4. FERAL UNGULATE SPECIES IMPACTS ON NAVY LANDS

Nonnative ungulates compete with native species for limited resources, alter and destroy habitats, transmit diseases, and cause millions of dollars worth of damage to infrastructure per year (Courchamp et al. 2003). Feral pigs are considered to be one of the 100 worst invasive species on a global scale (IUCN 2000) and can be a problem in their native range when densities increase due to loss of predators or presence of abundant food sources such as agricultural areas (Ickes 2001, Goulding and Roper 2002).

Recommendations have been made to reduce deer densities drastically through continuous harvest over large areas and eradicate them from sites of significant ecological value within the Mariana 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 numbers to the levels required to reverse current environmental damage and degradation. Significant reduction in numbers of feral ungulates on DOD lands is required as part of mitigation efforts for several DOD projects (see **Section 1.1.1**). 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.

4.1 Impacts on Terrestrial Habitats

In addition to rooting in soil for earthworms, rhizomes, and tubers, grazing by feral pigs, deer, and carabao 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 nonnative trees and remain more susceptible to grazing than faster growing nonnative species (Schreiner 1997, Perry and Morton 1999, Ritter and Naugle 1999).

Trampling by ungulates causes soil compaction that can deplete the soil of needed oxygen (Van Driesche and Van Driesche 2004). Tree rubbing removes bark and can eventually kill the plant. **Figure 4-1** provides examples of wallows and tree rubbing damage seen on NBG TS. Eventually, overgrazing, rooting, trampling, tree rubbing and establishment of wallows can denude areas and cause extensive soil erosion (Tep and Gaines 2003, Liddle et al. 2006). Pig rooting in mowed grassy areas along road sides and on bunkers in the NBG NMS removes vegetation cover which leads to soil erosion especially in areas that are steep and prone to high volumes of sheet runoff during heavy rain events. Carabao hooves shred grass cover on bunkers also causing soil erosion and preventing re-growth of grass. Pigs, deer and carabao prevent forest understory growth by eating seeds and seedlings and by rooting and trampling the ground. In wet areas especially near stream edges and along the Fena Reservoir, ungulate hooves continuously churn up the soil allowing for erosion and trample vegetation preventing plant growth. **Figures 4-2** and **4-3** show damage at NBG NMS. **Figure 4-4** shows carabao inside the bunker fence at NBG NMS.

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

Figure 4-1. Examples of Ungulate Damage on NBG TS

Figure 4-2. Pig Damage at NBG NMS with Pig in the Background

Figure 4-3. Pig Damage at NBG NMS

Figure 4-4. Carabao Inside the Bunker Fence at NBG NMS

4.2 Impacts on 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 people, 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 million per year.

Sedimentation is one of the primary threats to Guam's coral reefs. Sedimentation of the marine environment on Guam can be extreme following heavy rain events (**Figure 4-5**). Talafofo Bay is at the downstream end of the Fena Watershed, so erosion on the NBG NMS can directly affect the Bay and off shore habitats. 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 (Minton 2005). Ungulates such as 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 more than 60 times higher than in Guam's forests (NRCS 2001).

Sediment in runoff can smother coral on Guam's fringing reefs (Richmond 1993). Sediment that remains within the water column (suspended sediment), can reduce light penetration (Rogers 1990), reduce growth (Rogers 1990), and result in direct mortality of coral larval (Richmond 1997). Depending on oceanographic conditions, suspended sediments can settle on the bottom and bury coral and other substratum, potentially resulting in recruitment failure (Hodgson 1990, Gilmour 1999, Minton and Lundgren 2006, Minton et al. 2007). Sediment from runoff can also block gills; filter feeder apparatus; and smother sedentary aquatic plants, animals, and their eggs.

Source: A. Brooke, NAVFACMAR

Figure 4-5. Photos Showing Talofofo Bay Before Rain (top) and After a Heavy Rain (bottom)

The amount of marine habitat sedimentation caused as a direct result of ungulate-caused erosion on Navy lands is not known. However, coastal reefs to the south and west of NBG NMS (e.g., at the terminus of the stream(s) draining the watersheds of NBG NMS) are particularly affected by sedimentation.

4.3 Human Health and Safety Impacts

Feral pigs can harbor at least 30 significant viral and bacteriological diseases (Williams and Barker 2001). At least eight pathogens harbored in pigs can infect humans (brucellosis, leptospirosis, salmonellosis, toxoplasmosis, balantidiasis, trichinosis, trichostrongylosis, and sarcoptic mange). It is unknown to what extent pigs on Guam spread diseases that are harmful to humans, but there is a link between the area of highest carabao numbers and the frequency of human leptospirosis infection on Guam.

