DRAFT
JOINT REGION MARIANAS
ANDERSEN AIR FORCE BASE
UNGULATE MANAGEMENT PLAN

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ABBREVIATIONS

AAFB	Andersen Air Force Base
DoD	Department of Defense
DoN	Department of the Navy
ESA	Endangered Species Act
GDAWR	Guam Department of Agriculture, Division of Aquatic and Wildlife Resources
GNWR	Guam National Wildlife Refuge
HMU	Habitat Management Unit
JR INRMP	Joint Region Integrated Natural Resources Management Plan
MSA	Munitions Storage Area
NBG	Navy Base Guam
UMP	Ungulate Management Plan
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VCO	Volunteer Conservation Officer

EXECUTIVE SUMMARY

Navy lands at Andersen Air Force Base (AAFB) contain some of the highest quality remaining native forest and largest areas of remaining native terrestrial ecosystem on Guam. The majority of this natural habitat is included in the Guam National Wildlife Refuge as Overlay Refuge (10,219 acres) established in 1994 to (1) protect and recover endangered and threatened species, (2) protect habitat, (3) control non-native species with emphasis on the brown treesnake, (4) protect cultural resources, and (5) provide recreational and educational opportunities to the public where possible. AAFB lands provide habitat for endangered Guam rail, Micronesian kingfisher, and endangered Mariana crow that have been extirpated from Guam as well as threatened Mariana fruit bats, endangered *Serianthes nelsonii* tree, candidate treesnails and butterfly species.

Two non-native and invasive ungulate species (or hoofed animals), feral pig (*Sus scrofa*) and Philippine deer (*Cervus mariannus*) have significantly changed the native forest causing land erosion, loss of native plants, degradation and loss of habitats used by species listed under the Endangered Species Act (ESA). Non-native ungulates cause damage to installation facilities and infrastructure. High numbers of deer on AAFB attract illegal hunters creating additional security and safety issues.

Management to reverse the destruction caused by non-native pig and deer and protect Federally listed species habitat is a requirement of legal agreements with U.S. Fish and Wildlife Service. The AAFB Ungulate Management Plan (UMP) describes background, management options and proposed control of ungulates. The plan's objectives are to reach and maintain a sustained reduction of deer and pigs in unfenced areas of the AAFB, and completely remove ungulates from fenced management areas. These objectives will be achieved by implementing and monitoring results of recommended ungulate control methods in perpetuity or until control activities are no longer needed.

The UMP describes the impact of these animals on the AAFB, reviews the biology of the species and history of hunting on the installation. The UMP evaluates possible management and control strategies and recommends a course of action. Where reference is made to decision making by AAFB or installation commanders regarding the specifics of plan execution, the decisions would be informed by the installation Natural Resources Specialists via the Installation Environmental Program Manager and the Public Works Officer.

Control of ungulates on AAFB lands will be conducted by one or more contracted professional companies with expertise in ungulate population control. The contractor will have a proven track record of reducing ungulate numbers to the desired level in previous projects undertaken.

The contractor will use standard techniques for removing pigs and deer including live trapping, snaring, baiting, and ground shooting. When compared to other techniques (i.e. translocation, immuno-contraceptives) these methods have a higher probability of achieving the stated goals and objectives in a shorter time period

As required by the Northwest Field Beddown Section 7 consultation (PACAF 2006) and the ISR/Strike Biological Opinion (AAFB 2006a), deer and pigs will be completely removed from fenced management area at Ritidian point and the Habitat Management Unit (HMU). Elsewhere on AAFB, the number of deer and pigs will be reduced to and maintain at levels that allow for recovery of the native forest. These levels will be determined by monitoring ungulate numbers and the response of vegetation to reduction of browsing pressure. Recovery of native vegetation in areas of ungulate control will be a determining factor if control is effective at achieving the goals of the plan. Control will be adaptively managed to maintain low numbers in unfenced areas and no ungulates within fenced areas. Safety concerns preclude recreational hunting as part of the control program. Areas on AAFB open to recreational hunting will be determined by the installation commander

Carcass disposal or distribution will be determined by installation commander. Deer carcasses could be donated to charity or to the Government of Guam (Gov Guam) for distribution to village mayors providing that possible health risks and liability issues are addressed. Carcasses in remote locations would be left to recycle nutrients into the ecosystem. Currently it is not possible to donate pig meat due to disease risk (See Appendix A).

Costs for a 10-year period would range from $2,9M to $5.7M (see Section 7.9 for details on cost estimations)[1]. Table 6 presents a breakdown for annual and cumulative costs.

[1] Figures are based on 2011 cost estimates and are subject to change in the future

1.0 INTRODUCTION

Some of the best remaining limestone forest ecosystems on Guam are contained in the Guam National Wildlife Refuge (GNWR) Overlay lands on AAFB, including the Pati Point Natural Area, the proposed Ritidian Point Ecological Reserve. These native lands are habitat for threatened Mariana fruit bat, endangered Mariana crow and *Serianthes nelsonii* tree as well as providing habitat for the endangered Guam rail and Guam Micronesian kingfisher that are no longer found in the wild.

The Overlay lands of the GNWR are managed cooperatively with the U.S. Fish and Wildlife Service to (1) protect and recover endangered and threatened species, (2) protect habitat, (3) control non-native species with emphasis on the brown tree snake, (4) protect cultural resources, and (5) provide recreational and educational opportunities to the public where possible. The AAFB has primary jurisdiction over lands in the Overlay Refuge units and manages them in partnership with the U.S. Fish and Wildlife Service, in accordance with the Cooperative Agreement between the U.S. Air Force and U.S. Fish and Wildlife Service for the establishment and management of the Guam national Wildlife Refuge (1994)

The forests of AAFB have been dramatically changed by the introduction of non-native species. At least nine mammal, and 32 amphibian and reptile species, including the brown tree snake (*Boiga irregularis*), have been introduced to Guam since western settlement (Savidge 1987, Fritts and Rodda 1998, McCoid 1999, Christy *et al*. 2007). One result is the loss of the majority of Guam's native forest birds to brown treesnakes (Case and Bolger 1991, Dickman 1996, Fritts and Rodda 1998).

Philippine deer (*Cervus mariannus)* and feral pigs (*Sus scrofa)* have significantly changed AAFB's natural ecosystems. Browsing and rooting has caused the loss of forest cover, loss of native plants and animals, and degraded habitat for threatened and endangered species. Ungulates have caused damage to infrastructure such as buildings, fences, and munitions bunkers through their day-to-day activities. Areas of high ungulate densities on AAFB attract illegal hunters (poachers), creating additional security and safety issues.

1.1 Purpose and Objectives of the Proposed action

The purpose of the AAFB Ungulate Management Plan (UMP) is to define management actions for reduction in number of ungulates on AAFB lands. This management plan is the result of regulatory requirements from U.S. Fish and Wildlife Service for the base-wide reduction in ungulates to a level that native plants and animals and removal of ungulates from fenced enclosures. This plan is part of the Joint Region Integrated Natural Resources Management Plan.

The AAFB UMP discusses effects of ungulates on native ecosystems in terms of habitat modification, degradation, fire, and erosion. The document summarizes the biology and status on Guam of Philippine deer and feral pigs, including a discussion of ungulate density, and how ungulates have impacted islands and tropical environments. Plausible management actions are discussed and strategies for ungulate control are compared and evaluated. The AAFB UMP is a practical, long-term, sustained reduction program for non-native ungulates within the Overlay Refuge lands which have the largest areas of natural habitat impacted by ungulate activity. The plan's objectives are to achieve sustained reduction of ungulate densities in unfenced areas of the Overlay Refuge and eradication of ungulates within fenced exclosures to allow for recovery of damaged ecosystems, and fulfill legal requirements for ungulate control. These objectives will be achieved by implementing and monitoring results of recommended ungulate control methods in perpetuity or until control activities are no longer needed.

The goals of the Plan are to:

1. Comply with legal requirements for installation-wide reduction of ungulates, long-term management to maintain ungulates at low densities, and complete removal of ungulates from within fenced areas.
2. Maintain and improve biological resources, soil structure, infrastructure, and human health and safety concerns.
3. Reduce or eliminate ongoing disturbances to AAFB ecosystems caused by ungulates.
4. Prevent further listing of federally threatened or endangered species and contribute to recovery efforts through a reduction in habitat disturbance/destruction caused by ungulates.
5. Protect native plant species by eliminating browsing and rooting.
6. Lessen security risk posed by illegal hunters by reduction of ungulate densities.
7. Effectively implement ungulate management in a way that has a high probability of success.
8. Minimize long-term diversion of Joint Region Marianas personnel and resources from other resource management projects
9. Provide stewardship for the lands under AAFB care, as outlined in OPNAVINST 5090.1C, Environmental Readiness Manual.

Reducing ungulate numbers within the installation boundaries is the initial step to restoration of threatened and endangered species habitat and fulfilling the objectives of the following environmental laws.

Endangered Species Act

The Endangered Species Act (ESA) requires that Federal agencies including DoD ensure that any actions that are authorized, funded or carried out are not likely to jeopardize the continued existence of any Federally listed threatened or endangered species or result in the destruction or adverse modification of critical habitat. Under section 7(a)(2) of the ESA (16 USC section 1536), DoD is required to consult with the U. S. Fish and Wildlife Service (USFWS) on any action, including taking no action, that could affect listed species or critical habitat.

Sikes Act (16 U.S.C. 670a), as amended in the FY 2004 Defense Authorization Act

The Secretary of Defense shall carry out a program to provide for the conservation and rehabilitation of natural resources on military installations.

The Sikes Act directs the Secretary of each Department of Defense service to prepare and implement an integrated natural resources management plan (INRMP) for military installations that will provide for the conservation and rehabilitation of natural resources.

Executive Order 13112 of Feb 3, 1999

Executive Order 13112 was issued by President Clinton on February 3, 1999, to prevent the introduction of invasive species; provide for their control; and minimize the economic, ecological, and human health impacts that invasive species cause. This Order defines invasive species, requires federal agencies to address invasive species concerns, to not authorize or carry out new actions that would cause or promote the introduction of invasive species, and established the Invasive Species Council. The goals of DoD's Invasive Species Management Program are prevention, control of invasive species on military installations, and restoration using native plants (NISC web site).

In addition to these overarching regulations, the Navy is required to conduct ungulate control in the Overlay Refuge lands as part of conservation measures for several ongoing or proposed AAFB projects including, but not limited to: GUAM and CNMI Military Relocation EIS Biological Opinion (2010), NW Field Beddown (PACAF 2006), ISR/STRIKE (AAFB 2006a), HMU and wells (2009), and MIRC (2010). Excerpted text from these documents is presented below.

Animal Damage Control Act, 7 U.S.C. 426
The Secretary of Agriculture was given broad authority to investigate and remove predatory, wild, injurious, or nuisance animals for protection of birds and other wildlife.

Coastal Zone Management Act, 16 U.S.C. 1451
Supports the removal of non-native pest species that damage the coastal zone and wildlife that lives in the zone. The act was established to "preserve, protect, develop and where possible restore or enhance the resources of the nation's coastal zones".

National Historic Preservation Act, 16 U.S.C. 470 et seq., Archeological resources Protection Act, 16 U.S.C. 470aa-11
Protection of cultural and historic resources from disturbance and damage.

OPNAVINST 5090 1C
Navy Environmental and Natural Resources Program Manual. Natural Resources Management (Chapter 24] calls for meeting dual roles of stewardship and readiness essential in the long-term maintenance of both military and natural resources sustainability.

NW Field Beddown (2006)

Discusses need to develop and implement ungulate control plan:
The Air Force is proposing to develop and implement an ungulate control plan to remove deer and pigs from these areas and to reduce ungulate populations in non-fenced areas to promote forest regeneration.

From: PACAF. 2006. Environmental Assessment for Beddown of Training and Support Initiatives at Northwest Field, Andersen Air Force Base, Guam. Hickham AFB, HI. June.

ISR Strike Biological Opinion, October 3, 2006

Coordination with the (U.S. Fish and Wildlife) Service and the Guam Division of Aquatic and Wildlife Resources will be sought to develop a multi-year ungulate control plan in FY08. The plan will be designated to guide Andersen AFB ungulate eradication, depredation, and recreational hunting issues managed by the proposed Wildlife management Specialist. Consultants, with appropriate and recognized experience, will be used to develop the plan. The plan will be implemented by the proposed Andersen AFB Wildlife management Specialist, conservation officers, and other management stakeholders. The plan will focus on successful implementation of ungulate eradication within the ungulate exclosure areas and the reduction of ungulate densities in non-fenced areas. Control and monitoring techniques will be clearly outlined in the plan.

From: USFWS. 2006. Biological Opinion on the Establishment and Operation of an Intelligence, Surveillance, Reconnaissance, and Strike Capability Project on Andersen Air Force Base, Guam. October 3, 2006. 63 p.

HMU and wells (2009)

AFB wildlife management specialist will coordinate with the Adaptive Management team to develop and implement methods and schedules to remove brown tree snake and ungulates from the HMU.

From: USFWS. 2009. Informal Section 7 Consultation Regarding Construction of a Brown tree snake Barrier at the Habitat Management Unit, and Construction of Five Well Sites, Andersen Air Force Base, Guam.

Guam and CNMI Military Relocation Biological Opinion July 2010

The DoN's preparation and implementation of a Navy Joint Region Marianas ungulate management plan addressing the control and potential eradication of ungulates on DoD lands managed by Naval Facilities Engineering Command Marianas on Guam will minimize future degradation of forest habitat resulting from ungulates. The proposed action includes the development of an ungulate management plan as well as implementation of a long-term program and methods for a sustained reduction of ungulates on DoN lands. Eradication is the goal; however, if eradication is not feasible, ungulate control will be implemented with the goal of sustained suppression to levels that allow for forest regeneration and self-sustaining populations of native animals. The DoN will request the (U.S. Fish & Wildlife) Service's review and comments regarding the draft ungulate management plan.

The Ungulate Management Plan will be finalized by the DoN for DoD lands on Guam to include specific management and control of ungulates. The objective of the Ungulate Management Plan (in progress) is to improve habitat quality for special status species, reduce erosion, and reduce habitat degradation on DoD lands. Implementation of the plan will begin within one year of plan finalization (DoN 2010a, p. 129). The Service will be provided a 30-day period, from the date of receipt of the draft Ungulate Management Plan, to provide comments and recommendations for the DoN's consideration. The initial phase of management will entail significant effort; sustained maintenance and control will require less ongoing effort. (pg. 53)

From: USFWS. 2010. Biological Opinion for the Joint Guam Program Office Relocation of the U.S. Marine Corps from Okinawa to Guam and Associated Activities on Guam and Tinian.

2.0 AFFECTED ENVIRONMENT

The unincorporated U.S. Territory of Guam is the largest and southernmost island in the Marianas Archipelago (GDAWR 2006). The island is 209 mi^2 (541 km^2) and is located at latitude 13°28'N and longitude 144°45'E in the western Pacific Ocean. Guam is approximately 3,700 miles (5,950 km) west of Honolulu and 1,500 miles (2,414 km) southeast of Tokyo. Andersen Air Force Base (AAFB) covers 15,423 acres (6,242 ha), at the northern tip of the island of Guam. 10,300 acres included in the GNWR Refuge Overlay Unit at Andersen (JR INRMP 2012). AAFB and Navy Base Guam are managed as part of Joint Region Marianas by the Navy. AAFB serves as an operating base for combat and mobility contingency forces deploying or assigned in the Pacific and Indian Ocean areas (MIRC 2010).

2.1 Marine Environment

The marine environment off of AAFB supports a rich diversity of species including fish, sea turtles, corals, other invertebrates, and algae species. Surveys were conducted for each of the major groups of marine organisms (marine plants, corals, macroinvertebrates, and fish) in 1993 and 1994 on reef flats and reef slopes of the newly designated Marine Resources Preserve.

Coral coverage increased from the shore towards the beach side of the reef crest, 39 coral species were observed on the reef flat and 40 species were observed on the fore-reef. The surveys documented the abundance distributions of other macroinvertebrates besides corals. These invertebrates form a conspicuous and speciose part of coral reefs. Forty-one species were identified during this survey and were common and generally widespread western IndoPacific species. A total of 204 fish species from 28 families were observed, representing a wide variety of forms from the small reef-dwelling gobies and blennies to large midwater jacks and parrotfishes. Fish abundance was low and few species were seen in the shallow intergroove areas ("flats"). The highest fish abundance was found in the groove habitats near Tagua point (AAFB 1995).

