for all effects: treatment, period, and treatment x period interaction). Again assuming 8 periods, the current design will have 120 degrees of freedom for error. In the original design there would have only been 64 degrees of freedom for error. The analysis of variance table outline below summarizes these improvements from original to new.

<u>Source</u>	<u>df current</u>	<u>df original</u>
Treatment	2	1
Period	7	7
Trt x Per	14	7
Error	120	64

The study drop site was moved from Orote Peninsula to the northern area of Guam due to possible interference with ordnance operations. The new study area allows us to observe a decreased population of snakes due to treatment activity in the HMU and allows us to observe the immigration of snakes into the unfenced MSA. The new study area offers an increased number of treatments; increased number of transects observed, resulting in increased sample size and greater number of degrees of freedom for error.

DRAFT

APPENDIX D

WILDLIFE SERVICES DIRECTIVE 2.401, PESTICIDE USE

DRAFT

WS Directive

2.401 12/08/2009

PESTICIDE USE

1. PURPOSE

This directive will provide for the safe and effective storage, disposal, recordkeeping, and use of pesticides. It is also intended to mitigate releases of pesticides due to fire and non-fire events. This directive does not apply to sanitizers and disinfectants.

2. REPLACEMENT HIGHLIGHTS

This directive revises WS Directive 2.401 dated 10/9/09.

3. POLICY

Wildlife Services (WS) activities will be in compliance with applicable Federal, State, Tribal, and local laws and regulations pertaining to pesticides, including application, certification, storage, transportation, shipment, disposal, and supervision, or when recommending the use of restricted-use pesticides. Restricted use pesticides used or recommended by WS personnel must be registered by the U.S. Environmental Protection Agency (EPA) and the appropriate State regulatory agency.

WS personnel are responsible for all aspects of control operations involving WS restricted-use pesticides having label language that specifies *"for use only by USDA personnel or persons under their direct supervision."* Furthermore, pesticides displaying restriction-specific labels, and all derived chemical products, will not be transferred or otherwise released to non-authorized personnel per label restrictions. This restriction does not preclude or limit reimbursement to WS for any cost of materials or services provided involving these pesticides.

Pesticide use, storage, and disposal will conform to label instructions and other applicable regulations and laws. Before using any pesticide, WS personnel will be trained in its proper and safe use. For field applications, where other decontamination equipment of sufficient quantity and type is not readily available; WS personnel must carry a decontamination kit containing at least one quart of water, coveralls, disposable towels, and soap.

WS personnel will not conduct operational activities on private property where other persons are known to be using the same or a similar pesticide(s) intended for control of the same target species. WS equipment, materials, and warning signs will be promptly removed from the area if such use is discovered. WS will notify the property owner or manager of this action.

Material Safety Data Sheets and labels for each pesticide used by WS must be provided to all WS personnel and other potential users.

All pesticides, restricted-use or not, must be stored according to label directions in a locked or secured box, building, or vehicle when not in use. Warning signs or symbols required by Federal, State and Tribal laws and regulations must be displayed in the appropriate locations. Pesticides must be used in accordance with the WS' Standard for Storing Pesticides.

All unusable pesticides and by-products will be handled in a manner prescribed by the State Director and in accordance with EPA and State procedures and product labeling. State Directors are responsible for establishing proper accounting and monitoring procedures for all pesticides used in their program.

4. RECORDKEEPING REQUIREMENTS

Minimum recordkeeping for Federally registered, restricted-use pesticides require that the following information be recorded within 30 days following the pesticide application and be kept on file for at least 2 years [Note: State pesticide regulatory agencies may require additional recordkeeping and enforce longer retention dates]:

- a. The brand or product name, and EPA registration number of the restricted-use pesticide that was applied;
- b. The total amount of restricted-use pesticide applied;
- c. The location of application, size of the area treated, and crop, commodity, stored product, or site that a restricted-use pesticide was applied;
- d. The month, day, and year when restricted-use pesticide application occurred; and,
- e. The name and certification number of the certified applicator who applied or who supervised the application of restricted-use pesticide.

An inventory record will be maintained for pesticides in the Management Information System, Control Materials Inventory Tracking System. Records will be evaluated by Headquarters staff with periodic spot checks by designated officials.

Any toxic or adverse human effect which occurs to WS personnel, cooperators, or the public involving use, storage, or disposal of any pesticide registered by USDA, APHIS is to be immediately reported to the State Director and Director (as designated in Directive 1.101) with details recorded on WS Form 160 (2007) and WS Form 160A (2007). The forms serve to document the incident in sufficient detail to allow the Safety, Health and Environmental Protection Branch to determine if further investigation is needed. The Operational Support Staff Director, or designee, will report the incident and submit specifics to the APHIS, Environmental Services Director, as appropriate. An adverse human effect is defined by EPA as an incident in which a person suffers an adverse physiological or behavioral effect (other than local damage to or irritation of the skin or eye of the type commonly associated with dermal or ocular exposure when the label provides adequate notice of such a hazard).