The presence of feral ungulates can impact human health and safety indirectly through increased use of firearms and other weapons by hunters and poachers. Public and wildlife safety is a major issue on military lands. 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 is a problem on Navy properties. Evidence of illegal hunting on NBG NMS and NBG TS, is abundant. A U.S. Geological Service (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 without legal entry not only risk their own lives, but the lives of others. There is always a possibility that Navy personnel or authorized contractors could be injured or killed by poachers.

4.4 Impacts on Navy Lands and Facilities

Ungulate damage is evident on all Navy properties within the Overlay Refuge, raising the cost of managing natural areas, and degrading habitat for threatened and endangered species found there. Pig, deer, and carabao also continue to damage Navy facilities and increase operating costs for facility maintenance. The effects of erosion from ungulate damage to the vegetation on the upper plateau of NBG TS 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 nonnative invasive weed encroachment, reducing or eliminating recruitment of emergent tree species, erosion of essential top soil, and spreading of nonnative 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 feral ungulates can change the structure and composition of forests. At NBG TS, deer browse lines are evident in forested areas, resulting in very open forest understories, and degrading quality of endangered species habitat (Navy 2010, A. Brooke, NAVFACMAR, personal communication). In many areas over-browsing has caused considerable changes in forest composition and declining structural complexity (Conry 1988, Wiles et al. 1999). The forests have lost most ground cover, and browse lines are evident on woody vegetation (Conry 1988, A. Brooke, NAVFACMAR, personal communication).

Figure 4-6 shows changes over time to an area of forest in an ungulate exclusion plot after the ungulates were removed. The top left photo shows the plot immediately following removal of ungulates, and the other photos show recovery of forest cover over time. Schreiner (1997) observed an absence or reduction of some tree and shrub regeneration in disturbed native forests, resulting in an increase in abundance of nonnative species. Browsing by feral ungulates has greatly reduced recruitment of native limestone woody species into the upper canopy at AAFB (AAFB 2006).

Forest composition of native species can also be altered when unpalatable native plants such as *Guamia*, *Aglaia*, and *Ochrosia* are not browsed (Wiles et al. 1999). For example, in some areas of Pati Point, the native *Ochrosia marianensis*, whose leaves are not favored by deer, has become established in monotypic stands to the exclusion of other more palatable native species, due to selective grazing by deer (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 (Contractor), and personal communication).

4.4.1 Navy Lands

The cost of mitigating impacts of erosion on NBG NMS and NBG TS is high. In the past 10 years NBG has spent approximately $1.2 million on vegetation restoration and erosion-control projects (A. Brooke, NAVFACMAR, personal communication). This includes building a fire-break road, planting grasses on highly eroded badlands, and planting trees to create shaded fire-breaks. Revegetation was conducted primarily on NBG NMS with a small amount also conducted on Sasa Valley Tank Farm north of NBG NMS.

Source: USGS

Figure 4-6. Changes in Vegetation Structure Over Time Following Removal of Ungulates From a Fenced Area on AAFB

Pig damage has been observed in several areas on NBG NMS (NAVFAC Pacific 2010). In 2011 severe damage was reported on the earthen roofs of munitions bunkers (A. Brooke, NAVFACMAR, personal communication).

Feral pigs have been observed rooting up grass and soil on and around munitions magazines on NBG NMS. The necessity for repairs to magazines has greatly increased in the past few years. A recent estimate of $120,000 per magazine was proposed for repairs to a number of the magazines damaged by feral pigs (A. Brooke, NAVFACMAR, personal communication). If left uncorrected, the cost of pig damage to magazines in the future will incur similar to rising costs (C. Wood, NAVFACMAR, personal correspondence) depending on the number and severity of magazines damaged.

Extensive pig and deer damage has been observed at NBG TS within the Haputo ERA, particularly in the Tweeds Cave area. The damage is most apparent in areas away from the roadways, within forested areas below the cliffline (Lon Bulgrin, NAVFACMAR, personal communication).

The feeding and wallowing habits of the carabao have resulted in extensive accelerated soil erosion at NBG NMS. These animals also produce large amounts of fecal material in and around the shores of Fena Reservoir, which raises water quality concerns (Navy 2010). Carabao have also damaged fences on NBG NMS and have charged and damaged security vehicles.

Impacts on Fena Reservoir and Watershed

Fena Reservoir, which is on NBG NMS, is a major water storage facility for the U.S. Navy Water system and is the principal source of potable water for southern Guam (EMPSCO 2005). The reservoir was constructed in 1951 with a design capacity of 2.3 billion gallons of storage. The reservoir is fed primarily by three streams: Almagosa, Imong, and Maulap (SWCA 2007). The combined drainage area covers almost 6 mi^2. During the wet season, Fena Reservoir and water treatment plant provides 10 to 12 million gallons per day (MGD) but drops to 6 to 8 MGD during the dry season.