Migratory seabirds, marine mammals and sea turtles forage in the waters off AAFB, and green sea turtles nest in the beaches at Tarague Basin and the Pati Point Natural Area.

2.2 Geology and Soils

Guam is situated at the Mariana Ridge, a tectonically active region at the boundary of the Philippine and Pacific Plates. The island emerged as a result of the tectonic movements of these plates, volcanic activity, and the production of limestone by reef growth. The geological surface features of Guam have been classified into three major regions: the northern limestone plateau, the central volcanics, and the southern volcanics (Tracey *et al*. 1964, Prasad and Manner 1994, Gingerich 2003).

The complex geological formation of Guam is reflected in the island's soils. Five soil types occur on the island – laterite (or volcanic), riverine mud, coral rock, coral sand, and argillaceous soils (USFWS and USAF 2001). Unlike the volcanic soil found on the southern portion (Puglise and Kelty 2007), northern Guam has little volcanic material and consists predominantly of reefal limestone and sand derived from corals, coralline algae, the green alga *Halimeda*, and foraminiferan and molluscan skeletal material (Kurashina *et al*. 1990).

The geology of AAFB consists of massive limestone formations with scattered sinkholes. AAFB is located on a mostly flat plateau, with elevations ranging from 295 to 590 ft (90 to 180 m) above mean sea level. Steep cliffs surround the plateau on the north, west and east sides. A narrow lowland coastal terrace is found at the bottom of the cliffs (Navy 2010). Vegetation types found at AAFB include limestone forest, coastal strand, shrub lands, grasslands, and disturbed areas.

2.3 Vegetation

Terrestrial vegetation types, as generally defined by Fosberg (1960), Stone (1970), Engbring and Ramsey (1984), and GDAWR (2006) for AAFB are shown in Figure 1. Vegetation at AAFB consists of primary limestone forest, secondary (disturbed) limestone forest, coastal strand vegetation, mixed shrub, mixed herbaceous scrub, monotypical stands of invasive species such as *Leucaena leucocephala* and *Vitex parviflora,* and developed areas (Table 1, (AAFB 2008; Navy 2010). The most abundant vegetation type, following developed land, is disturbed limestone forest. However, a fairly large area of primary limestone forest also remains on AAFB lands.

There is one federally listed Endangered plant species on Guam, the fire tree, hayun lågu, (*Serianthes nelsonii*). The only remaining mature Serianthes tree on Guam is found on AAFB in the primary limestone forest above Ritidian point. Four saplings (from Rota stock) are planted in Tarague basin. To prevent deer from browsing on leaves and shoots, the Serianthes on AAFB are within fenced exclosures maintained to exclude deer and pigs.

Ungulate browse and trampling of seedlings are believed to contribute to habitat loss for candidate tree snail species (HDR 2012, Smith et al 2008). Host plants (*Procris pedunculata* and *Elatostema calcareum*) for larvae of the candidate Mariana eight spot butterfly, *Hypolimnas octocula mariannensis,* are found in the limestone forest of AAFB. Deer browse has limited occurrence of these plant species to pinnacle karst and cliff edges that are inaccessible to deer (HDR 2012).

AAFB supports approximately 2,000 locally rare trees, *Tabernaemontana rotensis*, considered a Species of Greatest Conservation Need (SOGCN) by GDAWR (2006). Over 21,000 *T. rotensis* individuals were found throughout AAFB at 265 mapped locations, mainly in the central portion of the base and near the limestone cliffs in the northwest and southeast corners. This is the largest number of *T. rotensis* on Guam. *T. rotensis* has a patchy distribution (aggregated clumps of individuals) and is often associated with other native and rare species (UOG 2007, Navy 2010).

Figure 1: AAFB and vegetation communities (AAFB 2008)

Vegetation Type	***ac (ha)***
Developed Land	4,501 (1,821)
Limestone Forest - Secondary (disturbed)	4,107 (1,662)
Limestone Forest - Primary	1,722 (697)
Vitex-Closed Canopy	851 (344)
Mixed Limestone Forest-Foreslope (Halophytic-Xerophytic Scrub)	834 (337)
Vitex-Sparse Canopy	807 (327)
Mixed Herbaceous Scrub	732 (296)
Hibiscus-Ochrosia Scrub	624 (252)
Coconut Forest	487 (197)
Hibiscus Scrub	431 (174)
Neisosperma Forest	286 (116)
Strand	186 (75)
Hibiscus-Leucaena	109 (44)
Casuarina Forest	102 (41)
Ochrosia Edge	38 (15)
Mixed Shrub	32 (13)

Table 1: Vegetation community types and area on AAFB lands (Navy 2010).

2.4 Threatened, Endangered Species and Candidate Species

Established in 1973, the Endangered Species Act (ESA) protects plants, fish, and wildlife designated as threatened or endangered and conserves habitats that support species survival. Section 7 of the Act requires Federal agencies to consult with the USFWS on all actions they fund, authorize, permit, or carry out in order to analyze the effects of a proposed action on listed species or designated critical habitat(s). Section 3 of the ESA makes it unlawful for a person to “take” a listed species. “Take” is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.”

Threatened or endangered species that have been documented as either occurring or potentially occurring on AAFB are listed in Table 2.

Eight ESA-listed species have been observed at AAFB, three of these species are no longer present in the wild on Guam (Mariana crow, Guam Micronesian kingfisher, Guam rail) and one species is present in southern Guam (Mariana swiftlet). The remaining wild Mariana crow on Guam was last detected on Guam in August 2011 (SWCA 2102).

Scientific Name	Common Name	Status	Locations where Currently Present
Pteropus mariannus mariannus	Mariana fruit bat	T	AAFB
Aerodramus bartschi	Mariana swiftlet	E	NMS
Corvus kubaryi	Mariana crow	E	*
Todiramphus cinnamomina cinnamomina	Guam Micronesian kingfisher	E	**
Gallirallus owstoni	Guam rail	E	**
Chelonia mydas	Green sea turtle	T	AAFB
Eretmochelys imbricata	Hawksbill sea turtle	E	AAFB
Hypolimnus octocula mariannensis	Mariana eight-spot butterfly	C	AAFB
Partula gibba	Humped tree snail	C	AAFB
Partula radiolata	Guam tree snail	C	AAFB
Samoana fragilis	Mariana Island fragile tree snail	C	AAFB
Serianthes nelsonii	Fire tree	E	AAFB
Vagrans egistina	Mariana wandering butterfly	C	unknown

Table 2: Federally listed species that occur or may occur on AAFB
.* - potentially extirpated, the single remaining crow was last detected in August 2011
** = No longer present in the wild
T-Threatened
E-Endangered
C- Candidate

3 UNGULATES

Two species of ungulates or hoofed animals are found on AAFB: feral pigs (*Sus scrofa*) and Philippine deer (*Cervus mariannus*).

3.1 Feral Pigs

Feral pigs (*Sus scrofa*) originated from Europe, Asia, Peninsular Malaysia, and the islands of Sumatra and Java (Ickes *et al*. 2005) but have been accidentally or intentionally introduced to most countries worldwide. In Guam, the feral pig descended from domestic pigs brought to the island by the Spanish between 1672 and 1685 (Conry 1989). The first confirmed record of feral pigs was in 1685 when the Spanish governor of Guam presented a number of pigs to visiting ships as a reward for their assistance in battle. Feral pigs on AAFB are descendants of the early domestic pigs brought by Spanish and contemporary domestic pigs.

3.1.2 Description

Feral pigs are predominately black in color but brown, white, red, and mixed-colored pigs occur on Guam. The species possess a long sloping snout, erect ears, and a high head crest. The legs are relatively short in length and each foot is covered with four hoofed toes. Feral pigs have a coarse, hairy, thick hide with elongated guard hairs occurring sporadically throughout. Erect hairs may occur along the back and neck and a small tassel of hair grows at the terminus of the tail (Conry 1989).

The average weight of a male feral pig in the Northwest Field (NWF) at AAFB was 86 lbs; females averaged 67 lbs (Conry 1989). The largest confirmed record on Guam between 1968 and 1987 was a 306.4 lbs male (Conry 1989). Male body length is generally marginally longer than that of females (Table 3). At NWF, total body length ranged from 46 to 65 inches in males and 44 to 57 inches in females (Conry 1989).

All mature pigs have permanent, enlarged tusks or canine teeth in the upper and lower jaws. Friction between these teeth creates sharp edges on the lower tusks that assist the animals with various behaviors such as feeding and fighting. The tusk of a male feral pig grows continually throughout its life due to an open apical foramen located at the tip of the root. When females reach around 2.5 years their apical foramen closes, causing the tusks to stop growing (Conry 1989).

Relative Age and Sex	Total weight (lbs)	Total body length (ft)	Shoulder height (ft)	Tusk length (in)
Adult Male (>13 months)	86.2	4.6	2.0	0.9* / 1.3**
Adult Female (>13 months)	67.0	4.3	2.0	0.5* / 0.6**
Juvenile Male (4-6 months)	17.0	2.6	1.3	0.1* / 0.2**
Juvenile Female (4-6 months)	25.1	3.0	1.3	0.2* / 0.2**

Table 3: Average weights and measurements of feral pigs from Northwest Field, n = 62 pigs, * = upper tusk length, ** = lower tusk length. Source: Conry (1989).

3.1.4 Behavior

Group size and organization of feral pigs depends on a variety of factors including age, sex, and environmental conditions such as resource availability and disturbances. In tropical areas, pigs have generally been seen in groups of 12 animals or less (Hone 1990). In the Munitions Storage Area (MSA) at AAFB, group size averaged 2.4 individuals; however, groups as large as 19 were observed (Conry 1989). Adult males over 18 months are usually solitary and secretive (Conry 1989, McGaw and Mitchell 1998, Twigg *et al*. 2005). Feral pigs have been reported to be most active in the early morning and late afternoon in tropical climates (Diong 1982); however, they are mostly nocturnal during warm, dry conditions (Wolf and Conover 2003). Feral pigs create large mud wallows as a form of thermoregulation, to disinfect wounds and to reduce ectoparasite loads (Fernández-Llario 2005). Fernández-Llario (2005) also suggested that wallowing serves a sexual function. Wallow complexes can be quite large; one large complex of wallows on AAFB exceeded 5.7 acres (Conry 1989). Wallows tear up the landscape, thereby impacting vegetation and standing water associated with the wallows can be a source of a variety of disease organisms.

The feral pig is omnivorous, consuming fruits, seeds, plant material, vertebrates (e.g. bird chicks and eggs, reptiles and reptile eggs, carcasses of larger animals), and invertebrates. They forage for food using their noses to search the soil and expose fresh roots and shoots (Conry 1989). Their diet can include native species including green sea turtle eggs, sea birds, endemic reptiles, and macro-invertebrates (Coblentz and D. W. Baber 1987; GISD 2006). Earthworms are a major source of protein in their diet, and foraging for earthworms by rooting in the soil is a major cause of soil disturbance in areas with feral pig (Hone 2002, Baubet *et al* 2003). Plant material found in the stomach of feral pigs inhabiting NWF comprised approximately 96 percent of the total wet weight (Conry 1989). Fruit is also an important component, followed by leaves, grass, bark, and roots. There have also been reports of brown tree snake scales and other vertebrates in pig scats.

The home ranges and movement patterns of feral pigs on Guam have not been studied. In most systems, male pigs have larger home ranges than females. At a density of 21 to 34 pigs/ mi^2, boars on Santa Catalina Island, California, had average home ranges of 494 acres while sows averaged 222 acres (Baber and Coblentz 1986). In South Carolina, the average home range of a male feral pig is 558 acres, while the average for females is 447 acres (Wolf and Conover 2003). These home ranges tended to decrease in size during the dry season (Wolf and Conover 2003).

3.1.5 Life History and Reproduction

Information on the life history and reproductive biology of feral *S. scrofa* on Guam was obtained by collecting data on captive progeny obtained from the wild. Sexual maturity, for both domestic and feral pigs, is regulated by weight rather than age (McGaw and Mitchell 1998). Captive pigs of both sexes on Guam have been reported to reach sexual maturity between 6 and 7 months (Conry 1989). Successful impregnation by domestic male pigs occurs shortly after reaching maturity, at an average of 8.3 months. Feral female pigs can breed as early as 6 months, but successful breeding usually occurs around 10 months compared to seven to 10 months for domestic females. The difference is probably due to better diet and nutrition in domestic sows. Free-ranging pigs on other islands tended to first conceive at one year or older (e.g., Baber and Coblentz 1986). Breeding is highly dependent on food availability and quality because pigs have enhanced energy requirements during newborn and lactation periods. Approximately 15 percent of the diet of adult mothers must be crude protein in order to successfully feed their young (McGaw and Mitchell 1998).

Feral pigs are polyestrous meaning that adult females have more than one estrus cycle (lasting 21 days) in a breeding season (McGaw and Mitchell 1998). The average gestation period of the domestic pig on Guam is 113.5 days (McGaw and Mitchell 1998). This is similar to feral *S. scrofa* in other tropical areas, such as Hawai’i and Australia, which have a gestation period of 113 days (Caley 1997, McGaw and Mitchell 1998). The average lactation period on Guam is between 3 and 4 months. Although breeding occurs throughout the year, it generally peaks at the beginning (between April and May) and end (December) of the wet season.

The average litter size reported for Guam is five (Conry 1989), which is typical for the species (Baber and Coblentz 1986). Feral sows in Hawai’i and mainland U.S. average between 0.9 and 1.1 litters per year (Baber and Coblentz 1986, Caley 1997). In the tropics, the potential multiplication potential rate with 100 feral breeding sows is 0.78 (McGaw and Mitchell 1998). Plant material is used to construct nests, which consist of a small mound of vegetation with a channel used to protect piglets during birth and the nursing periods. Typical nests are 10-13 feet long, 6-10 feet wide, and ranging in height from 8-12 inches (Conry 1989).

3.1.6 Distribution and Abundance

Feral pig distribution is dependent on two factors: daily water requirements and dense foliage for protection from extreme weather (Baber and Coblentz 1986, McGaw and Mitchell 1998). These two factors occur in abundance on Guam, thereby supporting high pig density. Because feral pigs are generally nocturnal, and difficult to observe, trends in abundance are based on reports from hunting and control activities. The highest pig densities are found in the secondary limestone forests in the north and the ravine forests in the south (Lujan 2000a). Feral pigs have no natural predators and both legal hunting and poaching have had minimal effect on the overall number of feral pigs. There is currently no legal pig hunting on NBG lands, while AAFB maintains a recreational hunting program.

In 2006 the estimated pig density in the Northwest Field was 55.4 pigs/mi^2 (21.4 pigs/km^2) (AAFB 2006). This density suggests that the 4,400-acre (17.8 km^2) Northwest Field supports approximately 381 feral pigs. Hunter data from 1990 to 1998 for the NWF indicates recreational hunters took 100 to 250 pigs each fiscal year (Figure 2). Data for pig takes from recreational hunting at NWF were not available for the years following 1998. Effort (number of 8-hr days per pig taken) increased steadily within the NWF over the 1990-1998 time period (Figure 3), and peaked in 1998, two years after the largest number of pigs was removed. It is unknown whether this is due to reduction in pig numbers from the hunting activities, or increased wariness of the pigs over time (or a combination of both). Since estimates are not available for pig numbers at NWF during this time period (1990-1998), it is not possible to make this determination with any finality.

Ungulate surveys conducted in the Munitions Storage Area of AAFB in 2000 to 2001 indicated a density of 98 feral pigs/ mi^2 (38 pigs/km^2) (Knutson and Vogt 2002, Department of Air Force 2006). This density is high: about 3 to 6 times higher than founds at NMS and NCTS, and about two to five times higher than pig densities observed at Haleakala National Park in Hawaii (Knutson and Vogt 2002). No recreational hunting is allowed in the MSA, which is a restricted area due to explosives hazards. Currently access to the MSA is restricted to archery hunting by MUNS personnel only (Joseph Vinch, Chief, Environmental Flight, AAFB, personal communication, 2011). For this reason, depredation activities in the MSA have occurred only once during the period of June 2008 – June 2010, with one pig and three deer taken. The lack of ungulate control within this area is most likely the reason pig numbers are so high here.

