10 Working Dogs

The Last Line of Defense for Preventing Dispersal of Brown Treesnakes from Guam

Daniel S. Vice, Richard M. Engeman, Marc A. Hall, and Craig S. Clark

CONTENTS

INTRODUCTION

The inadvertent introduction of the brown treesnake (*Boiga irregularis*) to Guam resulted in unprecedented losses to the island's fragile ecology and economy. A primary management objective is preventing the spread of brown treesnakes to other locations via Guam's transportation network. To achieve this, snake populations are suppressed in and around port and cargo staging areas through an integrated wildlife damage management approach, with the last line of defense for preventing their entrance into the outbound cargo flow inspection by trained snake detector dogs. The efficacy of working dogs on Guam has been evaluated from a variety of aspects.

Most snakes found in the course of dog inspections have been in immediate positions for transport to locations potentially vulnerable to their invasion; snakes typically removed from the cargo flow are generally smaller than snakes removed using other population control measures. The efficacy of the dog teams at finding randomly hidden snakes (not known to handlers) has remained at 62 to 70% as long as such unannounced plants are parts of regular training. Detector dog teams are limited resources relative to the volume of cargo and transportation flow from Guam. Thus, a thorough understanding of the transportation network is required to prioritize and apply detector dogs for maximal impact in reducing brown treesnake exportation risk. The dog handling teams used in conjunction with other control methods as part of a comprehensive containment program have been highly effective at preventing the transport of brown treesnakes from Guam to other vulnerable locations.

BROWN TREESNAKE IMPACTS ON GUAM

The brown treesnake (*Boiga irregularis*) on Guam is an extreme example of the effects an introduced predator can exert on native insular faunal populations. This snake, native to the northern and eastern coasts of Australia, eastern Indonesia, New Guinea and the Solomon Islands, likely was brought to Guam accidentally through post-World War II shipments of war materiels from New Guinea (Rodda et al., 1992). By the 1970s, native bird populations were absent from all but the northern third of Guam.

Disease and pesticides were first speculated to be responsible for the losses of avifauna (Grue, 1985; Savidge, 1987; Savidge et al. 1992), but predation by the arboreal and nocturnal brown treesnake ultimately was identified as the cause of the birds' disappearances (Savidge, 1987). Guam's wildlife evolved a resilience to the often dramatic habitat changes regularly inflicted by typhoons (and also by World War II; Engbring and Pratt, 1985), but native birds and other potential prey species on Guam had not evolved in the presence of predators such as the brown treesnake.

Of the 12 native species of forest birds on Guam, only the Mariana crow (*Corvus kubaryi*), the Mariana grey swiftlet (*Aerodramu vanikorensis bartschi*), and the Micronesian starling (*Aplonis opaca*) survive in the wild (Wiles et al., 2003; Clark and Vice, 2001). Guam's crow population is extinct. The birds remaining in the wild are offspring of individuals translocated from Rota (National Research Council, 1997; Wiles et al., 2003). Two species, the Guam rail (*Gallirallus owstoni*) and the Micronesian kingfisher (*Halycon cinnamomina*), were taken into captive breeding programs, with reintroductions of Guam rails initiated in the late 1990s (Anderson et al., 1998; Vice et al., 2001).

Recruitment in Mariana fruit bat (*Pteropus mariannus*) populations, already limited by human harvest, has essentially ceased as a result of predation by the brown treesnake (Wiles, 1987a and b; Wiles et al., 1995). Similarly, several indigenous or endemic species of lizards became extinct or endangered primarily due to brown treesnake predation (Rodda and Fritts, 1992), with only one of the 12 native lizard species appearing in similar density on Guam as on nearby snake-free islands (Rodda and Fritts, 1992).

Brown treesnakes are agricultural pests through depredations on chickens, pigeons, caged songbirds, newborn pigs, kittens, and puppies (Fritts and McCoid, 1991). The arboreal snake also climbs utility poles and wires, causing frequent electrical power failures when their bodies connect live and grounded wires. The outages result in millions of dollars of losses from damaged power equipment, electrical appliances and machines, as well as repair costs and losses of productivity (Fritts et al., 1987). Moreover, the brown treesnake is mildly venomous and readily enters dwellings at night. Many victims have been bitten during sleep. The brown treesnake is rear-fanged and must chew to envenomate its victims, making it primarily a health hazard to infants and small children who are less able to defend themselves from its bite and its constriction. A number of life-threatening snake bite incidents involving children have occurred on Guam (Fritts et al., 1990; Fritts et al., 1994), although no human fatalities are known from brown treesnake bites.