Incidents and/or accidents resulting from the use of pesticides must be immediately reported to the appropriate supervisor and to the WS Safety and Health Council. The WS Safety and Health Council are responsible to investigate and/or coordinate the investigation of any incident or accident related to the use of pesticides. A complete documented investigation must be performed by a competent person for any significant accident. A significant accident is defined as a death of any person, or a three-day (or more) lost time accident of an employee. The council will report any findings and recommendations to the WS Management Team in order to prevent a reoccurrence of such an incident.

Additionally, WS personnel are required to report to the State Director, any knowledge of adverse incidents involving APHIS registered products. An adverse incident has occurred if a person or nontarget organism is exposed to and/or has an adverse effect from a pesticide.

5. REFERENCES

. Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. 136 et ~.), as amended. Food, Agriculture, Conservation, and Trade Act of 1990 (FACT Act). National Environmental Policy Act (public Law 91-190, 42 U.S.C 4321 et seq.). 40 CFR Part 153.75 -Toxic or Adverse Effect Incident Reports, (a)(1)(i) through(iii). Federal Register Vol. 58, No. 67 p. 19014. National Fire Protection Association (NFPA) 434, Code for the Storage of Pesticides. NFPA 30B, Flammable and Combustible Liquid Code. NFPA 30B, *Storage of Aerosol Products*.

Deputy Administrator

APPENDIX E

EPA LABEL FOR ACETAMINOPHEN

DRAFT

**PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND
DOMESTIC ANIMALS**

CAUTION

Si usted no entiende la etiqueta, busque alguien para que se la explique a usted en detalle (If you do not understand the label, find someone to explain it to you).

READ THE ENTIRE LABEL AND FOLLOW ALL APPLICABLE DIRECTIONS, RESTRICTIONS, AND PRECAUTIONS. THIS LABEL MUST BE IN THE POSSESSION OF THE USER AT THE TIME OF PESTICIDE APPLICATION.

PERSONAL PROTECTIVE EQUIPMENT (PPE):

People who handle the product must wear:

- Long-sleeved shirt and long pants
- Socks and shoes
- Waterproof or rubber gloves

Applicators who handle bait must wear:

- Waterproof or rubber gloves

User Safety Requirements:

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions are provided for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

User Safety Recommendations:

Users should wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet. Users should remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

Users should remove PPE immediately after handling this product. As soon as possible, wash thoroughly and change into clean clothing.

**UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE**

4700 River Road, Unit 149
Riverdale, MD 20737

EPA Reg. No. 56228-34
EPA Est. No. 56228-CO-1
Net Contents: _____

Batch Code No.: _____

**ACETAMINOPHEN FOR
BROWN TREESNAKE
CONTROL**

ACTIVE INGREDIENT:

Acetaminophen: 72.73%
OTHER INGREDIENTS: 27.27%
TOTAL: 100.00%

This product may be used only to control brown treesnakes (Boiga irregularis) in non-crop areas in and around military bases, airports, shipping ports, and other areas where brown treesnakes may be present.

KEEP OUT OF REACH OF CHILDREN

**CAUTION
PRECAUTION**

FIRST AID

Have label with you when calling a doctor or poison control center, or obtaining treatment advice.

If swallowed	- Call doctor or poison control center immediately. - Have person sip a glass of water if able to swallow. - Do not induce vomiting unless told to do so by a doctor or the poison control center. - Do not give anything by mouth to an unconscious person.
If on skin or clothing	- Remove contaminated clothing. - Rinse skin immediately with plenty of water for 15-20 minutes. - Call poison control center or doctor for treatment advice.
If inhaled	- Remove person to fresh air. - If not breathing call 911 or an ambulance then give artificial respiration, preferably mouth to mouth. - Call poison control center or doctor for further treatment advice.
If in eyes	- Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses if present, after the first 5 minutes, then continue rinsing eye. - Call poison control center or doctor for treatment advice.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

For use only by employees of the U.S. State and Federal governments, the Government of Guam or the Commonwealth of the Northern Mariana Islands trained in brown treesnake control, or persons under their direct supervision.

USE RESTRICTIONS -

DO NOT apply this product in a manner that will contaminate food, feed, and water.
DO NOT apply this product in a manner where it is accessible to children or domestic animals.
DO NOT apply treated baits in areas where there is a danger that threatened or endangered species will consume baits unless special precautions are taken to limit such exposures. Such precautions shall include applying treated baits inside bait stations that will exclude threatened or endangered species that otherwise might feed upon baits.