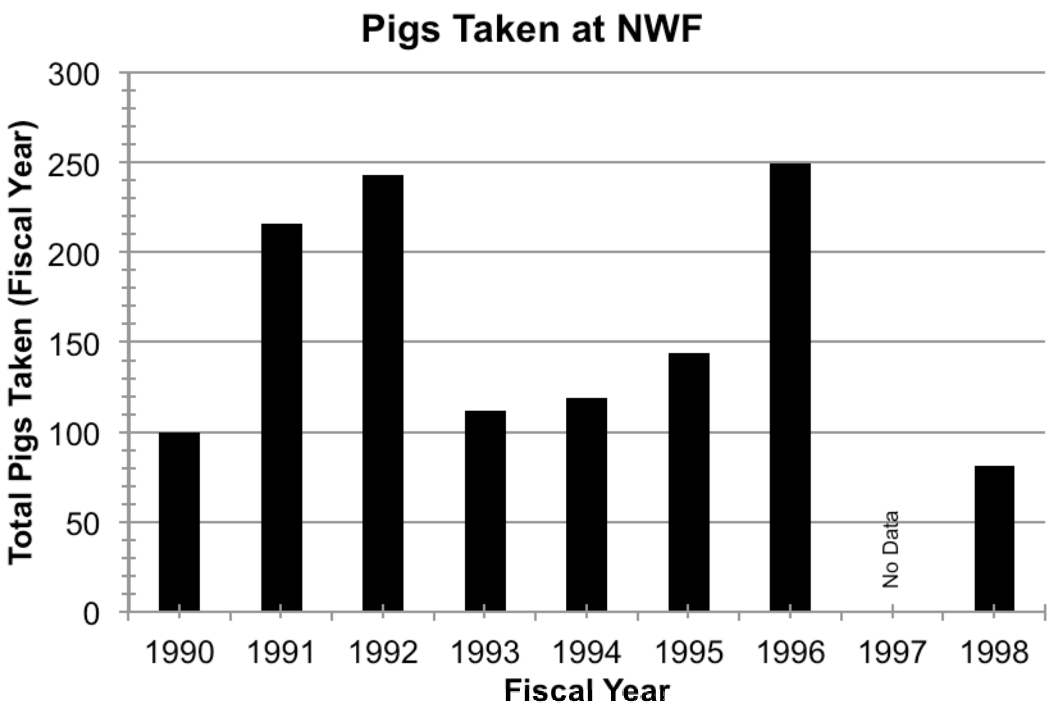

Figure 2: Number of pigs taken per fiscal year from NWF by recreational hunters.

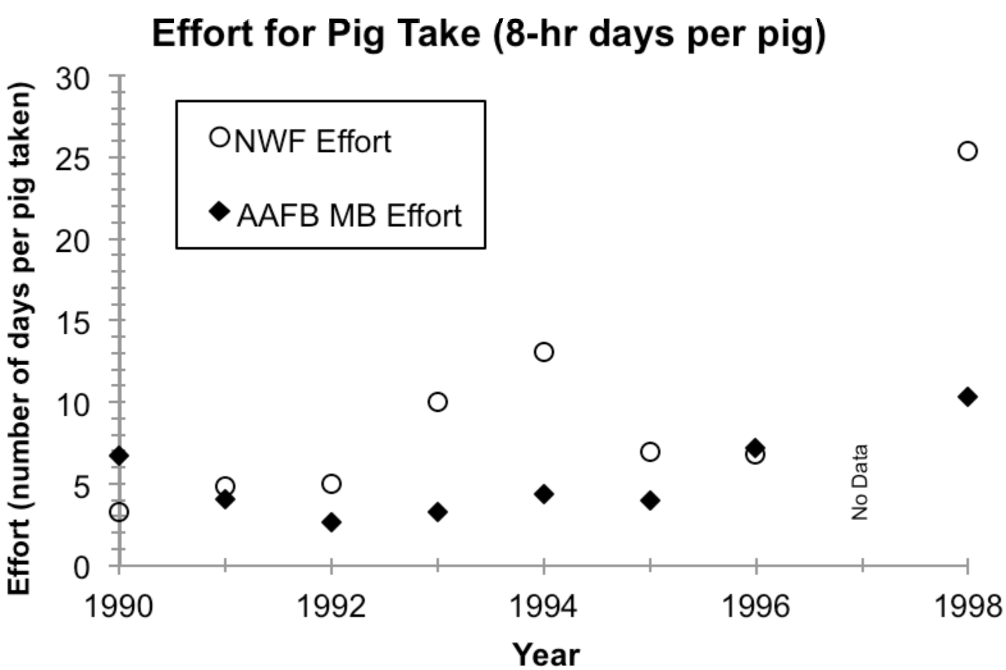

Figure 3: Effort per pig taken by recreational hunters (number of 8-hr days per pig). Open circle = NWF (Northwest Field), diamond = AAFB main base hunting areas. No data are available for recreational hunting efforts for pigs at NWF after 1998.

The density of feral pigs is thought to be low at Pati Point as compared to other areas at AAFB, most likely due to the steep rocky ground, which is unfavorable for pig foraging activities (Wiles *et al*. 1999). However there are no survey data to verify whether this is true or not.

Recreational hunting data for the whole of AAFB shows that recreational hunters took a larger number of pigs per year in the period of 1990 – 1998 than during the period of 2005 – 2009 (Figure 4). Data are missing for the years between these two time periods. It is unclear whether the hunters are taking fewer pigs because fewer pigs are found on base, if the pigs have become more wary of hunters, or that pig hunting had fallen in popularity and therefore less hunting effort. No data on total hunting hours put in by pig hunters is available from 1999 onwards, so it is impossible to determine if less time was put into pig hunting than in the past. Figure 4 shows that for AAFB main base (other hunting areas, excluding NWF), the effort required to take a pig decreased between 1990 and 1992 and then increased slightly over the time period of 1992 -1998.

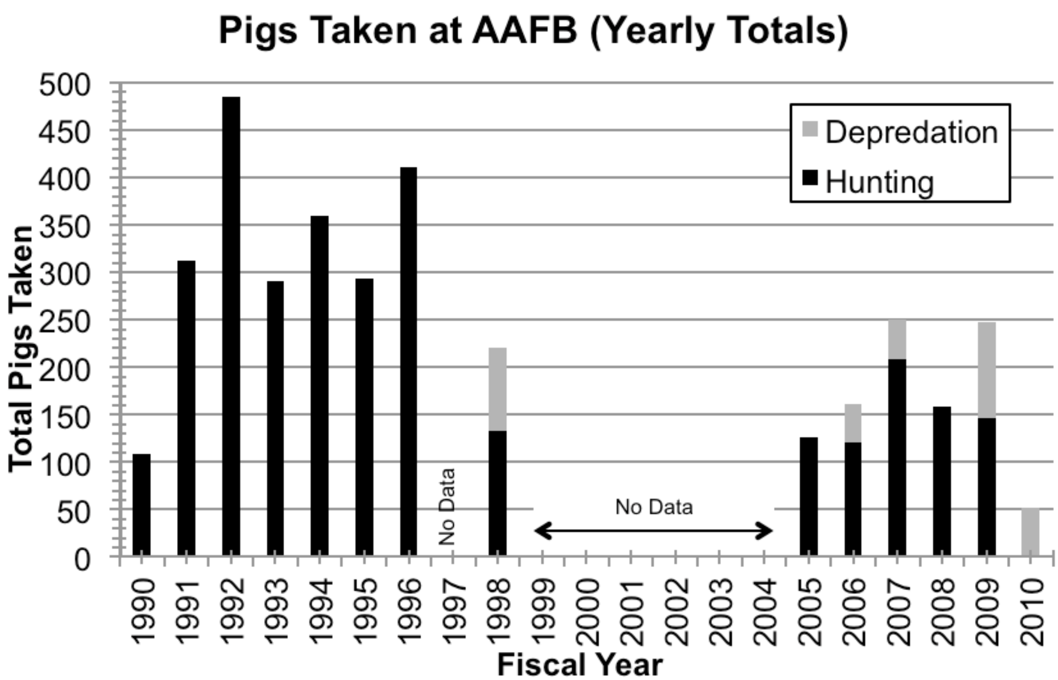

Figure 4: Total number of pigs taken per fiscal year by recreational hunting and depredation (all areas including NWF). Empty columns do not represent zero animals taken, but rather missing data for those years. 2010 data on hunter take was not available so 2010 take is for depredation only.

3.2 Philippine Deer

Philippine deer (*Cervus mariannus*) were introduced to Guam from the Philippines, an archipelago that lies approximately 932 miles west of the Mariana Islands. These animals were brought to Guam during the term of Mariano Tobías, who served as the island's Spanish governor between 1771 and 1774. Although the exact date of introduction is unknown, it is likely that Tobías imported the deer as a new meat source for the Chamorro people in 1771 (Wiles *et al*. 1999). The species was originally described as *Cervus unicolor* and commonly referred to as Sambar deer (Wheeler 1979). The largest population of Philippine deer in its native range are located on Luzon, Mindanao, Samar, and Leyte Islands (IUCN/SSC Deer Specialist Group 1998, Wiles *et al*. 1999).

3.2.1 Description

The Philippine deer is a short, stocky forest-dwelling deer. Males (toru in Chamorro) are much larger than females (båka in Chamorro). Genetic studies by Meijaard and Groves (2004) found that Philippine deer were morphologically similar to Philippine spotted deer (*C. alfredi*). The mean total length of a male is 55 inches and weight of 141 lbs; however, males can reach over 210 lbs (Wiles *et al*. 1999). Females have a mean length of 49.7 in and weight of 89 lbs (Wiles *et al*. 1999). Mean weights and measurements of adult deer on Guam are listed in Table 6.

The antlers of mature bucks are slender and generally three-tined; however antlers with four or five tines have been reported (Wheeler 1979). The single, long brow tine is the first division of the antlers that branches from the main base and the upper tine features a rear-facing terminal fork. The total antler length of a three-tined deer ranges from 2.2 to 5.3 ft (Wheeler 1979, Wiles *et al*. 1999). Antler morphology differs slightly between deer populations on different islands in Micronesia, suggesting some genetic variation. For example, the enlarged antlers found on Rota, Pohnpei, and Saipan have not been reported on Guam. However, genetic studies among the islands have not been conducted (Wiles *et al*. 1999). The antlers are shed and new antlers grow yearly. This replacement period varies from 16 to 19 weeks depending on the age of the deer and the number of antler tines. In contrast to deer found in temperate regions, Philippine deer can shed their antlers at any time of the year (Wheeler 1979).

Sex	Total weight (lbs)	Total length (ft)	Tail length (in)	Shoulder height (ft)	Hind foot length (in)	Ear (in)
Male	141.1 ± 45.2 (21)	4.6 ± 0.5 (24)	4.5 ± 0.6 (24)	2.6 ± 0.3 (25)	13.4 ± 1.0 (23)	4.2 ± 0.2 (25)
Female	89.1 ± 17.9 (21)	4.1± 2.6 (24)	4.2 ±0.6 (24)	2.3 ± 0.13 (25)	11.4 ± 1.1 (23)	4.0 ± 0.2 (25)

Table 4 Mean and standard deviation of various measures of adult Philippine deer. Number of animals sampled in parentheses. (Wiles *et al*. 1999).

3.2.3 Behavior

Philippine deer are known to be secretive but produce a range of barks, bleats, and wails that vary with age and sex (Wheeler 1979). Social organization is generally limited to small family groups of mixed age, but some adult-only groups have been documented (Wiles *et al*. 1999). No comprehensive investigation of movements and specific habitat use has been conducted on Guam. However, movement patterns and home-range size of tropical ungulate species are typically determined by seasonal changes in the environment (e.g. McShea *et al*. 2001). Habitat selection is strongly influenced by energy and nutrient needs particularly during gestation and lactation (Aung *et al*. 2001, McShea *et al*. 2001).

Philippine deer forage nocturnally, consuming fruits, shoots, leaves, stems, and bark of approximately 65 different plant species on Guam (Wiles *et al*. 1999). Their diet includes a variety of woody and herbaceous plants and grasses (Wheeler 1979), with a preference for native woody species over non-native species (Navy 2010). In areas where the deer are present, a noticeable browse line[2] is evident, and forest regeneration is prevented by heavy browsing on seedlings and saplings.

On Guam Philippine deer are known to consume the following: the fruit and seeds of *Artocarpus mariannensis*; the frond stems, fruit, and bark of *Cycas circinalis*; the foliage and fruit of *Triphasia trifolia*, *Passiflora suberosa*, *Pandanus tectorius*; the foliage of *Ficus microcarpa, F. prolixa*, *Psychotria mariana*, *Scaevola sericea*, *Scleria* sp., *Serianthes nelsonii, Pennisetum polystachion*; and the bark of *Pipturus argenteus*, *Premna obtusifolia*, and *Vitex parviflora* (Wiles *et al*. 1999). In addition, Wheeler (1979) reports that *Premna integrifolia, Leucaena glauca, Cocos nucifera, Arecea catechu, Miscanthus floridulus, Musa sp, Ipomoea sp*, and grasses such as *Cenchrus viridis* are part of the Philippine deer's diet on Guam.

3.2.4 Life History and Reproduction

Based on records from 1966, Philippine deer do not typically live beyond eight years (Wheeler 1979). Most deer species have a breeding season that is stimulated by seasonal environmental conditions, such as changes in light intensity and temperature (Wiles *et al*. 1999). Because there is little seasonal variation in the tropics, deer in these regions do not have a well-defined breeding season. On Guam, the Philippine deer breed year-round, generally producing one fawn each time (Wheeler 1979). Pregnant does and fawns have been reported in every month and females can breed as early as six months of age (Wheeler 1979).

3.2.5 Distribution and Abundance

Philippine deer are widely distributed throughout Guam, with the highest densities found on military installations. They are found mainly in limestone, ravine, and savanna habitats. Deer densities are high on military installations due to presence of large areas of suitable habitat and restricted access for hunting in most areas.

Following introduction to Guam, deer numbers increased rapidly. By 1819, annual harvests were estimated at 1,000 without any significant decrease in numbers on island (Wiles *et al*. 1999). By the mid 1880s, numbers declined due to a lack of compliance and enforcement of hunting laws. During World War II, the island was occupied by the Japanese, during which time numbers again increased. Deer were most common on Guam's military bases in the 1950s to 1970s since numbers were more heavily controlled elsewhere due to intense hunting pressure (Wiles *et al*. 1999). Deer populations increased rapidly on Guam after WWII. One reason may be that the initial deer hunting laws were established to reflect laws in the mainland US, where deer breed only seasonally. However, because of the tropical climate, deer in Guam are not restricted to a single breeding season and the number of deer in the population increased exponentially.

Based on spotlight counts conducted by the Guam Division of Aquatic and Wildlife Resources (GDAWR) 1963-1995, the distribution and abundance of the deer varies depending on hunting and forest clearing (Figure 5). Numbers are greatest in areas with high military security that deter illegal hunting. AAFB and NCTS (combined area of 27.6 mi^2) on the northern plateau support the largest deer numbers on the island (Wiles *et al*. 1999). Deer abundance can also be affected by weather patterns (such as droughts), which affect the availability of food and water.

[2] A browse line is defined as the boundary between upper normal plant growth and lower stripped and eaten-back growth that indicates the height reached in feeding by large herbivores.

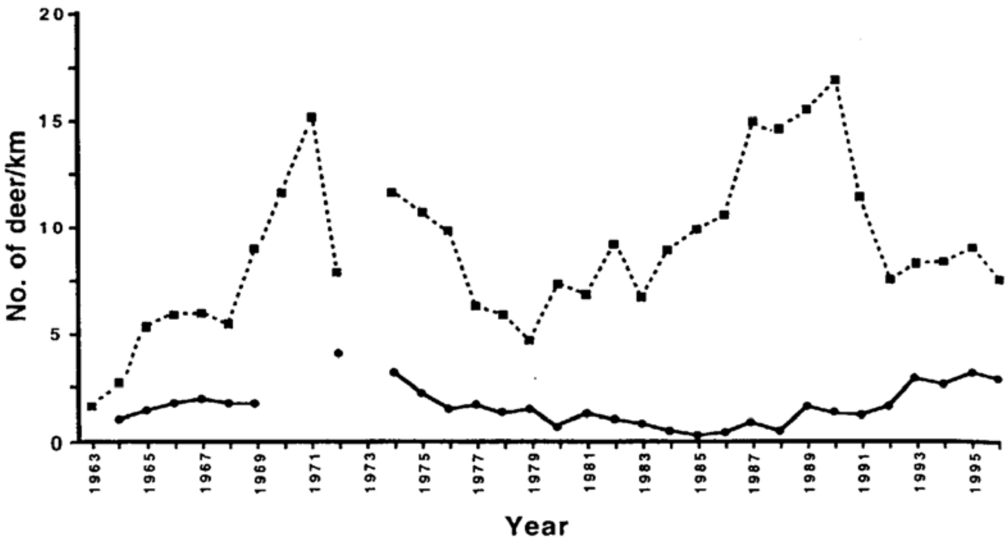

Figure 5: Philippine deer sightings during spotlight counts. Pati Point (dashed line) and NMS (solid line), 1963 -1996 (Wiles *et al*. 1999). Note: Data indicate number of deer seen per km of road driven, and are not density estimates, but rather an index of abundance.