THREAT OF DISPERSAL FROM GUAM

As global commerce increases, a concurrent, exponential increase in accidental transportations of species outside their native ranges has been widely documented (Mack et al., 2000). The brown treesnake presents an acute and chronic threat to areas beyond Guam because it is well suited for transport to and establishment at other locations (Fritts et al., 1999). The range of the brown treesnake on Guam encompasses the entire island, occupying virtually every habitat across urban and rural areas. High densities of snakes can be found in small forested patches in developed areas, landscaped areas adjacent to habitations and other buildings, and military and commercial port areas. Brown treesnakes are highly mobile, agile climbers that seek refuge from heat and light during the daylight.

Many types of cargo, shipping containers, and air and sea transport vessels offer daytime refuge. These elements, coupled with Guam's position as a focal point for commercial and military shipments of cargo and passengers throughout the Pacific, present a significant threat for further dispersal of brown treesnakes (Vice et al., 2003; Vice and Vice, 2004). Brown treesnakes associated with military or civilian transportation from Guam have been sighted on virtually every major island in the tropical western Pacific, including Oahu in Hawaii, Saipan, Tinian and Rota of the Commonwealth of the Northern Mariana Islands (CNMI), Kwajalein, Pohnpei, Chuuk, and Diego Garcia in the Indian Ocean, and Okinawa in the Ryukyu Islands of Japan. Brown treesnakes have also been found on the North American mainland and as far away as Rota, Spain (McCoid et al., 1994; Fritts et al., 1999). An incipient population likely now exists on Saipan, as credible sightings and captures now total over 75 in the past 10 years (McCoid et al., 1994). Even a single dispersal event may yield ecological disaster for a recipient location, considering that the Guam brown treesnake population may have originated from a single female snake (Rawlings et al., 1998).

Not surprisingly, the brown treesnake management objective that has received the most effort and attention to date is to deter their further dispersal beyond Guam (Engeman and Vice, 2001a). Federal control efforts were implemented in 1993 to address this objective (Vice and Pitzler, 2002). The primary areas on Guam targeted for snake control include the commercial and naval wharves, associated warehouses and outdoor cargo staging sites around Apra Harbor, the Won Pat International Airport and its cargo staging facilities, the flight line, warehouses and outdoor cargo staging facilities at Andersen Air Force Base (AAFB), commercial packers and shippers (distributed around central Guam), and military housing areas (high turnover of personnel at military bases daily presents a large amount of cargo associated with household moves). The areas subjected to control have continued to evolve along with greater definition of the cargo traffic flows within and from Guam (Vice et al., 2003).

DETECTOR DOG INSPECTIONS

Snake population suppression techniques such as trapping (Engeman and Linnell, 1998; Engeman and Vice 2001a and b; Vice et al., 2005), oral toxicants (Savarie et al., 2001), and spotlight searches of fences (Engeman et al., 1999; Engeman and Vice 2001a and b) effectively reduce snake populations locally, but snakes occasionally circumvent primary control measures and stow in outbound cargo. To minimize this risk, trained detector dogs are used to search, locate, and remove brown treesnakes prior to the departures of outbound military and commercial cargo and transportation vessels from the island. Each team is comprised of a handler and a unique detector dog assigned to that handler. Jack Russell terriers serve as the breed of choice due to their energetic and aggressive nature and ease of handling in cargo and confined spaces (see Figure 10.1). A variety of commercial and military locations are inspected, with 24-hour availability of handlers and their dogs for conducting inspections.

EVALUATION OF DETECTOR DOG EFFICACY

Efficacy based on risks posed by discovered snakes — Examination of the records of brown treesnakes detected during dog inspections revealed that 80% of the snakes found by the dogs were at high risk for export, with Hawaii, followed by the Micronesian islands, the most frequently identified potential destinations (Engeman et al., 1998a). A subsequent study corroborated these results, also showing snakes located by detector dogs were in positions for immediate export from Guam to vulnerable locations (Vice and Vice, 2004). Typically, snakes found during dog inspections averaged smaller in snout–vent length than snakes captured in traps or from spotlight searches of fences (Vice and Vice, 2004). These smaller snakes are more likely to evade other control measures and also less likely to be spotted by cargo or transportation workers.