Siltation of Fena Reservoir is a major problem. Denuded areas of the reservoir and watershed have led to considerable soil erosion. There are three primary causes for soil erosion in this area: (1) soil type, (2) feral ungulate damage, and (3) fires lit by poachers. Suspended sediment loads can have significant impacts such as siltation and infilling of water bodies, reduced light penetration inhibiting photosynthesis, and burying coarse bottom sediments leading to a loss of habitat and spawning sites for gravel bed dependent species. Rains wash eroded soil into Fena Reservoir and tributaries, causing substantial siltation and turbidity issues. Elevated turbidity roughly triples the average daily cost of treatment (A. Brooke, NAVFACMAR, personal communication). When turbidity becomes too high, the water treatment plant cannot operate and is shut down until turbidity levels drop. These closures interrupt access to a water supply and cost between $45,000 and $54,000 per day.

Storm events have caused Imong, Almagosa, and Maulap stream channels and Fena Reservoir to fill with sediment, resulting in a substantial loss of active storage volume. A recent study was undertaken to determine the feasibility and cost of dredging a portion (60 acres) of Fena Reservoir to remove accumulated sediment and restore usable water storage capacity (EMPSCO 2005). EMPSCO (2005) estimated $40.8 million would be required to restore the reservoir bottom bed profile to 1949 pre-construction conditions. Dredging to depths of 1 to 2 feet below the reservoir intake elevation would cost approximately $10.2 million.

Feral dogs have been observed to chase and kill deer, which often end up in Fena Reservoir (A. Brooke, NAVFACMAR, personal communication). These and other carcasses and excrement contaminate the water and augment the spread of waterborne diseases such as leptospirosis.

5. CONTROL TECHNIQUES FOR UNGULATE MANAGEMENT

Techniques for controlling ungulates are reviewed in the following sections. The advantages and disadvantages of implementing the control techniques are summarized in **Table 5-1**.

5.1 Hunting

Hunting is used extensively as an ungulate management tool worldwide. Typically hunting is carried out using shotguns (slugs) and rifles. In sensitive habitat, or close to infrastructure and human habitation where use of such weapons is undesirable, archery (bows and cross bows) is often used (Kuser and Applegate 1985, Curtis et al. 1995). Most hunting programs used in ungulate control aim to decrease significantly or totally remove a species from specific areas. These hunting programs differ significantly from recreational hunting programs.

Recreational hunting is an important form of outdoor recreation on Guam, and can be a source of food for fiestas and social gatherings. Legal hunting on Guam occurs during daylight hours (30 minutes after sunrise to 30 minutes after sunset).

Poaching (illegal hunting) also occurs on Guam, both on public and military lands. Poachers often use spotlighting techniques to increase their chance of success. The safety hazards associated with the presence of poachers is discussed in **Section 4.3**.

Culling is another form of hunting used to control animal populations. Culling is typically aimed at decreasing overpopulation in a specific area or removing malnourished, hurt, or diseased individuals, most often to enhance the overall health of a population (Walker et al. 1987). The practice of culling is not currently used on Guam.

Hunting can be an effective method of ungulate control if correctly used, but spatial variation in hunting pressure can greatly affect the efficacy of a hunting program (Wright 2003). For example, laws that prohibit or decrease hunting intensity could restrict some areas from effective ungulate control. The effectiveness of hunting programs to control invasive ungulates also depends on the goal of the program and its level of enforcement and regulation. For example, most recreational hunting programs aim to maintain or even increase the number of ungulates that are being hunted, which might be in direct opposition to natural resources management goals when the hunted animal happens to be an invasive species.

Table 5-1. A Summary List of Techniques for Ungulate Control Considered, Along With Their Advantages and Disadvantages