AAFB has the highest number of deer on the island (Wiles *et al* 1999). Pati Point and nearby Tagua Point have large numbers most likely because these areas are regularly patrolled and have never been managed or controlled (Wiles *et al* 1999). Spotlight counts collected from 1965 – 1996 in this area ranged from 7.2 to 26.6 deer per mile (4.5 to 16.6 deer per km) of road driven, with counts varying year to year (Figure 5). Pati Point showed a decline in deer abundance in 1990 due to an extended dry period from the El Nino Southern Oscillation (Wiles *et al*. 1999). However, numbers soon rebounded once the drought ended. In 2003 GDAWR spotlight counts averaged 15.1 deer/mi (9.3 deer per km) indicating that deer numbers continue to increase in the eastern portion of AAFB (GDAWR 2003). While spotlighting data do not provide an estimate of deer density, they can provide a general idea of changes in numbers over time. There are no density estimates available for deer at Pati Point and Tagua Point, as only spotlighting counts were conducted there.

Deer densities in the MSA have been extremely high. In 1997, a minimum density of 125 deer/mi^2 (48.3 deer/km^2) was reported in this area, although Wiles *et al*. (1999) concluded that the density was more likely to be between 155 to 207 deer/mi^2 (60 to 80 deer/km^2). Drive-counts conducted in 2000-2001 at MSA-1 estimated 468.5 deer/mi^2 (183 deer/km^2) or 920 individuals within the 1.94 mi^2 (5.03 km^2) area of MSA (Knutson and Vogt 2002). These numbers indicate MSA has had one of the highest deer densities in the world. Deer appear in good health, are reproductive within one year of birth, and have adequate resources available to sustain healthy numbers, and carrying capacity does not appear to have been met (Knutson and Vogt 2002). Vegetation communities in MSA offer better protection and foraging areas than other localities, as well as difficult poacher and hunter access (Wiles *et al*. 1999, Department of Air Force 2006). Spotlighting counts were conducted by DAWR in the MSA between October 1984 and December 2003. While these data do not provide density estimates, they can show trends in deer abundance within the area. Figure 6 shows deer observed per kilometer of road driven at MSA. During their spotlighting activities at MSA-1 in 2000-2001, Knutson and Vogt (2002) observed an average of 4.79 deer per km road driven. This fits in with the DAWR data collected for the time period (average = 5.25 deer per km road driven). The estimated number of deer in MSA-1 was about 183 deer per km^2 in 2000-2001, suggesting that the deer per km observed can be multiplied by roughly 40 to get deer per km^2 estimates for the area.

Lower numbers of deer have historically been recorded in NWF where hunting was more common (Wiles *et al*. 1999). However, spotlight surveys of NWF conducted in January 2006 found a maximum deer density of 315.9 deer/mi^2 (122 deer/km^2) (AAFB 2006b). Hunting data also supports that the number of deer in this area has been increasing over time and has reached high numbers. The number of deer taken by hunters has increased greatly between 1990 and 2010 (Figure 7) and yet effort per take remained more or less stable indicating overall effort per take has decreased over time (Figure 8). Figure 7 shows the number of deer taken by hunters (for each Fiscal Year) over time at NWF. Data is missing for several years as shown by the blank spaces in 2002, 2004 and 2005 (as those years had deer taken by hunters missing data should not be interpreted as zeros). Recreational hunting records for AAFB as a whole mirror NWF, as NWF was the prime gun hunting area and thus had the highest counts. Figure 9 shows total deer taken by hunters and animal control activities on AAFB over time. Effort per take also decreased at AAFB as a whole, from 15-20 days per deer taken during 1990-1998 to 7 to 9 days per deer in the 2000s. An unusually high effort per take of nearly 40 days per deer taken was found in 1999, there was no indication for the cause of this in the DAWR annual report (GDAWR 1999).

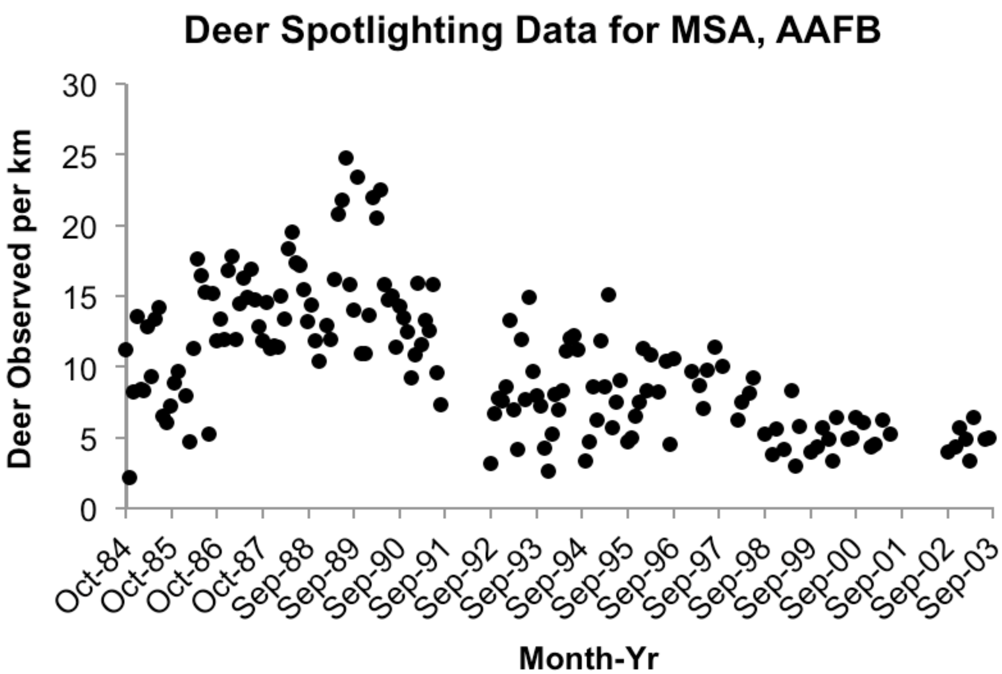

Figure 6: Deer observed per kilometer of road driven during spotlight counts in the MSA.
Guam Dept. Ag and Wildlife Resources: deer/km monthly spotlight count at MSA, Andersen Air Force Base

4 HUNTING AND DEPREDATION PROGRAMS

AAFB has had a recreational public hunting program since 1964 (Wheeler 1979). The intent of the hunting program was 'to manage feral game animals at levels that will prevent irreversible damage to native forests that serve as essential habitat for a number of endangered and rare species." (AAFB INRMP 1995). The public hunting program is managed by a small group of hunters known as the Volunteer Conservation Officers (VCOs). In the past, the VCOs also conducted depredation hunts to control problem animals on the golf course, MSA, and elsewhere on AAFB. Animal control or depredation was conducted by USDA Wildlife Services at the golf course 1997-2002, MSA and Tarague beaches in 2002.

Ungulate control by the VCOs increased over the years although effort for take (number of days to take one animal) for VCO control activities was considerably lower than recreational hunting – with an average of only 0.92 hunter days per deer taken between September 2008 and June 2010. Figure 10 shows effort per take for deer at AAFB conducted by VCOs only. Data on effort by recreational hunters is not available for more recent years so a direct comparison of effort per take is not possible. Assuming that conditions in 2003 (last year of data on recreational hunting effort) are similar to current conditions, the effort per take for recreational hunters (8.6 days per deer in 2003) is about 9.3 times higher than average effort for take (0.92 days per deer) for VCOs during 2008-2010. These numbers indicate that animal control actions are more efficient than recreational hunters.

Ungulate management within the fenced airfield is under the control of Air Force Operations (AFO), currently managed by the 36th Operations Support Squadron (OSS). The OSS is permitted by U.S Fish and Wildlife Service (USFWS) to manage the depredation efforts within the airfield fence (SMSgt. Lewis, OSS, personal communication). Currently the OSS has one permitted hunter managing the depredation efforts on AFO lands. The duties of this squadron member have mainly pertained to bird interference. There have been no pig or deer airfield incidents in the past three years (A. Bernardo, CTR USAF PACAF 36 CEF/CEC, personal communication).

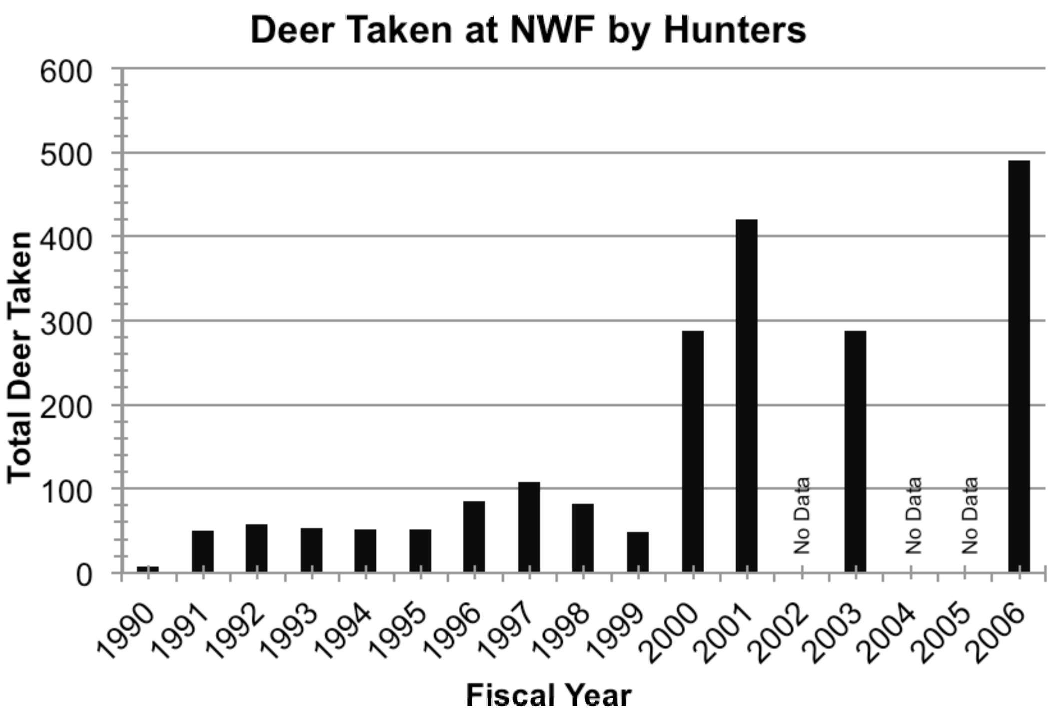

Figure 7: Deer taken at NWF by public hunting. Empty columns are missing data.

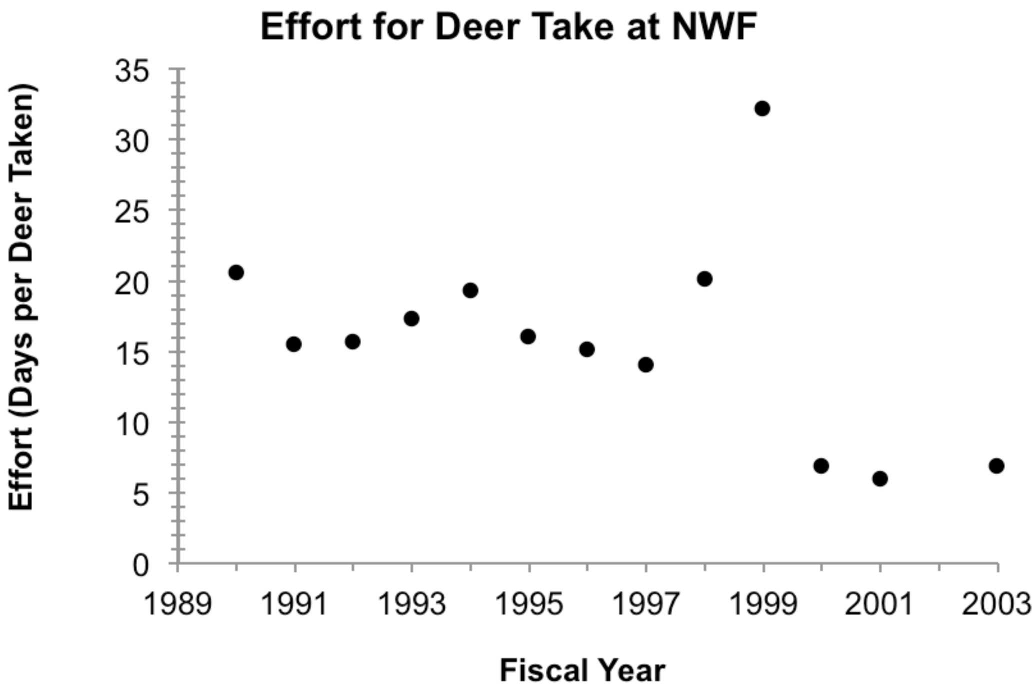

Figure 8: Effort per deer take at NW. Average is 15.7 days per deer taken.

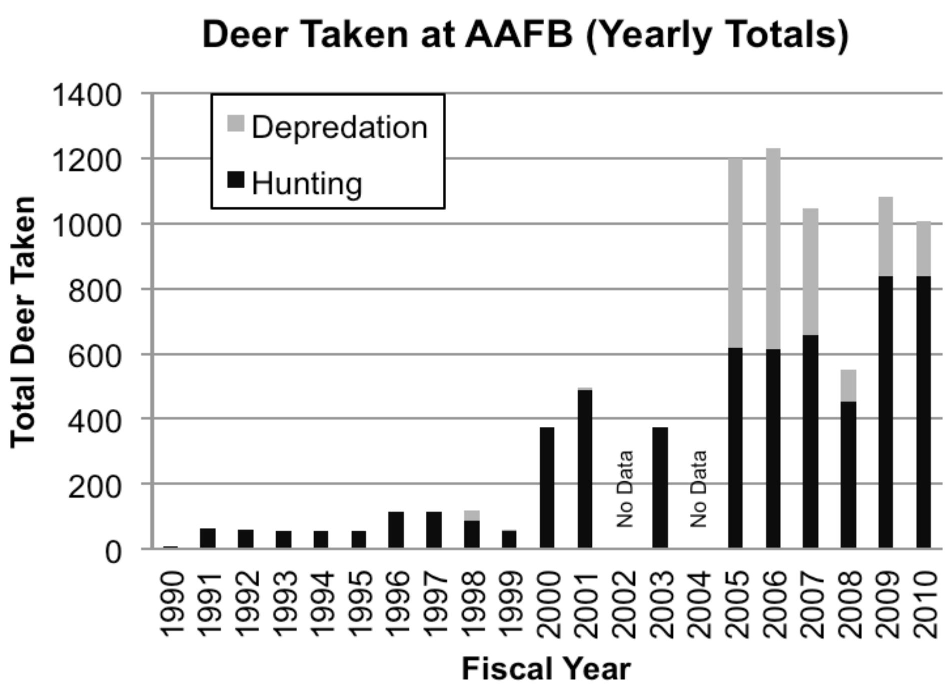

Figure 9: Total deer taken at AAFB

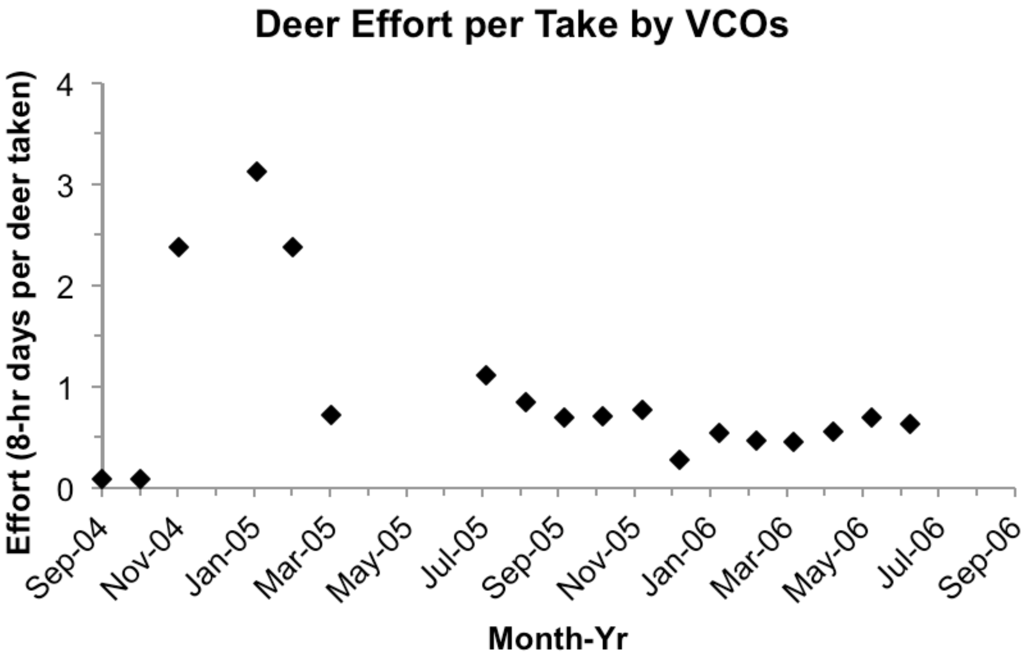

Figure 10: Effort per deer take for VCO control activities on AAFB (8-hr days/deer). Average over the time period is 0.92 hunter days per deer taken.