Natural disasters such as the typhoons that frequently strike Guam exert substantial impacts on snake habitat and movements, result in increased cargo flow for the recovery process, and damage the traps and fences used in control efforts or force their removal from the environment. This combination of impacts increases the likelihood of the snakes' entry into the cargo flow and elevates the importance of detector dog inspections following such events (Vice and Engeman, 2000). Additionally, stochastic events such as typhoons impact surrounding islands and may dramatically affect transportation volume, as recovery support that originates on Guam or transits the island further increases the risk of brown treesnake dispersal. Vice and Engeman (2000) observed an increase in the rate of brown treesnake discoveries by detector dogs in the 10 weeks following the highly destructive supertyphoon Paka. While that storm, one of the most powerful ever recorded in the world, rendered many brown

FIGURE 10.1 Snake-detecting Jack Russell terrier.

treesnake control technologies inoperable, the detectors dogs were able to resume duties the day after the storm (Vice and Engeman, 2000).

Efficacy based on locating planted snakes — The efficacy of the teams of handlers and their dogs for locating stowed brown treesnakes was investigated by planting live brown treesnakes (in escape-proof containers) in cargo without the knowledge of the handlers responsible for inspecting the cargo (Engeman et al., 1998b; Engeman et al., 2002). See Figure 10.2. When an observer attended the inspection to watch procedures, 80% of the planted snakes were located. Otherwise, 70% of the planted snakes were discovered, but only after such plantings had become routine. Prior to that, efficacy was nearly 50% less. The reasons dog teams missed some planted snakes were attributed to insufficient search patterns by the handlers or the failures of handlers to detect indications from the dogs that snakes were present. The interaction between dog and handler is complex and it is impossible to precisely determine in the latter situation whether (1) the dog did not detect the snake, (2) the dog detected the snake but did not respond, or (3) the handler did not recognize a response by the dog. Continued testing has found efficacy to remain around two-thirds for finding brown treesnakes planted in cargo and fewer missed snakes caused by insufficient search patterns (Engeman et al., 2002). The same study also indicated efficacy was higher for daytime inspections indoors than outdoors.

These studies indicated that discontinuation of the random trials of the dog teams with planted snakes likely would lead to decreased attentiveness to inspection