Technique	Advantages	Disadvantages
Ground hunting	• Capable of removing enough individuals to be effective • Cost per animal is relatively low • Effective in accessible areas • 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
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 • Noise
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 ungulate control specialists to control numbers. • Focus on trophy animals • Resistance to reducing ungulate numbers 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 for ungulate control • Cost effective • Intensity and duration of hunting can be dictated by the control program	• Can 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 ungulate control specialists	• Well-trained dogs are expensive and can be hard to obtain • Dogs could be injured or killed by target animals or firearms • Should only be utilized by professional ungulate control specialists • Inadequately trained dogs could take non-target animals • Some concerns regarding humaneness of method • Animal take per day is low compared with some other methods • In unfenced areas, could drive animals into sensitive natural areas • Could cause friction with recreational hunters
Live trapping (including corrals)	• Multiple animals can be taken at once • Could 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 could become trapped • Trap shyness could 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 • Could catch animals that avoid other methods • Effective at low densities • Can catch animals breaching fence	• Ineffective for carabao • Low public acceptance • Potential harm if snared too long • Non-target animals could become snared • Snares can’t be used with hunting dogs • Could 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 • Could catch animals that avoid other methods • Cost-effective • Can take advantage of nocturnal feeding habits	• If used with hunting, can be time-consuming • Might not be as attractive to volunteers as active hunting • Bait could provide a food source for other pest species such as rats • Some seed bait could germinate and establish • Could 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 • Could be fitted with one-way gates to allow animals to exit	• Disruption of movement patterns could 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)	• Could 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 carabao and 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, deer and carabao • Can be administered by dart gun • Considered humane	• 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	• Might be more acceptable to the public • Useful in limited basis to remove small numbers of animals that are considered valuable resources (e.g., carabao).	• 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 could flee

Guam's hunting has been exclusively carried out by foot or from vehicles. Deer are the preferred targets, but feral pigs are also hunted. The legal deer hunting season occurs from October 1 to March 31. There are also special hunts that extend the season. Historically there was a limit of one antlered deer per licensed hunter. However, in the mid-1990s the harvest limit was increased to three antlered bucks per person. The annual legal take during the regular hunting season has steadily increased since the early 1980s, from 25 to 50 deer in the early 1980s, to 70 to 90 deer in the early 1990s, to 100 to 125 deer in 1996 (GDAWR, unpublished data from 1984 to 1996). Typically, the local authority issues licenses to 250 to 450 hunters per year (GDAWR, unpublished data).

5.1.1 Ground Hunting

Ground hunting is hunting that is conducted on foot or from vehicles, and can occur during daylight or at night. 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 are difficult for hunters to locate and kill with a single shot. Ground hunting alone will not achieve meaningful control of ungulates unless there is a sustained effort. Without heavy hunting pressure, the number of animals removed will not outnumber 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, Hawaii, and New Zealand (Barrett and Stone 1983, Clarke 1988, Schuyler et al. 2002). Schuyler et al. (2002) reported that after 3 years of pig hunting on Santa Catalina Island, California, there was no significant long-term decline in pig abundances. 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 pig numbers, even though 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 30 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 to 70 percent 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 to 70 percent removal rate will only slow or halt population growth and will not reduce actual numbers, due to replacement of removed adults by young produced each year. Therefore, an even higher rate of removal is needed to reduce feral pig numbers on NBG lands. Prior to commencing any control work, a current estimate of ungulate numbers within the management units will be made (see **Section 6.4**).

Most feral ungulate control programs use ground hunting in combination with other efforts, which are described in the following sections.

5.1.2 Aerial Hunting

Aerial hunting, hunting from helicopters or planes, has been effective at reducing ungulate numbers, particularly in remote or inaccessible areas. Aerial hunting has the advantage of not leaving human scent, 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 charters can exceed $1,200 per hour, often with a minimum of 4 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 danger of low-altitude flight are all factors that limit the use of aerial hunting. Since the shooter is some distance away from the target and the noise of an aircraft can often frighten the target animals, there is a higher risk of non-fatal strike and ricochet than shooting from the ground (Kessler 2002). In addition, aerial hunting in areas with dense vegetation is unreliable because target animals can disappear from site under the vegetation canopy.

Aerial hunting might be effective at reducing ungulate numbers, but it cannot be used on the NBG NMS because of safety requirements and flight restrictions and it cannot be used at NBG TS or NBG MB because of the proximity to humans and infrastructure. However, aerial hunting should not be completely discounted without careful consideration of the various options for use in some areas of NBG NMS using DOD-supplied helicopters and pilots.

5.1.3 Ungulate Control Specialists

Use of ungulate control specialists can be effective in ungulate management. Previous ungulate control programs that have used ungulate control specialists have been much more successful than those that relied on volunteer hunting. Eradication of feral ungulates would not be possible in unfenced areas on NBG because there would be constant immigration from surrounding areas. However, ungulate control specialists could reduce ungulate numbers to levels that allow for recovery of vegetation communities, as required by the various mitigation programs on Navy lands (see **Section 1.1.1**).

5.1.4 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 remaining animals after initial control efforts and thus are used primarily in low-density scenarios. Most managers agree that finding the last remaining individuals takes as much effort as it takes to that point (or more), because capture success declines considerably as animal numbers decrease. Dogs are effective at locating individuals that evade detection by hunters alone. Trained dogs will also corner animals, not simply pursue them. 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 6 months of hunting, 150 of an estimated 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). The safety of the dogs 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. Having the dogs fitted with tracking devices has proven effective in eliminating these problems.