4.1 Current Hunting Regulations

The only authorized means of take for any listed Guam game species on AAFB is bow tackle. Use of shotguns is not permitted on the installation. Currently, only Munitions Squadron personnel conduct depredation hunts and only in the MSA.

Increased training in NW Field has restricted the areas for all hunting (Figure 11). The public is authorized to hunt on weekends with bow tackle in the A Areas, on the southern side of Rt 3a. VCOs may hunt in the C areas after regular working hours during the week, and in the A hunting areas after working hours and during the week. Depredation in the MSA is conducted exclusively by the Munitions Squadron personnel hunting on the weekends.

All hunting effort, whether MUNS, VCOs, or public participants, is documented by the VCOs. AAFB natural resources staff coordinate the number of personnel, times, areas of hunting, and review recent sightings of Mariana fruit bats and Mariana crows to avoid impacts prior to authorizing hunts.

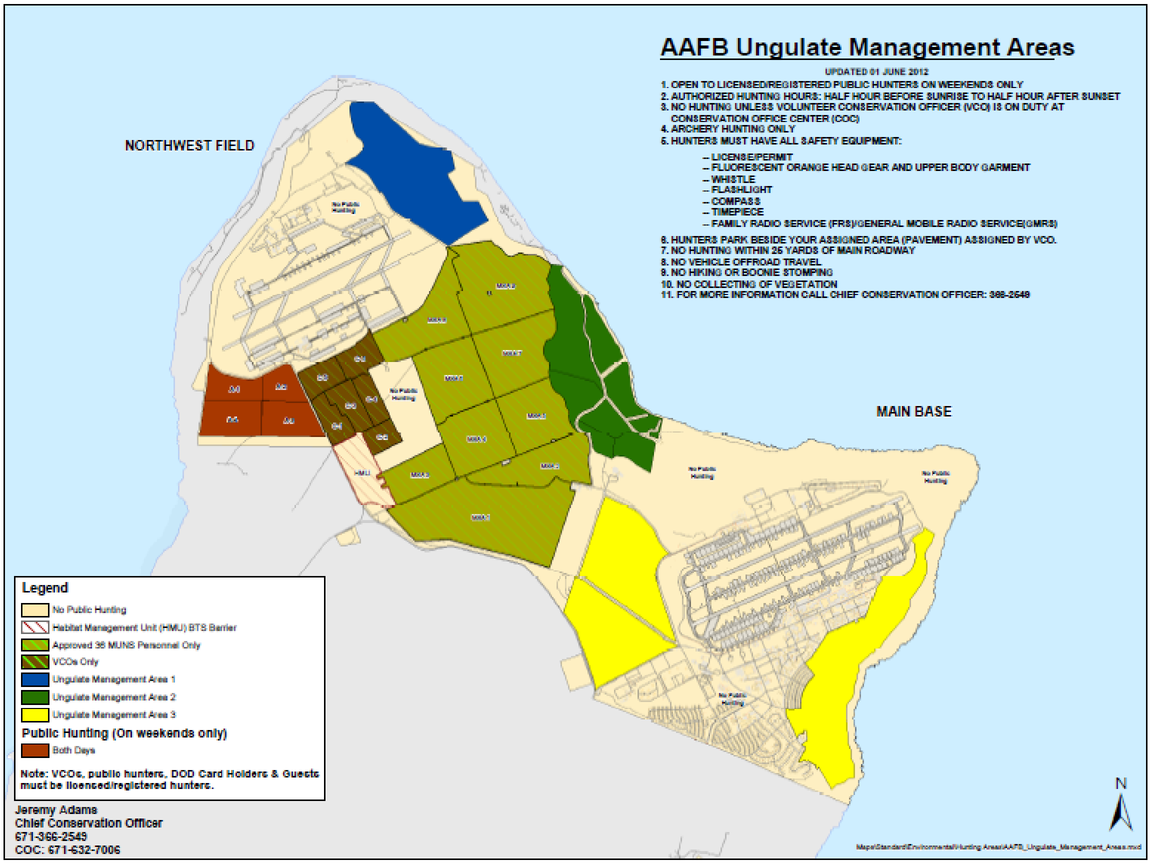

Figure 11: Recreational and depredation hunting areas 2012.

5 IMPACTS OF NON NATIVE UNGULATES ON DOD LANDS

Feral pigs are considered to be one of the 100 worst invasive species on a global scale (IUCN 2000) and potentially problematic in their native range when densities increase due to loss of predators and/or presence of abundant food sources such as agricultural areas (Ickes 2001; Goulding and Roper 2002). In the absence of restraints, non-native ungulates compete with native species for limited resources, alter and destroy habitats and ecological relationships, transmit diseases and cause millions of dollars worth of damage to infrastructure per year (Ikuma *et al*. 2002, Courchamp *et al*. 2003). Recommendations have been made to drastically reduce deer densities through continuous harvest over large areas and eradicate them from sites of significant ecological value within the Marianas Islands (e.g. Wiles *et al*. 1999). High ungulate densities (some of the highest in the world) exist in areas on DoD properties where both recreational hunting and depredation hunting occurs. This indicates that current levels of control are not sufficient to reduce ungulate populations to the levels required to reverse current environmental damage and degradation levels. Significant reduction in numbers of feral ungulates on DoD lands is required as part of mitigation efforts for NW Field Beddown (AAFB 2006) and ISR/Strike (PACAF 2006). From an environmental and legal perspective, the outcomes of current ungulate management programs on DoD Overlay Refuge lands do not support the conservation of native ecosystems and recovery of endangered species.

5.1 Impacts to Terrestrial Habitats

In addition to rooting in soil for earthworms, rhizomes and tubers, grazing by feral pigs and deer impacts forest composition and ultimately leads to a reduction in canopy cover. A reduction in canopy cover and disturbance of soil increases the amount of sunlight reaching the soil surface, which alters soil properties such as temperature, salinity, elevation, and soil structure. This also causes a disruption to ecosystem function by increasing the rate of decomposition and evaporation (Ford and Grace 1998). Damage to forest understory provides opportunities for invasive plants to establish and out-compete native species (Diong 1982, LaRosa 1992, Stone *et al*. 1992). Native tree seedlings tend to grow slower than non-native trees and remain more susceptible to grazing than faster growing non-native species (Schreiner 1997, Perry and Morton 1999, Ritter and Naugle 1999).

The consumption of native fruit and large seeds by pig and deer further reduces the potential for successful plant reproduction and forest regeneration for those plant species not adapted to the presence of large mammals that can crush and destroy seeds (Wiles *et al*. 1999, Ali 2004). Furthermore, these ungulates can provide fertilizer in the form of excrement and further spread invasive plant seeds via their droppings.

Litter production, root growth, root respiration, and nutrient uptake have been shown to decrease in the presence of herbivores (Ford and Grace 1998). Pigs readily establish large wallows that act as pits that trap water during rain, disrupting ecological processes such as succession and species composition, and creating breeding grounds for mosquitoes and other disease organisms (GDAWR 1994). Constant trampling causes soil compaction that can also deplete the soil of needed oxygen (Van Driesche and Van Driesche 2004). Tree rubbing removes bark and can eventually kill the plant through removal of too much bark or by allowing pathogens and pests to enter the plant through the exposed areas. Figure 12 provides examples of wallows and tree rubbing damage seen on NCTS. Eventually, overgrazing, rooting, trampling, tree rubbing, and establishment of wallows can denude areas and cause extensive soil erosion and depauperate soil conditions (Tep and Gaines 2003, Liddle *et al*. 2006). As observed in the Hawaiian Islands, ungulates are likely to further alter Guam’s forest condition so drastically that the ground can no longer maintain native plants.

5.2 Impacts to Marine Habitats

Guam’s marine habitats, including its unique coral reef ecosystems, deep water and mangroves, represent a significant asset to the island’s economy and culture. Guam's reefs are a valuable source of food for local populations, are an important component of Guam's tourism industry, and provide protection from flooding and storm surge, among other services. Van Beukering *et al*. (2007) estimated the total economic value of the services provided by Guam’s coral reefs to be more than $127,000,000 per year.

Sedimentation has been identified as one of the primary threats to Guam's coral reefs (Burdick *et al*. 2008). Sedimentation of the marine environment in Guam can be extreme following heavy rain events. Any land activity that alters or removes vegetation cover, loosens soil, or promotes faster overland movement of water can increase erosion rates and associated sedimentation on Guam's reefs (Schemen *et al*. 2002, Minton 2005). Pigs uproot vegetation and create hard packed trails that promote increased water flow and likely increased erosion. Ungulates contribute to shifts in vegetation community through consumption of tree seedlings. Changes in vegetation structure can significantly increase erosion rates. For example, erosion rates in Guam's grasslands have been shown to be over 60 times higher than in Guam's forests (NRCS 2001).

Figure 12: Examples of ungulate damage
Top: Feral pig (*Sus scrofa*) wallow, near Haputo ERA. Bottom Left: Philippine deer (*Cervus mariannus*) rub on an *Aglaia mariannensis* tree. Bottom Right: Philippine deer and feral pig (*Sus scrofa*) rub on a *Cycas micronesica* tree. Photos courtesy of SWCA (2010).

Eroded soils that have entered coastal waters through silt-laden run-off can smother coral on Guam's fringing reefs (Richmond 1993, Wolanski *et al*. 2003). Sediment that remains within the water column (suspended sediment), can reduce light penetration (Rogers 1990, Reigl and Branch 1995), reduce growth (Rogers 1990), and can result in direct mortality of coral larval (Richmond 1997). Depending on oceanographic conditions, suspended sediments may settle on the bottom and also bury coral and other substratum, potentially resulting in recruitment failure (Hodgson 1990, Gilmour 1999, Minton and Lundgren 2006, Minton *et al*. 2007). Sediment from run-off can also block gills, filter feeder apparatus and smother sedentary aquatic plants, animals and their eggs.

5.3 Human Health and Safety Impacts

Feral pigs can harbor at least 30 significant viral and bacteriological diseases (Williams and Barker 2001). Forrester (1991) documented 45 different parasites and infectious diseases in the feral pig population of Florida. Protozoans, nematodes, acanthocephalan, louse, ticks, and mites as well as bacteria and viruses affect pigs and deer. At least eight pathogens harbored in pigs can infect humans (brucellosis, leptospirosis, salmonellosis, toxoplasmosis, balantidiasis, trichinosis, trichostrongylosis, and sarcoptic mange). Pig ticks will opportunistically feed on humans (Tisdell 1991). It is unknown to what the extent feral pigs on Guam spread diseases that are harmful to humans. Certainly there have been many reports of leptospirosis in areas of Guam inhabited by feral pigs (Office of Epidemiology and Research 2002). By 2002, the island had recorded at least 43 confirmed cases of leptospirosis (Office of Epidemiology and Research 2002, Dr. Robert Haddoc, Guam Territorial epidemiologist, personal communication), of which at least eight have been associated within the Fena watershed area. Ticks are also prevalent but are unlikely to spread disease that can be fatal to humans on Guam.

Public and wildlife safety is a major issue on military lands. CASH (2008) reported almost 200 hunting accidents in the U.S. during 2008 and almost 150 in 2007. Accidental shootings resulting in death have occurred on Guam, some by authorized hunters, others by poachers (e.g. AAFB property in June 2003, Northwest Field AAFB January 2006).

Poaching (illegal hunting) is a problem on DoD properties. Evidence of illegal hunting on AAFB and NMS in the form of spent cartridges, discarded items, and gunshots heard are abundant. A USGS working dog was shot and killed by a poacher on AAFB property on 13 August 2006 (J. Stanford, USGS, personal communication). In recent years there have been two instances of poachers shot and killed on AAFB. The restriction of hunter access on military land has lead to increased illegal entry by poachers. This creates an additional safety risk since the whereabouts of poachers is usually unknown, and because poachers will often engage in unsafe actions in an effort to evade detection and apprehension. Poachers trespassing not only risk their own lives, but the lives of others.

5.4 Impacts to Cultural Resources

Non-native ungulates impact cultural resources by trampling and rooting of sites during browsing activities. Feral pigs root in the soil, overturn stones and mix up the soil horizon, disturbing archeological finds. Non-native ungulates affect distribution and abundance of culturally significant natural resources such as medicinal plant species. They impact native plants directly by browsing on them, often killing the plant in the process, and indirectly by providing a pathway for establishment of invasive plant species, which out-compete culturally significant native plants. Establishment of dense patches of invasive plants may also make discovery and relocation of archeological and cultural sites more difficult.

5.5 Impacts to AAFB Lands and Facilities

Ungulate damage is easily seen on AAFB ,raising the cost of managing natural areas, degrading habitat for threatened and endangered species, and damaging facilities. The effects of erosion from ungulate damage to the vegetation on the upper plateau of AAFB can be found in the lower coastal forests and cliffs (Navy 2010).

Impacts of feral pigs include extensive wallowing, scat, and bark rubbings. Pig wallows and rooting of vegetation directly impacts native vegetation and causes secondary impacts such as facilitating non-native invasive weed encroachment, reducing or eliminating recruitment of emergent tree species, erosion of essential top soil, and spreading of non-native invasive species through ingestion and subsequent defecation of seed material. Pig damage is prevalent throughout the properties, but is more intense in areas farther away from human activity (Navy 2010).

Browsing by non-native ungulates has changed the structure, complexity, and forest composition (Conry 1988, Wiles *et al*. 1999). At AAFB, deer browse lines are evident in forested areas, resulting in very open forest understory's (Conry 1988). Figure 13 shows changes over time to an area of forest in an ungulate exclusion plot before and after the ungulates were removed. Schreiner (1997) observed an absence or reduction of some tree and shrub regeneration in disturbed native forests, resulting in an increase in abundance of non-native species. Browsing has greatly reduced recruitment of native limestone woody species into the upper canopy (AAFB 2006b). Ungulate browsing has been identified as the major factor for inhibiting recruitment of the native *Artocarpus mariannensis* tree at AAFB (Wiles 2005). Wiles documented a 65% decrease in *Artocarpus mariannensis* trees within MSA-1 from 549 individual trees in 1989, to 190 trees in 1999. Other native trees in secondary forests that are declining due to lack of recruitment include the *Serianthes nelsonii* (hayun lågu), *Elaeocarpus yoga*, *Heritiera longipetiolata* (ufa halomtano), *Pisonia grandis*, *Barringtonia asiatica* (puting), *Tristiropsis obtusangula*, and *Instia bijuga* (Wiles, *et al*. 1995; Wiles 2005; Schreiner 1997; Guam DAWR 2005; AAFB 2006b).