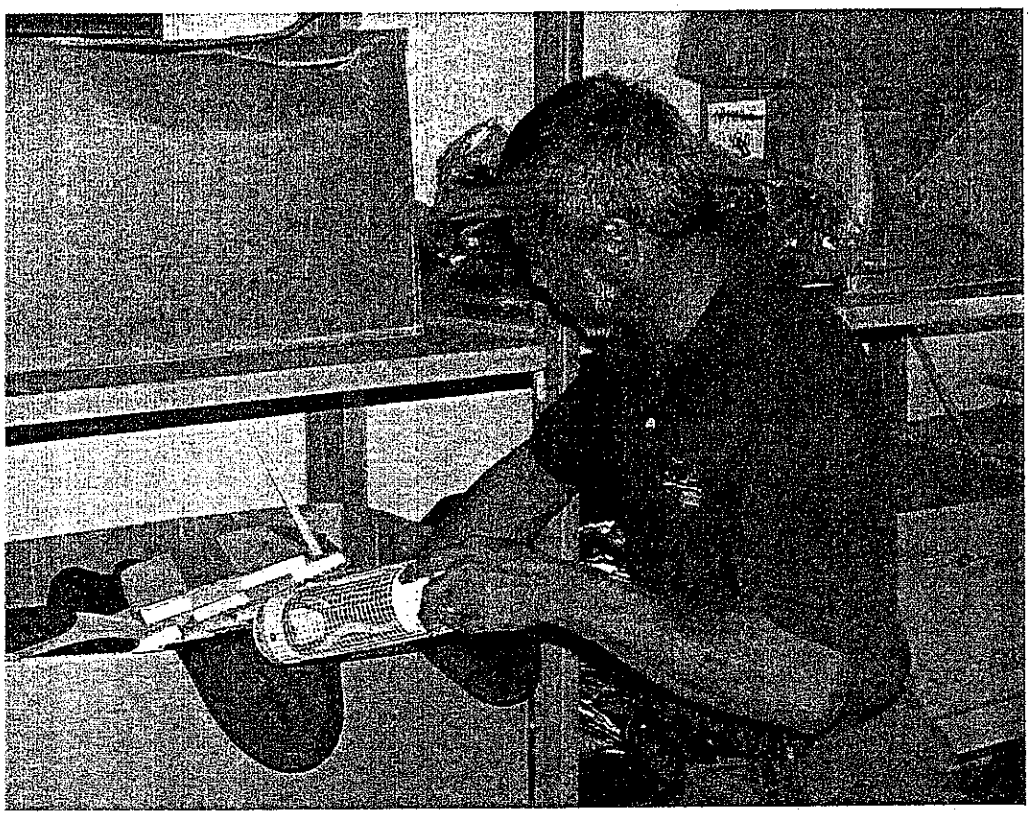

FIGURE 10.2 Planted snake.

procedures and a subsequent decrease in efficacy. Beyond that, finding planted snakes instills confidence in the dogs from their handlers. Similarly, facility workers and managers at sites where inspections occurred have expressed greater confidence and interest in the abilities of the handlers and dogs, leading to more proactive snake control efforts by employees at regularly inspected facilities (Engeman et al., 1998b).

In recent years, the detector dog program has transitioned through aggressive (biting) to passive (sitting) response training protocol to an active (scratching) response. Since the transition to the active response protocol, the Guam program has also instituted a permanent quality assurance program using snakes planted in cargo in a manner consistent with earlier efficacy evaluations. Although not applied in a scientifically rigorous manner, this project has produced detection rates consistently over 75%. This effort is used to enhance and maintain dog team efficacy and build employee morale via a reward system for high achieving canine teams.

DEFINING AND PRIORITIZING EFFORTS

The use of the dog teams to investigate cargo is the result of cooperative arrangements and coordination with agencies, organizations, and companies transporting cargo from Guam. A thorough understanding of cargo transport from Guam is necessary to effectively apply the dogs (and other control methods) as part of a comprehensive containment program. Cargo inspections on Guam are prioritized according to several risk factors, such as probability of establishment in recipient location, type of movement, and size of movement.

Although desirable, it is not logistically feasible under current program structure to search all outbound cargo. To augment existing containment activities on Guam, some recipient locations have established their own detector dog programs. Hawaii conducts detector dog inspections of inbound cargo from Guam using trained beagles. The dogs are available for commercial flights from Guam and they are cross-trained to also detect agricultural products (Kaichi, 1998). Searches of inbound cargo from Guam with trained detector dogs have been conducted for several years on Saipan, Tinian, and Rota in the CNMI. No live brown treesnakes have been located by detector dogs on Hawaii or the CNMI.

The use of dogs to inspect cargo also points to some policy issues (Immamura, 1999) related to training issues such as standards for methods and efficacy across programs and inspection quality control in the face of task monotony. Economic issues relating to vessel delays due to inspection times, refusal of entry for unsearched cargo, costs of certification requirements, expanded search times following a positive dog response, and protocols for handling cargo after a positive response was exhibited but no snake found must be resolved in an acceptable manner. Resolution of such policy issues will insure the efficacy and harmonious coordination of detector dog programs with cargo facilities and the cargo handling process. These points become more acute at recipient locations where the probability of locating a snake appears extremely low.

CARGO CERTIFICATION PROCESSES

In most quarantine programs, recipient locations ultimately shoulder the responsibility for ensuring that goods and vessels arriving at their borders are pest-free. Containment of the brown treesnake on Guam presents a unique quarantine situation in which recipient locations depend upon the prevention of snake incursions into cargo prior to departure from Guam. Quarantine efforts at the origination site create challenges in documenting (certifying) the completion of adequate canine inspections, particularly for cargo.

Commercial surface cargo shipments are consolidated at more than 30 different warehouses around Guam, with contents typically placed inside containers over the course of one or more business days. Upon completion of consolidation, containers are customs-sealed and transported to their respective civilian or military shipping ports. To validate the inspection of all contents on a single manifest, canine teams must be on-site for the entire loading process that may last 4 or more hours. The length of this process renders efficient certification of surface commodities virtually impossible based on the current manner in which cargo is loaded. Managers on Guam are working with local businesses, port operators, and other pertinent organizations to develop procedures for certification that are more conducive to canine inspection requirements.