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

5.2 Trapping

5.2.1 Live Trapping

Trapping of feral ungulates using cage, box, or corral traps allows animals to be taken alive. This provides 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 percent of the feral pigs (Parkes et al. 2010). **Figure 5-1** shows an example of a trap with bait used for pigs on NBG MB.

Trapping has primarily been used for pig control but large animals like carabao can also be trapped. Modified versions of baited Clover traps (Clover 1954) have been used successfully to 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.

Trap corrals are used to control cattle in Hawaii (Reeser and Harry 2005). These methods could be modified to capture carabao for relocation, lethal removal, or to fit radio-tracking devices. Deer can be captured using corral traps, drop nets, or a net gun fired from a helicopter. The control of royal deer in southeast Australia included trapping in enclosures, but trapping was limited by the trap-wariness of the deer (NSW National Parks Service 2002). Over a 2-year period, trapping removed only 30 deer from two locations and did not provide an effective long-term solution to deer management.

Figure 5-1. Baited Pig Trap on Naval Base Guam Main Base

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 wander freely 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 (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 installations where sensitive equipment, such as telecommunications equipment or munitions storage facilities, prohibit the use of firearms and urban and residential areas where discharge of firearms is illegal or unsafe. The animal is usually unharmed by the capture process and therefore non-target animals that are caught can be released because traps are live capture.

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 and trapping operation requires road access.

Even small ungulate traps can be heavy and cumbersome, requiring two or more people and trucks to deploy and maneuver. Traps must be checked, cleared, and refurbished with bait regularly. As with any trapped animal, there are safety concerns for those checking and releasing individuals. Trapping can be less cost-effective than other methods because of higher labor and material 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. They can be less effective when food is plentiful (bait is less attractive). Animals can also escape from traps if frightened. In corral traps, a frightened animal can alarm others in the trap (Barrett and Birmingham 1994). Finally, there will always be a residual number that will be reluctant to enter traps (NSW National Parks Service 2002). Therefore, traps alone will not result in the desired level of control; however if used in conjunction with other techniques, they can be a useful tool.

5.2.2 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 to 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).

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. Leg snares provide an alternative to cable snares and work by trapping the animal’s limb. They might be considered by some to be more humane than cable snares provided they are constantly or frequently monitored. The actual cost of snares is low ($12 to $20 per snare), but 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. Furbishing a snare with a radio transmitter can increase the cost of snaring considerably (Halstead et al. 1996).

Snares can be more effective than hunting to catch residual 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).

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 might 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, since there are no non-target native ground dwelling mammals within the control areas, this risk would be minimal in NBG lands.

5.2.3 Toxic and Non-toxic Baits

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), but 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, the USDA-Animal and Plant Health Inspection Service- (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 5.2.1**. On Sarigan, shooting over bait at night was effective when pig concentrations were high and naive to humans (Kessler 2002).

5.3 Other Control Methods

5.3.1 Fencing

Fences have been constructed as physical barriers to impede ingress, egress or both in an area (Reeser and Harry 2005). Most are designed to exclude ungulates from specific areas, but in some instances the aim is to keep them contained until removal can take place. Where fencing is impractical or cost-prohibitive, natural barriers such as cliffs and ocean can 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.

A properly constructed fence is humane and highly effective when maintained. The type and condition of fencing material can affect the susceptibility of animals to injury. Mesh size can dictate whether a horned animal is more or less likely to become trapped in the fence (Long and Robley 2004). A damaged fence not only allows access, but also provides a surface in which individuals can become snagged or injured.

No fence can be considered to be completely ungulate proof. Given the right stimulus, deer can jump an 8-foot-high fence and pigs can dig under a barrier (Z. Lopez, U.S. Air Force, personal communication). Additionally, not all targeted species can be contained or excluded by a standard, or species-specific fence design. Some deer require 10-foot-high fences, but most are deterred by 6- to 8-foot barriers (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). Carabao are more problematic since they frequently breach barriers with ease due to their large body mass. For this reason, carabao are not typically fenced. Elk fences, successfully used in Oregon to contain Rocky Mountain mule deer (*Odocoileus hemionus hemionus*) and Rocky Mountain elk (*Cervus elaphus nelsoni*) (Bryant et al. 1993) could be modified for use with carabao. Constructed of high-tensile woven wire, the 8-foot-high fence requires minimal maintenance (Bryant et al. 1993). Tension curves in the wire result in a particularly flexible fence that could withstand carabao impact. Bison- or beefalo-proof fences can also be employed for carabao control, since the animals are of similar size. Modified versions of 4-foot-high, hog-wire fencing implemented to control goats, cattle, domestic sheep, and pigs in Hawaii (Reeser and Harry 2005) might also be an option.