Forest composition of native species has been altered as shown by the dominance of species that are not favored by deer, *Guamia, Aglaia,* and *Ochrosia* (Wiles *et al*. 1999). Along the cliffline at Pati point, native *Ochrosia marianensis* has become established in monotypic stands to the exclusion of other more palatable native species (GDAWR 2006). The establishment of *Ochrosia* stands is further aided by deer, which eat the fruits and spread the seeds in their excrement (Leanne Obra, AAFB 36 CES/CEV, personal communication).

Feral pigs damage fences, facilities, training grounds, and the AAFB Golf Course grounds through rooting and foraging activities. There is constant maintenance to the fence lines of the Tarague Well sites due to the extensive pig and deer damage that occurs. There is noticeable erosion caused by ungulates around the infrastructure of the bunkers in the munitions storage areas (MSA). Fence maintenance and erosion control are included in AAFB maintenance activities supported by the Operation Squadron and the Wing Safety department.

Minimal expenditures outside of maintenance have been affiliated with ungulate management on AAFB (D. Lotz, AAFB CEVN, personal communication). Efforts to replant native limestone forest species were made at Urunao IRP restoration site. Ungulate browsing inhibited the growth of the plants, reducing the success of the restoration efforts.

Funds from other agencies have been spent research ungulate numbers on AAFB. According to the 2010 Annual Project Performance Report conducted by the Department of Agriculture through the Guam Division of Aquatic and Wildlife Resources, $2,903.66 was spent towards estimating the deer populations of AAFB at Pati Point, Munitions Storage Area and Northwest Field. The Guam Wildlife

Restoration Program, funded through a grant received through GDAWR from the USFWS, allotted $3,871.58 in 2010 to analyze the annual hunter harvest on AAFB. These counts have yet to be published due to their inaccuracy (J. Quitugua, GDAWR, personal communication).

Figure 13: Changes in vegetation structure over time. Two areas showing the same photo-point location following removal of ungulates from a fenced area on AAFB. Source: USGS.

6 CONTROL TECHNIQUES FOR UNGULATE MANAGEMENT

Techniques for controlling ungulates are reviewed in the following pages, the advantages and disadvantages are summarized in Table 5.

6.1 Fencing

Fencing is used to exclude ungulates from specific areas or to contain ungulates in specific areas until removal can take place (Reeser and Harry 2005). A feral pig eradication program at Hawaii Volcanoes National Park used containment to enclose nine management areas (total 30 mi^2) and contributed to the successful eradication of ungulates in each (Katahira *et al*. 1993). A successful eradication program of feral pigs on Santa Cruz Island began with dividing the island into sections with the use of fences (Parkes and Panetta 2009). Where fencing is impractical or cost prohibitive, natural barriers such as cliffs and ocean may be used as an alternative (Buddenhagen *et al*. 2006). Gates can be built into fences to allow controlled movement of people or animals across the barrier.

Most ungulate control programs fence small management units within management areas (Katahira *et al*. 1993, Reeser and Harry 2005). Smaller areas are easier to manage and cheaper to fence and maintain. Dense cover and rugged topography typically require smaller management units in order for removal actions to be successful.

A properly constructed fence is humane and highly effective when maintained, although no fence can ever be considered completely ungulate proof. Most deer are deterred by 6-8 feet fences (Anderson 1999, Barnes 1993). Pig fences are at least 3 feet high and require a guard such as barbed wire or an apron to prevent pigs from forcing their way underneath (Long and Robley 2004). Modified hog-wire fencing is used to control goats, cattle, domestic sheep, and pigs in Hawaii (Reeser and Harry 2005) may also be an option.

Although electric fences are widely used in the mainland U.S. and Australia (Littauer 1997), they are impractical for Guam where maintaining an uninterrupted power supply in remote, wet, stormy, and corrosive conditions decreases fence integrity, increases maintenance costs and the risk of electric shock to humans (E. Campbell, U.S. Fish and Wildlife Service, personal communication). In 2003, the USGS Brown Tree Snake Project built a five-foot high fence with a concrete apron clad on both sides with ¼ inch mesh to prevent snake movement into and out of a 12 acre area. Although only five feet high, the fence has successfully deterred deer and pig from entering the enclosure (G. Rodda, US Geological Survey, personal communication). Many management areas in New Zealand use predator-proof fences that have an underground and aboveground portion, and can effectively prevent movement of animals as small as mice. However, these fences are quite expensive to install.

Ungulate fencing in Hawai'i has typically used rolls of graduated woven wire livestock fence with barbed wire run at the bottom to deter pigs from digging underneath. The height of deer fencing is determined by the species being excluded and the location circumstances of the fence. In forested areas where deer are unable to take a running jump, effective fence height may be less than in open habitats. To increase fence height, strands of barbed wire may be run above the woven wire fence.

Small pigs have been found to push through woven wire fencing and start new populations in areas pigs had previously been removed at the U.S. Army, Schoefield Barracks, Oahu (S. Mosher, personal communication). Rigid, welded wire livestock panels with three inch openings at the bottom are now being used as an alternative to woven wire fencing by the Army. Staked at ground level, the rigid panels do not bend and are effective at deterring pigs from digging underneath. Woven wire skirting is extended over areas where pigs may dig underneath and secured with anchor stakes (Figure 14). Where the ground is uneven, crossing rocky or karst terrain, the welded wire panels can be cut to fit (Figure 15). If low points are crossed, an apron of woven wire is attached at the base of the fence and staked with anchors to the ground.

An alternative to barbed wire strands at the top of the fence is the addition of polypropylene deer mesh above the welded wire panels. Deer mesh is used for gardens and other temporary fencing. A wire is run at the desired height of the fence and clipped to the livestock panels. The Army is now using deer mesh above welded wire panels to extend fence height (Figure 16).

This combination fence made of welded wire panels and deer mesh has several advantages for Guam. The rigidity of the panels provides support for the fence and installation is easier in difficult terrain as rolls of wire do not need to be laid out before tensioning. In pinnacle karst, panels can be cut to fit the limestone outcropping with wire mesh skirts attached and staked to deter pigs from getting under the fence. The polypropylene deer mesh is less costly than wire fencing and comparatively easy to replace.

Figure 14: Hogwire skirting added at the base of a woven wire fence (U.S. Army, Hawaii)

Figure 15: **Welded wire panels being cut to fit uneven terrain (U.S. Army, Hawaii)**

Figure 16: Polypropylene deer mesh attached above welded wire panels in a 7 ft high fence. (U.S. Army, Hawaii)

6.2 Live Trapping

Deer and pigs can be trapped using cage, box, or corral traps providing the option of releasing captured individuals elsewhere, giving them away, or humanely dispatching them at close range. Traps used in combination with other methods are useful tools, but as a sole method of control; traps have had limited success (e.g., Schuyler *et al*. 2002). Schuyler *et al*. (2002) used two types of box traps to catch pigs on Santa Catalina to remove approximately 40 percent of the population. On Santa Cruz Island, traps were used to remove approximately 16% of the feral pig population (Parkes *et al* 2010).

Trapping has primarily been used for pig control. Modified versions of baited Clover traps (Clover 1954) have been used to successfully capture elk in flat terrain in Arizona (Dodd *et al*. 2007) and forested, steep terrain with elevations to 6,988 feet in Montana (Thompson *et al*. 1989). Elk in Arizona have been captured with remote-triggered drop nets (Dodd *et al*. 2007). Moose were successfully trapped using 98 x 16 x 8 feet rectangular woven-wire corrals (LeResche and Lynch 1973).

Deer can be captured using corral traps, drop nets, or a net gun fired from a helicopter. The control of royal deer in south-east Australia included trapping in enclosures, but trapping was limited by the trap-wariness of the deer (NSW National Parks Service 2002).

By baiting the area around and inside the trap, capture success is greatly increased. Take can be further increased if baited trapping is timed to coincide with low food availability (Barrett and Birmingham 1994). Pre-baiting allows individuals to freely wander into the traps to forage without getting caught. This period is important as it permits ingress and egress of individuals as they get used to the trap. The method increases the chance of catching multiple animals in one trap (Littauer 1997). In Hawaii, traps that were set during peak breeding seasons increased the probability of catching family groups or roaming solitary males (Katahira *et al*. 1993).

Corral traps work well if the target species congregates in an area. Corral traps need to provide adequate cover, food and water because they are usually deployed for extended time periods. By placing one or two decoy animals in the corral, others are attracted to the area (Barrett and Birmingham 1994). Since corral traps are designed to attract as many individuals as possible and are set in one location for greater periods of time than other traps, the high concentration of animals can cause damage to the environment in which the corral traps are set.

Trapping is particularly useful in areas where other methods are considered unsafe or unfeasible. These include military instillations where sensitive equipment for telecommunications prohibits the use of firearms, Because traps are live capture, the animal is usually unharmed by the capture process and therefore non-target animals can be released unharmed. If animals are captured for relocation or fitting of radio transmitters, live trapping is necessary.

There are disadvantages to live trapping. Trapping can be viewed as inhumane by the public. Traps can be logistically challenging and labor intensive to deploy. A trapping operation requires road access. Traps must be checked, cleared, and refurbished with bait regularly. Trapping can be less cost effective than other methods because of higher labor and materials costs. The process of discovering the optimum bait type and conditioning animals to take the bait in the presence of traps can be frustrating and time consuming. There will always be a residual number that will be reluctant to enter traps (NSW National Parks Service 2002). Therefore, while traps alone will not result in the desired level of control, if used in conjunction with other techniques they can be a useful tool.

Trapping has been used by the VCO program on AAFB to control pigs on the Golf Course, in Senior

Officer Housing area, and Tarague Recreational Beach Area. An average of 3-6 pigs have been taken per month using this method (Joseph Vinch, Chief, Environmental Flight, AAFB, personal communication, 2011).

6.3 Ground Hunting

Ground hunting is conducted on foot or from vehicles, during daylight (recreational hunts) or at night (e.g. depredation). The success of ground hunting depends on the terrain, visibility, and the skill level of the hunters themselves. Ungulates can be shot opportunistically by hunters walking or driving along a road, but such hunting is not likely to adequately reduce numbers. Deer and pig camouflaged by dense foliage or in inaccessible areas can be difficult for hunters to locate and kill with a single shot. Ground hunting alone will not achieve meaningful control of ungulate unless there is a sustained effort. Without heavy hunting pressure, the number of animals removed will not out number births. Hunters on Guam have taken deer and pigs for sport and subsistence since the 1700s, yet numbers of these species remain high and continue to increase, even while bag limits have increased. This finding is consistent with preliminary results of the effectiveness of sport hunting (which is primarily low intensity ground hunting) in reducing feral pig numbers in California, Hawai'i, and New Zealand (Barrett and Stone 1983, Clarke 1988, Schuyler *et al*. 2002). Schuyler *et al*. (2002) reported that after three years of pig hunting on Santa Catalina Island, California, there was no significant long-term decline in pig abundances there. The program was modified and control efforts increased. Along with trapping, pigs were eradicated from a small portion of the island by intensive hunting over 18 months.

In response to the loss of native species on Santiago Island (Galapagos), a pig eradication program was initiated in 1974 (Loope *et al*. 1988, Steadman 1986). Hunting was sporadic between 1974 and 1985 with very little impact on the feral pig numbers although more than 18,000 pigs were removed. However, with increased hunting efforts coupled with a pig-baiting program, eradication was finally achieved. However, this took almost thirty years of effort due to the fact that hunting pressure was not high enough initially to achieve population control.

For feral pigs, it is estimated that at least 60-70% of the population must be removed annually before population growth is slowed or halted (B. Higginbotham, Texas A&M University AgriLife Extension Service wildlife biologist, cited in TSCRA 2011). It is very important to note that this 60-70% removal rate will only slow or halt population growth – it will not reduce the number of animals due to replacement of removed adults by young produced each year. Therefore, an even higher rate of removal will be needed to reduce feral pig numbers on DoD Overlay Refuge lands. Prior to commencing any control work, an estimate of ungulate numbers within the management units will be made. Most feral ungulate control programs utilize ground hunting in combination with other efforts, which are described in the various sections below.

6.4 Hunting Dogs

The use of tracking dogs is a cost-effective method to locate ungulates present in steep terrain and dense vegetation. Dogs are often brought in to find the remaining animals and thus are utilized primarily in low-density scenarios. Most managers agree that finding the last remaining individuals of a population takes as much effort as it takes to get to that point (or more), because capture success declines considerably as animal numbers decrease (Parkes *et al* 2010). Kessler (2002) reported the use of dogs during control efforts to eradicate goats and pigs on Sarigan. Dogs were able to locate and corral on average two, and sometimes up to four, animals per day before the dogs were too fatigued to be effective.

Dogs were used to locate small numbers of goats in remote areas of Hawaii Volcanoes and Channel

Islands National Parks (National Park Service 2004). Pig hunting with dogs proved the most successful option in Volcanoes National Park where after six months of hunting, 150 of an estimated population of 175 pigs were taken by hunters with dogs (Katahira *et al*. 1993). Following aerial hunting on Sarigan Island, dogs were brought in to locate and chase feral pigs to natural barriers where hunters could eliminate them (Kessler 2002). Dogs were also an important component of eradication efforts on Santa Cruz Island (Parkes *et al* 2010), Santa Catalina Island, California (Schuyler *et al*. 2002) and Santiago Island, Galapagos (Cruz *et al*. 2005). Dogs are effective at locating individuals that evade detection by hunters alone. Trained dogs will also corner animals not simply pursue them.

The safety of the dog and non-target species must be considered. Other considerations such as adequate rest time for the dogs, weather conditions for successful tracking, and the use of dogs after dark need to be addressed. Strong handler skills are essential to decrease the risk of dogs becoming separated from their hunting group and potentially forming feral dog packs. In addition, hunting dogs may interact with feral dogs, leading to possible injury or disease transmission.

It is assumed that dogs would be a part of any professional hunting effort that takes place on Guam, at least in the later stages of the control project, and that the cost for the hunting dogs would be included in the contract for the professional hunters, who would supply and care for the dogs, if they choose to use them.

6.5 Snares

Snares are particularly effective in catching pigs and deer. For example, adult and juvenile feral pigs were removed from a remote area of Hawaii by snares (Anderson and Stone 1993). Snares set between 2 – 8 inches from the ground caught 228 pigs in almost 4 years. Total eradication of pigs in Haleakala National Park was achieved via a variety of methods including snaring (Van Driesche and Van Driesche 2004). On Sarigan, a locally fashioned snare had limited success but was a low cost method of capturing pigs (Kessler 2002).

Snares can be more effective than hunting to catch remaining animals in heavily vegetated, rugged terrain. In fact, snares are often used to capture wary individuals that have evaded other methods (Littauer, 1997, Buddenhagen *et al*. 2006, Katahira *et al*. 1993) and are particularly useful in fenced areas. However, understanding home ranges and dispersal paths is an important factor in determining the placement of snares, particularly if the goal is to catch specific individuals (Anderson and Stone 1993).

There are a number of commercially available and hand made snares used for ungulate control. Cable neck snares are made of steel cable, looped and fastened to a secured or heavy object along a narrow path or small pass-through. The animal is caught by the neck as it passes. Rope leg snares provide an alternative to cable snares and work by trapping the animal’s limb in a loop of rope. They may be considered by some to be more humane than cable snares provided they are constantly or frequently monitored. Although the actual cost of snares is low ($12 - $20 per snare) the cost of maintenance and monitoring needs to be considered. Anywhere from 20 to 200 snares can be set and monitored in a day but number and placement is dependent on personnel, travel time, suitable placement sites, terrain and setting time. Fitting a snare with a radio transmitter can increase the cost of snaring considerably (Halstead *et al*. 1996).

Snares are very effective, but have been criticized as inhumane if they are not checked frequently. Further, there is a heightened risk of injury if snares are set on sloping ground that could cause the animal to slip or lose its footing. Alarms or telemetry devices have been used to alert personnel when a snare has been tripped, leading to a quicker reaction time and less chance for injury (Marks 1996). However, reducing response times may be logistically impractical in isolated areas and cost can be prohibitive. Conversely, the effectiveness of snares can be greatly reduced by frequent checks because of the human scent left behind (Hawaii Conservation Alliance 2005). Non-target animals are also susceptible to snares since snares are not species specific. However, as there are no non-target native ground dwelling mammals within the control areas, this risk would be minimal in DoD lands.