SINGLE BAIT PREPARATION - Manually insert one 80-mg or two 40-mg acetaminophen tablets into the throat of a dead mouse pup (approximate age: 10-15 days).

BAIT STATIONS - Construct bait stations from lengths of PVC pipe that are 2 to 4 inches (5.1 to 10.2 cm) in diameter and 12 to 18 inches (30.5 to 45.8 cm) in length. Alternatively, use wire mesh funnel traps. Hang bait stations in trees and on fences at heights of approximately 4.9 feet (1.5 meters) above ground. Place single mouse baits inside individual bait stations. Place bait stations at intervals of approximately 22 yards (20 meters) or greater in and around forested areas and along fence lines. Bait density must not exceed 15 baits per acre (36 baits per hectare). Bait stations may be restocked at a minimum interval of two days and may be operated continuously throughout the year.

BROADCAST APPLICATION - Baits may be hand broadcast or dropped from helicopters and fixed-winged aircraft. If the desired bait placement is in the forest canopy, attach a small piece of netting or other material to the bait. During one baiting period, apply no more than 90 baits per acre (36 baits per hectare) per drop, with a minimum interval between drops of 2 days. No more than 15 drops may occur in a single baiting period. No more than two baiting periods per acre or hectare may occur in a single year.

ENVIRONMENTAL HAZARDS

Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage and disposal.

Pesticide Storage: Store only in a closed container in a dry place that is inaccessible to children, pets, and domestic animals.

Pesticide Disposal: If the product cannot be disposed of through use in accordance with product label directions, contact your Territorial Pesticide or Environmental Control agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

Container Disposal: Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. Offer for recycling, if available. Otherwise, puncture and dispose of in a sanitary landfill or incinerator, or, if allowed by state and local authorities, burn. If burned, stay out of smoke.

ENDANGERED SPECIES CONSIDERATIONS

NOTICE: It is a Federal offense to use any pesticide in a manner that results in the death of an endangered species. Before undertaking any control operations with the product, consult with local, State, and Federal wildlife authorities to ensure the use of this product presents no hazard to any endangered species.

To reduce the hazard baiting may present to non-target species, consultation and concurrence will be obtained from Federal and local wildlife management authorities (e.g., U.S. Fish and Wildlife Service (FWS) Ecological Services, and Government of Guam Division of Aquatic and Wildlife Resources) prior to use in threatened or endangered species habitat (including habitat of the Mariana crow, Guam rail, or other reintroduced species).

Threatened or endangered Species – Guam:

Bat, Little Mariana fruit (*Pteropus tokudae*)
Bat, Mariana fruit (*Pteropus mariannus mariannus*)
Broadbill, Guam (*Myiagra freycineti*)
Crow, Mariana (*Corvus kubaryi*)
Kingfisher, Guam Micronesian (*Halcyon cinnamomina cinnamomina*)
Mallard, Mariana (*Anas oustaleti*)
Moorhen, Mariana common (*Gallinula chloropus guami*)
Rail, Guam (*Gallirallus owstoni*)
Sea turtle, green (*Chelonia mydas*)
Sea turtle, hawksbill (*Eretmochelys imbicata*)
Sea turtle, leatherback (*Dermochelys coriacea*)
Sea turtle, loggerhead (*Caretta caretta*)
Swiftlet, Mariana gray (*Aerodramus vanikorensis bartschi*)

Endangered Plants: Iagu, Hayun (*Serianthes nelsonii*)

ENDANGERED SPECIES CONSIDERATIONS

(continued)

Threatened or endangered Species –

Commonwealth of the Northern Mariana Islands:

Crow, Mariana (*Corvus kubaryi*)
Mallard, Mariana (*Anas oustaleti*)
Megapode, Micronesian (*Megapodius laperouse*)
Monarch, Tinian (*Monarcha takatsukasae*)
Moorhen, Mariana common (*Gallinula chloropus guami*)
Rail, Guam (*Gallirallus owstoni*)
Sea turtle, green (*Chelonia mydas*)
Sea turtle, hawksbill (*Eretmochelys imbicata*)
Sea turtle, leatherback (*Dermochelys coriacea*)
Sea turtle, loggerhead (*Caretta caretta*)
Swiftlet, Mariana gray (*Aerodramus vanikorensis bartschi*)
Warbler, nightingale reed (*Acercyphalus luscini*)

Endangered Plants: Iagu, Hayun (*Serianthes nelsonii*)

Amended 11/2009