Electric fences are widely used in the mainland U.S. and Australia (Littauer 1997), but they are not as practical for small islands like Guam. Maintaining an uninterrupted power supply in remote, wet, stormy, and corrosive conditions decreases fence integrity and 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 5-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. The fence has successfully deterred deer and pig from entering the enclosure (G. Rodda, USGS, personal communication).

Ungulate fencing in Hawaii 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 might be lower than in open habitats. To increase fence height, strands of barbed wire can be run above the woven wire fence.

Small pigs have been found to push through woven wire fencing and start new groups in areas where pigs had previously been removed at the U.S. Army, Sheffield Barracks, Oahu (S. Mosher, personal communication). Rigid, welded wire livestock panels with 3-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 can dig underneath and is secured with anchor stakes.

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.

The combination fence made of welded wire panels and deer mesh has several advantages for Guam. The rigidity of the panels provide 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.

Fencing costs are highly variable and depend on the purpose, species to be controlled, accessibility, terrain, substrate and the amount of area that needs to be cleared. Cost estimates on the U.S. mainland range from $10 per linear foot for basic fencing on flat ground to $30 per foot in rugged, inaccessible terrain. Guam prices are higher, primarily due to shipping costs and retail mark-up. The erection of a 6-foot, vinyl-coated, chain-link fence in flat, sandy soil at the Guam National Wildlife Refuge cost $27 per foot in 2008 (C. Bandy, U.S. Fish and Wildlife Service, personal communication). Quotes for 8-foot, vinyl-coated, chain-link fence at the refuge averaged $31 per foot. Vinyl-coated, chain link might not be practical for Guam as sunlight can cause the coating to crack, allowing moisture to be trapped against the metal, accelerating fence corrosion, and reducing the effective life of the fence. A 2007 quote for fencing on the NBG NMS was approximately $25 per foot for installation of 2 one-acre enclosures, 5.9 to 6.5 feet high, made of woven, galvanized mesh graduated from smaller mesh size on the bottom to larger mesh size on the top (A. Brooke, NAVFACMAR, personal communication). Costs of materials have increased since this last estimate was made.

In addition to being effective over a long period of time, fences can be cost-effective if maintained. They significantly reduce the need for continuous, labor-intensive control inside a protected area. Snares can also be set along fence lines (Reeser and Harry 2005). Conversely, the lifespan of a fence can be considerably reduced by exposure to salt spray, high rain volume, and typhoons. Corrosion, storms, falling trees, and vandalism can affect the integrity of a fence, and lead to further disintegration. Once a fence is breached, considerable effort is needed to restore barrier effectiveness.

Fences on NBG NMS would be temporary, made from plastic deer mesh secured to trees and non-ground invasive posting to avoid concerns with Unexploded Ordnance. Determination of the location of fencing needs to consider ungulate behavior. Placement of a fence can block established movement corridors or cut off access to food or water. This can result in extended effort by ungulates to break through or get around (dig under or get over) the fence resulting in damage to the fence and unwanted ingress. The size of a fenced management unit should depend on manageability. Larger fenced areas will take longer for ungulate removal and could result in concentration areas for ungulates over time if they cannot all be successfully removed. Smaller fenced management units should take less time to successfully remove ungulates and there is less potential for ungulate ingress because maintaining the integrity of the fence will take less effort. The size of any fenced unit should be based in large part on what can be managed over time.

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 requires smaller management units in order for removal actions to be successful.

There are specific challenges associated with fencing on the NBG NMS. First, the explosive arcs around bunkers and magazines will likely preclude the use of fences in many areas. Second, the cost of fencing such a large, rugged, and partially inaccessible area would be prohibitive. Third, water bodies such as Fena Reservoir and the multitude of streams and rivers could not be successfully fenced, particularly for pigs. Fourth, the presence of carabao poses particular problems for fencing, as standard chain-link fences might not be adequate. If fencing were to be used on NBG NMS, it would have to be limited to the enclosure of management units rather than fencing the area in its entirety. Ungulate control using standard fencing is more feasible at NBG TS, NBG MB, and other NBG areas.

While fencing is an appropriate tool for ungulate management in many parts of the U.S., its large-scale use could prove impractical on Guam due to the high cost of maintenance (e.g., fast growing vegetation, vandalism, storm and corrosion damage). Also, unexploded ordinance (UXO) from World War II is prevalent and all fencing projects will require extensive use of UXO monitoring and clearance, which can double the price of a fencing project.

Despite any logistical difficulties, fencing should be considered as part of the ungulate-control program. Priority should be given to areas with significant natural resources, such as native forests, or areas with threatened and endangered species. Fencing of an area followed by eradication of ungulates within the fenced area is the most efficient management method and reduces long-term costs.