6.6 Aerial Hunting

Aerial hunting – hunting from helicopters or planes - has been effective at reducing ungulate numbers, particularly in remote or inaccessible areas. Nearly 80 percent of the 5,036 pigs on Santa Cruz Island were dispatched from a helicopter over a 15-month period, at a cost of $3,900,000 (Morrison 2007). The remaining pigs were removed from Santa Cruz Island through trapping and ground hunting with the use of trained dogs and "Judas pigs" equipped with GPS locators (Parkes 2010). Helicopters were also used on Santa Catalina Island in conjunction with baiting to eradicate pigs (Schuyler *et al*. 2002) where foraging pigs investigating bait stations after dark were shot from the air.

Aerial hunting has the advantage of not leaving human scent to which ungulates can cue, or requiring disturbance or destruction of vegetation and soils for construction of roads or trails. Like all control methods, aerial hunting has its own limitations. The method is particularly expensive on Guam where helicopter charter can exceed $1200/hr, often with a minimum of fours hours per charter. This cost could be reduced if aerial hunting were to occur as part of a military training exercise. The combination of training exercises with natural resources management has been successfully achieved at the Marine Corps Base Hawaii (Drigot 2008).

Rough terrain, poor weather, flight in restricted airspace over military facilities, noise issues, and the inherent dangers of low-altitude flight are all factors that limit its use. Since the shooter is some distance away from the target and the noise of an aircraft can often frighten the target animal(s), there is a higher risk of non-fatal strike and ricochet than shooting from the ground (Kessler 2002). Further, aerial hunting in areas covered by thick canopy is unreliable because the target animal can disappear from sight under the canopy. On Sarigan, aerial hunting was used as the initial step in a pig and goat eradication program (Kessler 2002). However, this method was discontinued because thick forest canopy prohibited effective hunting (Kessler 2002). Although aerial hunting may be useful in limited areas of NMS and AAFB, it cannot be used at NCTS because of the proximity to humans and infrastructure. Because of these factors aerial hunting could only be utilized in select areas on DoD properties. However, its use should not be completely discounted without careful consideration of the various options available for use of DoD supplied helicopters and pilots.

6.7 Toxic and Non-toxic Baits

Although toxic baits (e.g., sodium fluoroacetate (1080), yellow phosphorus, warfarin) are routinely used around the world and have been found to be the most cost-effective technique for feral pig control (Choquenot *et al*. 1996), no toxicants are currently registered for use on ungulates in the United States. Therefore, the technique cannot be considered for ungulate control in Guam. However, it should be noted that the USDA-APHIS-Wildlife Services has been conducting trials for a pig toxicant (sodium nitrite) and developing a delivery system that minimizes non-target exposure that could be registered in a few years (Katie Swift, USFWS, personal communication). It would be useful to check on the progress of this registration during later phases of the ungulate control program, as it could be very useful in areas that are not practical for hunting or snaring.

The use of non-toxic baits to encourage ungulates into traps has been discussed previously (see

Section 6.2). On Sarigan, shooting over bait at night was effective when pig concentrations were high and naive to humans (Kessler 2002).

6.8 Fertility Control

Immunocontraception is a method of fertility control that prevents reproduction by stimulating the immune system (Walter *et al*. 2002). It has been used primarily in zoos since 1992 (Frank *et al*. 2005) but also in situations where lethal removal is not a viable option (Kirkpatrick *et al*. 1997). Porcine zona pellucida (PZP) immunocontraception has been used on more than 110 species including bears, zebra, primates, and ungulates (Kirkpatrick *et al*. 1995, 1996; Frisbie and Kirkpatrick 1998; Frank and Kirkpatrick 2002; Deigert *et al*. 2003). Ungulates form the largest single taxon group and have provided the largest body of information regarding effectiveness and safety of PZP treatment (Kirkpatrick *et al*. 1996, Frank and Kirkpatrick 2002, Deigert *et al*. 2003).

Immunocontraception entails injecting females with PZP using darts fired from cartridge-capture rifles. The application of PZP requires two initial inoculations and a single annual booster. The first booster is administered approximately three weeks following the first exposure to the vaccine, and followed by re-inoculations every 12 months for the reproductive life of the individual. The combination of inoculations is designed to maintain contraceptive antibody titers and infertility. The method has been effective (≥ 90 percent) in primarily captive animals including wild horses (Rutberg *et al*. 2004), deer (Turner and Kirkpatrick 2002) and other ungulates (Deigert *et al*. 2003). Kirkpatrick (1996) tested 45 animals, primarily deer, with mixed results. Formosan sika deer (n=10), Himalayan tahr (n=4), and Roosevelt elk (n=8) were successfully treated, axis deer (n=6) treatment was moderately successful and PZP was ineffective for sambar deer (n=15). Horses are seasonally reproductive, with distinct breeding periods, and this has a bearing on the contraceptive effectiveness (Frank *et al*. 2005). Animals with less seasonal breeding patterns need more frequent booster inoculations (Frank *et al*. 2005). This would be the case on Guam where pigs and deer breed year round.

Immunocontraception is most useful in reducing fertility in captive animals, however it is not practical to reduce large numbers of free roaming wild deer or pigs. Drugs must be administered repeatedly to the same individual animals at regular intervals by injection. Darting has been the preferred way to deliver injections however getting close enough to dart becomes more difficult as animals learn to avoid the darters. Without repeated inoculation, reproduction is not suppressed.

Table 5: Summary list of control techniques

Technique	Advantages	Disadvantages
Aerial hunting	• Effective along steep, rugged and inaccessible terrain • Does not leave human scent • Does not require paths or roads • Only target animals are taken • Results are immediate • Rapid removal of many animals	• Undertaken by professional hunters only • Canopy cover limits effectiveness • High risk • Helicopter time is expensive • Weather conditions affect scheduling
Ground hunting	• Capable of removing enough individuals to be effective • Cost per animal is relatively low • Effective in accessible areas • Can be undertaken by VCOs and professional hunters • Only target animals are taken • Results are immediate • Rapid removal of many animals	• Less effective along steep, rugged and inaccessible terrain, and in dense vegetation • Safety issues • Leaves human scent • Requires paths or roads
Recreational hunters	• Cost per animal is low • Provides public access to game resources • Good Public Relations	• By itself, fails to remove enough of a population to be effective control • Effectiveness low where densities are low and access is limited • Safety issues • Presence of amateur hunters makes animals wary of humans and therefore makes it harder for professional hunters to control populations. • Focus on trophy animals • Resistance to reducing ungulate populations to a lower level • Possible poaching or take of non-target species • Leaves human scent
Ungulate Control Specialists	• Capable of removing enough of a population to be effective • Cost Effective • Intensity and duration of hunting can be dictated by the control program	• May cause friction with recreational hunters • Limited safety issues • Leaves human scent

Technique	Advantages	Disadvantages
Hunting with dogs	• Capable of removing enough of a population to be effective • Cost Effective • Intensity and duration of hunting can be dictated by the control program • Effective for animals that have evaded other methods • Dogs increase efficiency of hunters	• Well trained dogs are expensive and may be hard to obtain • Dogs may be injured or killed by target animals or firearms • Should only be utilized by professional hunters • Inadequately trained dogs may take non-target animals • Some concerns regarding humaneness of method • Animal take per day is low compared with some other methods • In unfenced areas, may drive animals into sensitive natural areas • May cause friction with recreational hunters
Live trapping (including corrals)	• Multiple animals can be taken at once • May catch animals that avoid other methods of control • Non target animals captured can be released unharmed • Allows potential to relocate animals to other areas	• Requires road or helicopter access • Traps are heavy and require multiple personnel to operate • Less effective when food is plentiful (bait is less attractive) • Considerable time needed to find attractive bait or condition animals to take bait • Non- target animals may become trapped • Trap shyness may preclude some individuals from capture • Must be checked regularly to reset and add bait • Some concerns regarding humaneness of method
Snares	• Effective for pigs and goats • Relatively inexpensive • May catch animals that avoid other methods • Effective at low densities • Can catch animals breaching fence	• Low public acceptance • Potential harm if snared too long • Non-target animals may become snared • Snares can't be used with hunting dogs • May be less humane than other methods
Lethal baits	• Very effective • Cost effective • Modest labor requirements • Can be aerially distributed in remote areas	• Not licensed for use in Guam.

Technique	Advantages	Disadvantages
Non-toxic Baits	• Can be species specific • Complements other methods such as trapping • May catch animals that avoid other methods • Cost effective • Can take advantage of nocturnal feeding habits	• If used with hunting, can be time consuming • May not be as attractive to volunteers as active hunting • Bait may provide a food source for other pest species such as rats • Some seed bait may germinate and establish • May attract non-target species
Fencing	• Highly effective at blocking/enclosing animals • Precludes need for continuous, labor-intensive control • Deters illegal trespass • Cost-effective if maintained • Can create a barrier against which to hunt • May be fitted with one-way gates to allow animals to exit	• Disruption of movement patterns may increase damage to adjacent areas and have negative effects on non-target animals • Expensive to build and maintain • Guam conditions decrease the longevity of most fences • Currently not typhoon proof • Can be breached by poachers, particularly in remote areas
Radio-telemetry (Judas animal)	• May be used for pigs • Effective at finding evasive herds • Aerial telemetry can be used to locate herds in remote areas • Can be used in conjunction with live trapping	• Efficacy for deer unknown • Animal must be captured and sedated • Telemetry equipment is costly • Transmitter collars can cause irritation and injury to the animal
Fertility Control	• Can be used where lethal removal not an option • Effective on pig and deer • Can be administered by dart gun • Considered humane • Up to two successful inoculations per day	• Cannot remove all ungulates • Requires two initial inoculations and an annual booster • Logistical issues associated with maintaining frozen vaccine • Must be hand-delivered to Guam • Successful use requires individual identification of females • Not all individuals are easy to locate • Relatively expensive • Treatment must continue long term • Damage to the environment will continue while control occurs

Technique	Advantages	Disadvantages
Translocation	• May be more palatable to the public •	• Cannot remove all ungulates • Requires use of tranquilizers, which are restricted substances needing a prescription • Veterinarian must mix drugs • Can cause undue stress to animal • Some safety concerns for personnel and animal • Labor intensive • Treatment administered in accessible areas only • Darted animal may flee

7 Implementation

AAFB Natural Resource Specialists will manage the programs for fencing, control, and monitoring fulfilling the duties of the 'Wildlife Management Specialist' in the ISR/Strike Biological Opinion (USFWS 2006).

7.1 Community Outreach and Education

Recreational hunting is an important part of life for many people on Guam. Control of deer and pig may be misunderstood by people who do not agree that ungulates cause damage to native vegetation. Knowledge levels regarding invasive species and the harm they can cause are relatively low among the general public (Conover 2002).

AAFB natural resources staff will work with the Public Affairs Officer to respond to questions, queries, and requests for information on why ungulate control is needed, what measures are currently being implemented to control ungulate populations, and the long-term goal for control on AAFB land. Public awareness regarding an ungulate reduction program should be promoted whenever possible. AAFB personnel will work with community leaders in an effort to maintain communication avenues and resolve issues should they arise.

7.2 Ungulate Management Areas

This plan divides AAFB into 12 ungulate management areas (UMAs) to refine control actions (Figure 16). Boundaries of the UMAs will make use of cliff lines and existing fences that restrict ungulate movements. Temporary fences may be added to augment the permanent structures. The UMAs are intended to help facilitate control and may be adapted as needs change.

Three of the areas will have permanent fencing: Habitat Management Unit (HMU) (135 acres), Area 50 (59 acres), and Ritidian Point (306 acres). The eight unfenced UMAs are: Tarague (from below the cliff line, west of the CATM range and Pati Point Natural Area), Pati Point Natural Area (including the CATM range), Golf course, Main base, Munitions storage area (MSA), Northwest field, Northwest field north, Northwest field south, and RHS quarry (AAFB lands west of Rte 3A, adjacent to Navy Base Guam Telecommunications Site).

Temporary fences will be used to define UMA boundaries, as needed, and to create smaller areas within the UMAs. Temporary fences may be constructed from a variety of fencing materials including high-tensile electric fencing and polypropylene deer mesh (Figure 14). The location of temporary fences will be determined by the timing and need for control actions in each UMA. Temporary fences will be erected and removed as needed.

Within permanent fenced UMAs, the goal is complete removal of deer and pigs as per legal requirements. The fenced UMAs will continue to be monitored for ungulate sign to document ungulate absence. If ungulate presence is observed, control will resume until eradication is confirmed. In unfenced ungulate management areas, removal of deer and pigs will continue indefinitely to maintain numbers at levels that allow for recovery of the vegetation communities. These maintenance levels will be determined by ongoing ungulate density surveys and by monitoring vegetation response to reduced ungulate pressure.

Actions in the MSA and NW Field South UMA will be coordinated to occur at the same time as any closure of the MSA also effects NW Field South. RHS quarry UMA will be coordinated with control on

NBG Telecommunications Site as these two areas are contiguous. The force protection fence at NW Field isolates UMA at RHS quarry from the NW field and main base.

The perimeter Force Protection fence at NW Field and chain link fencing along the south-eastern boundary act as barriers to ungulate dispersal and immigration. Construction of additional perimeter fencing would aid in retaining low density on AAFB although it is beyond the scope of the Natural Resources Program at this time.

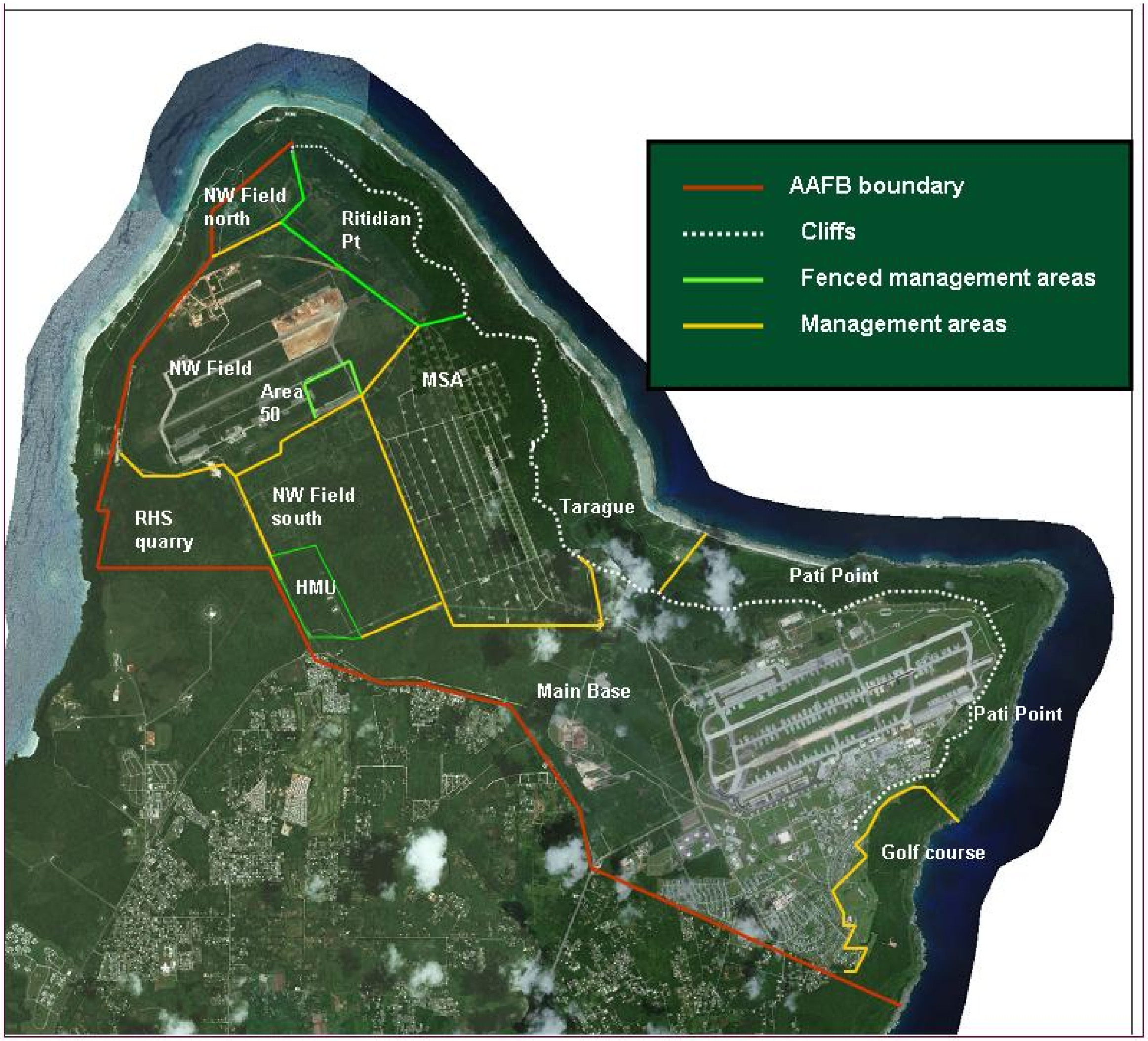

Figure 17: Ungulate Management Areas

7.3 Ritidian Fence

Ritidian Point UMA will have 1.5 miles of fencing erected along the existing dirt road and through limestone forest out to cliff edges (Figure 18). Any areas of cliff edge where ungulates could potentially enter the management area will be blocked with welded wire livestock panels. Vegetation will be cleared on each side of the fence a distance of five feet.