Commercial air freight presents even more substantial challenges in certification of inspection. Typically, air freight is consolidated into unsecured containers that are closed via Velcro or snapped curtains. No customs seals are applied to the containers (airway bills typically have customs information attached). Shippers and airlines frequently add commodities to a container after initial loading on a space-available basis. Again, program managers on Guam work closely with commercial aviation companies to minimize opportunities for missed inspections via this pathway.

TRAINING AND EVALUATION STANDARDS

A critical component of effective canine detection is consistent, relevant training. All canine handling teams on Guam undergo periodic proficiency training and are tested annually; formal testing consists of written and a canine handling components. The annual testing requirement coupled with the transition to active response protocols has enhanced the efficacy of handling teams, as reflected by increased snake detection rates in the overall quality assurance program. Further improvements in inspection procedures and detection rates can be attributed to the current training regime. Dog handlers must achieve better understanding of canine responses to effectively detect target odors.

DISCUSSION

The integrated wildlife damage management methods for snake removal (Engeman and Vice, 2001), of which detector dog inspection is a vital component, have been highly effective on Guam. As effective as the methods may be individually, they must be carefully applied using the available information on their application or their efficacy will suffer. Also, their use must be integrated to maximize efficiency of the methods and ensure that the scenarios by which a brown treesnake could evade the controls and depart the island are minimized. Continued improvements in understanding snake survivability in transit from Guam, a thorough understanding of cargo flows from Guam (Vice et al. 2003, Perry and Vice, 1998), and public awareness of the need to cooperate with snake control efforts allow more precision and efficiency in the application of detector dogs, a relatively high investment technology in limited supply.

REFERENCES

Anderson, R.D., Beauprez, G.M., and Searle, A.D. (1998). Creation of a snake-free area on Guam using trapping and barrier technology. *Brown Treesnake Research Symposium*. Honolulu, HI. 10.

Clark, C.S. and Vice, D.S. (2001). Protecting the endangered Vanikoro swiftlet from brown treesnakes. *Brown Treesnake 2001 Research and Management*. Andersen Air Force Base, Guam. 9–10.

Engbring, J. and Pratt, H.D. (1985). Endangered birds in Micronesia: their history, status, and future prospects. In Temple, S.A., Ed. *Bird Conservation*, Vol. 2. Madison: University of Wisconsin Press, 71–105.

Engeman, R.M. and Linnell, M.A. (1998). Trapping strategies for deterring the spread of brown treesnakes (*Boiga irregularis*) from Guam. *Pacific Conservation Biology*. *4*, 348–353.

Engeman, R.M., Linnell, M.A., Aguon, P., Manibusan, A., Sayama, S., and Techaira, A. (1999). Implications of brown treesnake captures from fences. *Wildlife Research*, *26*, 111–116.

Engeman, R.M., Rodriguez, D.V., Linnell, M.A., and Pitzler, M.E. (1998a). A review of the case histories of brown treesnakes (*Boiga irregularis*) located by detector dogs on Guam. *International Biodegradation and Biodeterioration, 42,* 161–165.

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

Engeman, R.M. and Vice, D.S. (2001b). A direct comparison of trapping and spotlight searches for capturing brown treesnakes on Guam. *Pacific Conservation Biology. 7,* 4–8.

Engeman, R.M., Vice, D.S., Rodriguez, D.V., Gruver, K.S. Santos, W.S., and Pitzler, M.E. (1998b). Effectiveness of detector dogs for locating brown treesnakes in cargo. *Pacific Conservation Biology, 4,* 348–353.

Engeman, R.M., Vice, D.S., York, D., and Gruver, K.S. (2002). Sustained evaluation of the effectiveness of detector dogs for locating brown treesnakes in cargo outbound from Guam. *International Biodegradation and Biodeterioration, 49,* 101–106.

Fritts, T. H. and McCoid, M.J. (1991). Predation by the brown treesnake (*Boiga irregularis*) on poultry and other domesticated animals on Guam. *Snake, 23,* 75–80.

Fritts, T.H., McCoid, M.J., and Gomez, D.M. (1999). Dispersal of snakes to extralimital islands: incidents of the brown treesnake (*Boiga irregularis*) dispersing to islands in ships and aircraft. In Rodda, G. et al., Eds. *Problem Snake Management: Habu and Brown Treesnake.* Ithaca: Cornell University Press, 209–223.