5.3.2 Judas Animals

Some species of ungulates are highly social animals, so an individual equipped with a radio transmitter can lead hunters to locations where the species congregate (Taylor and Katahira 1988, White and Garrott 1990). This technique, called the Judas method, was developed by Taylor and Katahira (1988) to find the last remaining goats in Hawaii Volcanoes National Park. The technique entails the capture of a target animal, fitting it with a telemetry collar, and releasing it. If the collared individual is gregarious, it will rejoin its herd, allowing personnel to locate and kill the herd. Usually the Judas animal (which is often sterilized and cannot reproduce) is left unharmed to escape and find a new herd.

The Judas technique has potential for carabao control. A typical carabao herd on NBG NMS consists of approximately 30 individuals, primarily first and second generation offspring of the lead females (Nowak 1999). Since these older females lead the group, affixing radio-tracking devices to them can assist location of the herd, if they cannot be found using traditional techniques. Aerial telemetry could be more effective than ground telemetry because of the rugged terrain associated with NBG NMS. Prior to fitting the radio transmitter, the animal must be captured and restrained. Capture is often achieved with traps and sedation.

It is unclear how successful the use of Judas animals would be on deer, because they tend to be less social. Efforts to use Judas deer in New Zealand were not successful, although only two deer were tested (A. Fairweather, New Zealand Department of Conservation, personal communication).

5.3.3 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; Frank and Kirkpatrick 2002). Ungulates provided the largest body of information regarding effectiveness and safety of PZP treatment (Kirkpatrick et al. 1996, Frank and Kirkpatrick 2002).

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 3 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 in primarily captive animals including wild horses, deer and other ungulates. 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). Animals with less seasonal breeding patterns need more frequent booster inoculations (Frank et al. 2005). This would be the case on Guam where pigs, deer, and carabao breed year round.

In 1996 the Navy began testing immunocontraception and enacted a program targeting breeding-age female carabao in 1999–2003. The program had moderate success. Transportation and storage of the sedative drugs was difficult as the vaccine must remain frozen until use, and cannot be reliably shipped. Hand-delivery from the U.S. mainland to Guam was made annually. One power outage in 2003 resulted in several thousand dollars of vaccine being destroyed.

The vaccine’s complex proteins cannot pass through the digestive tract of any animal, but remain intact and with biological activity when injected in the blood stream. Therefore, meat of carabao injected with immunocontraception vaccine is considered safe for human consumption (J. Kirkpatrick, Zoo Montana, personal communication).

The downside of using immunocontraceptives is that the method does not address the immediate problem of too many carabao on NBG NMS and infertile females will likely live longer and be healthier due to the elimination of the stresses associated with reproduction. Carabao are capable of bearing calves even if they are inoculated with the vaccine. Immunocontraception is also not a preferred method for reducing the numbers of a long-lived species and on Guam; carabao can live to 18 years of age. Approximately 50 percent of the carabao on NBG NMS are less than 4 years old; therefore, significant population reduction utilizing only immunocontraception will require an excessively long time period. Finally, labor costs associated with this method are expensive and the immunocontraceptives have to be kept refrigerated and stored cold.

Vaccine costs approximately $24 to $30 per treatment (Walter et al. 2002). Assuming 50 percent of treatments are successfully applied and carabao in Guam are reproductively active for an average of 10 years, the estimated cost of the vaccine per carabao is between $500 and $600 over its lifetime. These costs, however, do not include labor, materials, or transportation costs. Walter et al. (2002) estimated a cost of $1,128 per deer in a group of 30 treated for 2 years. More than 64 percent of the total budget was labor. Costs on Guam will be higher because the island is isolated and travel, labor, and materials are generally more expensive. Based on Walter et al. (2002) budget calculations, a conservative estimate of between $7,000 and $15,000 would be required per carabao for 10 years of treatment. Previous estimates by Navy personnel of an average cost of $2,250 per carabao was based on 3 years of treatment and did not include labor, baiting, travel, missed targets, or transportation of the vaccine to Guam.

Immunocontraception is most useful in reducing fertility in captive animals; however, it is not practical to reduce large numbers of free-roaming wild deer, pigs, or carabao. 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.

5.3.4 Translocation

Translocation is the act of capture, transport, and release of a species from one location to another. In the context of ungulate control on Guam, translocation is not an option for pigs or deer. However, it might be feasible for yearling carabao in NBG NMS and has been used previously. Between 2001 and 2004 the Navy, in cooperation with the Guam Mayor’s Council and GDAWR, supported a carabao calf giveaway program. The program was initiated by village mayors and organized by GDAWR. Carabao calves (between the ages of 1 and 2) were sedated using restricted drugs under the direct supervision of the Government of Guam Territorial Veterinarian. The sedatives were delivered by darts using a capture rifle. While sedated, carabao were branded for identification and fitted with a nose ring. Animals were then transported to a village mayor’s office and given away to member of the local community upon request.