The fence line will be constructed with 16 foot x 42 inch galvanized livestock panels secured to nine (9) ft t-posts. Polypropylene deer mesh will overlap with the welded panels by two feet and extend 3.5 feet above the panels (Figure 16). The fence will be seven feet in height.

Each galvanized panel will overlap with the adjacent panels by two squares, approximately 16 inches on each side (32 inch overlap per panel) with an effective length for each panel of 13.3 feet. Panels will be clipped together with 9 gauge hog rings. The fence material will be supported by steel fence T-posts placed no more than 6-8 feet apart throughout the fence line. At least three to five (3-5) pieces of smooth wire (10 inches long) will be used to anchor the panels to the posts. T-posts will be pounded into the ground to a depth of one (1) foot.

Hogwire skirting will be used in the karst areas (Figure 14), overlapping the welded wire panels one foot and secured to the fence with hog rings. Hogwire skirting cut to fit to the landscape of the karst substrate with galvanized steel pins or dead-man posts used to anchor down the skirting.

All metal used in construction of fence will be galvanized or stainless steel. Brace wire will be 9 gauge and hog rings, fence clips, and/or U-nails (used to secure fence to the posts) are to be 11 gauge. All wire ends will be wrapped or cut flush to reduce the hazard of impalement.

Two (2) welded steel vehicle gates will be set at ground level with the minimal gap possible to prevent pigs from passing under the gate. Support posts on either side of the gate will be four inch (4) diameter galvanized schedule-40 pipe posts set in the ground to a depth of three ft (3). Three (3) welded steel walking gates will be covered with livestock panel secured with hog rings. The gate will be inserted into a livestock panel so that there is no gap at the bottom for pigs to enter.

Figure 18: Location of proposed Ritidian ungulate exclosure fence


Figure 19: Vertical cliffs above Tarague basin, looking north and south from Pajon Point

7.4 Monitoring to determine levels of ungulate population control

Monitoring programs for ungulates and vegetation will be used to determine the amount of effort needed for control, the effectiveness of control actions, and the need to continue efforts in each UMA. Survey transects will be established and baseline counts will be made prior to start of control actions. Surveys will be conducted at least once annually to monitor ungulate density and impacts to vegetation.

7.4.1 Monitoring ungulate density

DISTANCE SAMPLING is a widely used program designed to provide an accurate and effective estimate of animal densities from visual sightings (http://www.ruwpa.st-and.ac.uk/distance/). Visual surveys are made from a road or transect, a range finder is used to determine the distance to any ungulates observed. Once transects have been established, surveys are repeated to achieve statistical accuracy. The program calculates density based on parameters of the transects and sightings.

Measuring density does not take into account movement, (e.g., dispersal and emigration), and the rate of births and deaths. Repeated density surveys over time will help to evaluate these factors however studies using radio telemetry will provide more accurate information. Conducting movement studies are an agreed mitigation under the 2006 ISR/Strike Biological Opinion. AAFB natural resources staff will capture and fit 20 deer with radio transmitters to track dispersal and movement patterns. The goal will be to follow half females and half males from different UMAs for a period of up to six months per animal.

Abundance of pigs will be assessed in transect surveys following the methods of Anderson and Stone (1994). The frequency of digging, wallows, scat, tracks, trails, and other sign are recorded in three age classes: fresh, intermediate, and old. Pig activity will be monitored on transects in each UMA.

7.4.2 Vegetation monitoring

To determine the effects of ungulate control on forest health, surveys of vegetation structure and community composition will be conducted prior to the start of ungulate control. Within each ungulate management area, permanent photo-points and vegetation transects will be established. These sites will be revisited over time to measure changes in response to ungulate control (Hall 2001; Lucey and Barraclough 2001). Photo-points and transects will be positioned so that major vegetation types within each UMA are represented. The number of transect points in each area will be sufficient for statistical analysis.

Photo-points and transects will be revisited at least twice annually for the first three to five years of the ungulate control program. Changes in vegetation structure and community composition can be compared between the unfenced and fenced areas to determine if ungulate control efforts are sufficient in the unfenced areas. As changes to the vegetation community begin to slow (for example as forest canopies close), surveys can be conducted with less frequency.

The level of control in non-fenced UMAs will gauged by the response of the vegetation communities as AAFB does not have a complete perimeter fence and immigration from off-base will continue. Recovery of native vegetation should be used as an index to determine if the level of ungulate control is sufficient. This can be easily observed over time by photo points, through studies of vegetation community structure, species composition, presence of new growth, levels of damage to plants from rooting, scraping, and browsing, and presence or absence of a well defined browse line. If browsing and rooting behavior continues to limit vegetation recovery after initiation of ungulate control techniques, then efforts will be increased. These areas can be identified during control activities and prioritized for additional management activities, including fencing, ungulate eradication, and restoration activities.

7.5 Ungulate control

Ungulate control l techniques will consist of ground shooting, live trapping, snaring, and baiting as appropriate. Hunting dogs, radio telemetry, and other methods will be used as needed. Control actions will be conducted to fulfill the agreed mitigation requirements to remove all ungulates from fenced management areas and to reduce the number of ungulates in non-fenced areas to levels that allow for forest regeneration and self-sustaining populations of native animals. Operational actions of AAFB preclude recreational hunting occurring in UMAs during control.

Given the amount of over-browsing that is currently observed on AAFB, a standard response would be to reduce deer densities to 10% of the existing number and reduce pigs to at least 20% of the current number present. For example, using the 2000 data from the MSA (Knudson and Vogt 2002) the goal would be to reduce deer densities from 1.83/ha to 0.18/ha, and pigs from 0.38/ha to at least 0.7/ha. Ongoing density estimates will guide the level of control. Once low numbers are reached, population growth from reproduction will be slowed and maintained at low levels to facilitate recovery of native vegetation.

Control will be conducted by one or more professional ungulate population control companies who will be contracted specifically for this work. The ungulate control specialist is a full time employee of a fully insured business entity, non-profit group, or government agency engaged in wildlife management activities that include trapping, snaring, tracking with dogs, immobilization, use of Judas animals and radio telemetry, and lethal removal through hunting. The contractor will have a proven track record of reducing ungulate numbers to the desired level in previous projects undertaken. The ungulate control specialists must possess all necessary licenses for firearms possession and use, firearms safety training, permits, and base access documentation. The contractor must be able to demonstrate ability to ensure humane and effective wildlife removal as outlined in recommendations of the American Veterinary Medical Association for humane treatment of animals (AVMA 2007). Ungulate control specialists will have working knowledge and experience using ungulate control methods other than hunting. The contractor will be responsible for ensuring their employees meet the requirements listed above.

Within fenced areas complete removal of deer and pigs within the shortest time frame possible is the goal. After ungulates have been removed, these areas can be used as controls to determine vegetation recovery rates and to compare with vegetation recovery in the unfenced areas.

The timing of control actions within the RHS quarry UMA will be coordinated with Navy Base Guam natural resources staff to occur simultaneously with control actions at Navy Base Guam Telecommunications Site as these areas are contiguous and not fenced.

7.6 Final Disposition and Use of By-Products

When possible, demographic information (sex, age, condition) will be collected on all animals taken during control efforts for use in statistical analysis. Carcass disposal or distribution will be determined by installation commanders. Deer carcasses may be donated to charity or to the Government of Guam (Gov Guam) for distribution to village mayors providing that possible health risks and liability issues are addressed. Carcasses in remote locations will be left to recycle nutrients into the ecosystem. According to the U.S. Department of Agriculture, Food Safety Inspection Service, non-native deer are not covered by mandatory inspection and their meat may be donated if deemed acceptable by local and/or territorial governing officials (see Appendix A). Under current USDA regulations, pig meat cannot be donated due to lack of inspection facilities or an exemption from the Secretary of Agriculture (see Appendix A).

7.7 Humane Treatment of Animals

All actions which involve direct management of individual animals, ranging from ground surveillance to live capture and lethal removal, will be conducted in a manner which minimizes stress, pain, and suffering to every extent possible. All control methods must be conducted by experienced professional hunters specifically trained in deer and pig management. In addition to other federal contracting requirements, for the purposes of this plan, a contractor is a fully-insured business entity, non-profit group, or government agency engaged in wildlife management activities that include trapping, snaring, immobilization and lethal removal through hunting. The contractor (and hunters employed by the contractor) must possess all necessary licenses for firearms possession and use, firearms safety training, permits, and base access documentation. If necessary, contractors would be accompanied by base security personnel. Skilled hunters can deliver a lethal first shot to target animals and would be required to demonstrate their ability to ensure humane and effective wildlife removal as outlined in the recommendations of the American Veterinary Medical Association for humane treatment of animals (AVMA 2007). The contractor will be responsible for ensuring its employees meet the requirements listed above. As such, every effort would be made to minimize the degree of human contact during all procedures that require handling of feral ungulates. In addition, an attempt would be made, in all pertinent alternatives (B, C, D, and E) to “reduce pain and distress to the greatest extent possible during the taking of an animal’s life” (AVMA 2007).

7.8 Schedule

	Management Areas	**Start Date**	
Fence construction	HMU	FY09	Completed FY12
	Ritidian	FY13	Complete FY13
Evaluate Cliff-edge	Ritidian fence	FY13-14	Install additional fencing if needed FY14
Pre-control surveys: deer density, pig sign, vegetation, photo points	Tarague UMA, Golf course, HMU	FY13	
	Ritidian Point,	FY14	
	MSA, NW Field S	FY14	
	NW Field, NW Field N, Main Base	FY14	
	Pati Point	FY14	
	RHS quarry	FY14	
Control	Tarague UMA, Golf course, HMU	FY13	
	Ritidian Point	FY14	
	MSA, NW Field S.	FY14/15	
	NW Field, NW Field N, Main Base	FY14/15	
	Pati Point	FY14/15	
	RHS quarry	FY14/15	
Ungulate Movement Studies	To be determined	FY14/15	Radio collar 20 deer

7.9 Costs

Assuming 100 percent of the Overlay Refuge (11,589 acres) is ungulate habitat, a ten year ungulate control program using professional hunters could cost between $ $347,670 and $579,450 per year. The total cost would be within the range of $3,476,700 to $5,794,500 over a ten-year period, using this estimate. Costs may be reduced by decreasing the initial population of species rapidly, employing salaried rather than contracted personnel and utilizing other methods in concert with hunting (e.g. Parkes *et al* 2010).

Another way to estimate the costs of professional hunters is to assume that two to three professional hunters would be employed fulltime to reduce ungulate densities to the desired levels. It is estimated it would cost approximately $120,000 per hunter per year (this includes salary, plus other expenses like insurance, overhead, etc.) for a total of $240,000 - $360,000 per year to hire the hunters. In addition to the cost of the hunters, it is estimated that approximately $100,000 in start up costs would be used in the first year to purchase equipment, conduct training, and obtain other necessary supplies, permits, and miscellaneous expenses as needed to run the program. After the first year, it is estimated that equipment and supplies would cost $50,000 per year.

Total costs for five years of a professional hunting program would range from approximately $1,500,000 to $2,100,000.

Areas where all ungulates are removed (fenced areas as required by mitigation plans for AAFB projects) would have lower costs, as control efforts would be greatly reduced (to checking fences, repairing damages, and making sure no ungulates have entered the exclosures. Total long-term financial outlay of the program could be significantly reduced if the Overlay Refuge units were fenced and ungulate eradication within the fenced areas became the goal. Additional monies would be needed to install, monitor and repair fence lines. However these fences could also serve security purposes and reduce illegal access to the DOD properties, if placed along property lines. The existing Force Protection Fence covers approximately 3 miles from Potts junction to the Main gate. Additional fencing would be needed to fence to the Wildlife Refuge boundary along Route 3a, on the western side of the installation, and from the end of the existing fence eastward along the boundary of AAFB and the Anao Conservation Area.

Table 6 presents the cost data in an easy to compare table format with the annual cost breakdown for the first year, second and third year, and next 7 years, as well as the totals for a 10-year program. Minimum and maximum costs for each item are based on the assumptions as described above. For the Sarigan-based cost estimate of professional hunters, the costs are the same each year.

For the professional hunter cost estimate scenario based on the cost of $120,000 per hunter per year, the minimum cost for year one is for 2 hunters plus $100,000 startup costs. The maximum cost is based on 3 hunters plus startup costs. Costs for year two through three are based on 3 hunters plus $50,000 in equipment costs per year (minimum cost), or 3 hunters plus equipment cost (maximum costs). Costs for years 7-10 are based on 2 hunters plus $50,000 in equipment costs per year.

Table 6: Estimated annual costs, under two cost estimation scenarios.

Activity		First Year	Years 2-3	Years 4-5	Total cost 5 year program	Years 6-10	Total cost 10 year program
Based on Sarigan estimates	Min	347K	347K	347K	1.738M	347K	3.476M
	Max	579K	579K	579K	2.897M	579K	5.794M
Based on $120k per hunter per year estimate plus $100k for startup	Min	340K	290K	290K	1.500M	290K	2.95M
	Max	460K	410K	290K	1.8M	290K	3.31M

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Appendix A

Letter from U.S. Department of Agriculture, Food Safety Inspection Service to NAVFACMAR

United States Department of Agriculture

Food Safety and Inspection Service

Denver District Office of Field Operations
Denver Federal Center, Building 45
PO Box 25387
Denver, Colorado 80225-0387
Telephone: (303) 236-9800
Fax: (303) 236-9794

March 14, 2007

Ms. Ann Brooke
Natural Resource Specialist
US Naval Base
Guam, 96915

Dear Ms Brooke:

On March 7, 2007, the Denver District Office received your letter inquiring about regulations regarding the control and slaughter of animals on the Naval Lands of Guam.

In your letter you have listed three types of species, non-native deer, feral water buffalo and feral pigs. By virtue of the *Federal Meat Inspection Act (FMIA)* the non-native deer and water buffalo are not covered by mandatory inspection. These animals can be slaughtered and used, if acceptable to the local and/or territorial governing officials.

Another option is under 9 CFR 352.2, exotic animals can be slaughtered for meat and meat food products under voluntary inspection. Voluntary Inspection, an inspection and certification service for wholesomeness relating to the slaughter and processing of exotic animals and the processing of exotic animal products. All provisions of this part shall apply to the slaughter of exotic animals, and the preparation, labeling, and certification of the exotic animal meat and exotic animal products processed under this exotic animal inspection service that would include the deer and water buffalo.

Feral pigs on the other hand, would require mandatory inspection if they are going to be sold or donated. In any territory not organized with a legislative body solely for the distribution with such Territory when the secretary determines that it is impractical to provide such inspection within the limits of funds appropriate for administration of this Act and that such exemption will otherwise facilitate enforcement of this Act, again if this is acceptable to the local and/or territorial governing officials.

If the feral pigs are obtained by an individual themselves, the individual could, under section 23 of the *FMIA* and 9 CFR 303.1(a) (b) (c) slaughter these animals for the exclusive use in the household of such owner, by him, members of his household and his non-paying guests and employees, if the animal was presented for slaughter or processing. This would require a facility that meets current Federal standards for the production of meat or meat products for human consumption.

For more information, you can access the USDA Website at http://www.usda.fsis.gov or you can contact the Denver District Office at (303) 236-9800.

Sincerely,

Edward Carr
Acting District Manager
Denver District

cc: E. Carr, Acting DM
J. Adams, DDM
R. Nelson, DDM
A. Gallegos, DDICS
C. Southard, DDDA
G. Merritt, EIAO