Fritts, T. H., McCoid, M.J., and Haddock, R.L. (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., McCoid, M.J., and Haddock, R.L. (1994). Symptoms and circumstances associated with bites by the brown treesnake (Colubridae: *Boiga irregularis*) on Guam. *Journal of Herpetology, 28,* 27–33.

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

Grue, C.E. (1985). Pesticides and the decline of Guam's native birds. *Nature, 316,* 301.

Immamura, C.K. (1999). A preliminary examination of public policy issues in the use of canine detection of brown treesnakes. In Rodda, G. et al., Eds. *Problem Snake Management: Habu and Brown Treesnake.* Ithaca: Cornell University Press, 353–362.

Kaichi, L. (1998). An overview of the state of Hawaii's detector dog program. *Brown Treesnake Research Symposium.* Honolulu, 23.

Mack, R.N., Simberloff, D., Lonsdale, W.M., Evans, H., Clout, M., and Bazzaz, F. (2000). Biotic invasions: causes, epidemiology, global consequences and control. *Issues in Ecology, 5,* 1–20.

McCoid, M.J., Fritts, T.H., and Campbell, E.W., III. (1994). A brown treesnake (Colubridae: *Boiga irregularis*) sighting in Texas. *Texas Journal of Science, 46,* 365–368.

National Research Council. (1997). *The Scientific Bases for the Preservation of the Mariana Crow.* Washington: National Academy Press.

Perry, G. and Vice, D.S. (1998). Evaluating the risk of brown treesnake dispersal in surface and air shipping: lessons from thermal research. *Brown Treesnake Research Symposium.* Honolulu, 30.

Rawlings, L.R., Whittier, J., Mason, R.T., and Donnellan, S.C. (1998). Phylogenetic analysis of the brown treesnake, *Boiga irregularis*, particularly relating to a *population on Guam.* Brown Treesnake Research Symposium. Honolulu, 31.

Rodda, G.H. and Fritts, T.H. (1992). The impact of the introduction of the colubrid snake *Boiga irregularis* on Guam's lizards. *Journal of Herpetology*, 26, 166–174.

Rodda, G.H., Fritts, T.H., and Conry, P.J. (1992). Origin and population growth of the brown treesnake, *Boiga irregularis*, on Guam. *Pacific Science, 46,* 46–57.

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

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

Savidge. J.A., Sileo, L., and Siegfried, L.M. (1992). Was disease involved in the decimation of Guam's avifauna? *Journal of Wildlife Diseases, 28*, 206–214.

Vice, D.L., Beck, R., Aguon, C.F., and Medina, S. (2001). Recovery of native bird species on Guam. *Brown Treesnake 2001 Research and Management*. Andersen Air Force Base, Guam, 24–25.

Vice, D.S. and Engeman, R.M. (2000). Brown treesnake discoveries during detector dog inspections following Supertyphoon Paka. *Micronesica, 33*, 105–110.

Vice, D.S., Engeman, R.M., and Vice, D.L. (2005). A comparison of three trap designs for capturing brown treesnakes on Guam. *Wildlife Research, 32*, 355–359.

Vice, D.S., Linnell, M.A., and Pitzler, M.E. (2003). *Summary of Guam's Outbound Cargo Handling Process: Preventing the Spread of the Brown Treesnake*. Working Draft Report, USDA/APHIS/Wildlife Services, Barragada, Guam.

Vice, D.S. and Pitzler, M.E. (2002). Brown treesnake control: economy of scales. In Clark, L., Ed. *Human Conflicts with Wildlife: Economic Considerations*. Fort Collins, CO, 127–131.

Vice, D.S. and Vice, D.L. (2004). Characteristics of brown treesnakes (*Boiga irregularis*) removed from Guam's transportation network. *Pacific Conservation Biology, 10*, 216–220.

Wiles, G.J. (1987a). The status of fruit bats on Guam. *Pacific Science. 41*, 148–157.

Wiles, G.J. (1987b). Current research and future management of Marianas fruit bats (Chiroptera: Pteropodidae) on Guam. *Australian Mammalogy, 10*, 93–95.

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

Wiles, G.J, Bart, J., Beck, R.E., and Aguon, C.F. (2003). Impacts of the brown treesnake: patterns of decline and species persistence in Guam's avifauna. *Conservation Biology, 17*, 1350–1360.

CANINE ERGONOMICS

The Science of Working Dogs

Edited by

William S. Helton

2009

CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business