The sedation, capture, and removal of carabao proved more difficult than expected and only 18 animals were captured over a 9-month period. An intensive capture program between 2003 and 2004 was more successful and resulted in the capture of 37 animals. The fate of these animals is unknown. GDAWR suspended the capture after several weeks of unsuccessful attempts to dart additional young animals. The estimated cost (including labor, supplies, medicine, and transportation) of the carabao calf giveaway program was $1,000 for each individual successfully relocated.

The program was accepted by the local community and generated some positive public relations. The problem of liability for Government of Guam employees involved in the removal of carabao from Navy lands was an issue and the Navy subsequently required the Government of Guam to sign a Release of Liability and Indemnification for Carabao. The Navy’s legal opinion was that if the carabao was young and became the “property” of the Government of Guam before being transferred to private ownership, the Navy liability would be reduced and was worth the risk. Older individuals were considered too problematic to capture, translocate, and domesticate; therefore, they were not included in the program.

5.3.5 Sedation

Sedation can be necessary to relocate live-captured carabao calves or enable radio-tracking collars to be fitted if the Judas Technique were used. The use of the ultra potent morphine-like drug, carfentanil could be considered for immobilization (Bailey et al. 1985). Phencyclidine at doses of 0.5 to 1.0 milligram/kilogram was effective for the immobilization and capture of feral water buffalo in northern Australia but xylazine at doses of 0.5 to 1.33 milligram /kilogram was ineffective (Keep 1971). However, using a combination of xylazine and acepromazine at doses of 0.5 to 1.0 milligram/kilogram and 0.1 milligram/kilogram respectively were extremely effective in the immobilization of carabao after capture (Keep 1971). A mixture of xylazine and telazol was tested and found to be effective on captive

Philippine deer on the nearby island of Rota (J. Haigh and C. Kessler, unpublished data) although dosage rates are unavailable. The same sedative mix could be effective for carabao. Xylazine was used on the previous carabao giveaway program on Guam, and was administrated by the Guam Territorial Veterinarian (A. Brooke, NAVFACMAR, personal communication). If sedatives are used again, they would be supplied through the Navy's Bollard Veterinary clinic and the Guam Territorial Veterinarian would be present when the carabao are darted (A. Brooke, NAVFACMAR, personal communication).

Tranquilizers are useful for the live capture and removal of animals, but there are some limitations to their use with large and unpredictable species such as the carabao. Sedating and removal of carabao is extremely labor- and resource-intensive, requiring up to eight people to move one animal. Tranquilizers are restricted substances and therefore need to be prescribed by a veterinarian. A veterinarian must also be present to mix the drugs properly for the dart. Only personnel trained to use a dart gun can administer the tranquilizer. Even with care, complications can occur, resulting in death or injury to personnel or the carabao. Further, a truck and trailer are required to move the animal. Access to tranquilized animals for removal means they must be darted on even terrain near a road. If the terrain is too rugged the animal could flee into inaccessible terrain in the minutes it takes for the drug to take effect. Coupled with the possibility of injuring itself, such animals are difficult to relocate and remove. In cases where tranquilized animals move into locations that limit the ability for them to be safely and humanly removed, they should be left in place and monitored until the tranquilizer wears off enabling the animal to safely move on.

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6. IMPLEMENTATION

Methods employed to control ungulates are dependent on the species, and the biological and geological features of the ecosystem in which control is to occur. Safety, feasibility, cost-effectiveness, and humaneness of implementation must be carefully considered. The choice of methods requires a comprehensive evaluation of all these aspects to achieve the desired results. Successful ungulate control or eradication programs generally employ a number of different control techniques, often conducted in a specific order (Parkes et al. 2010). It is unlikely a single technique used alone would result in the eradication of any ungulate species. As the control program progresses it is frequently the case that finding the last remaining animals 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). Proper planning is important because the total cost of the program can increase substantially if proper management actions are not implemented at the start of the eradication or control program.

Ungulate reproductive rates are density dependent (Gogan et al. 2001). At lower numbers each species will have an increased number of births and higher survival of individuals. The effects of control activities can therefore be mitigated within a comparatively short period of time by an increase in the reproductive output of individuals.

Control of feral pigs and deer is not currently conducted on NBG NMS or NBG TS. Some trapping of pigs currently occurs in the Orote Peninsula area of NBG MB. Carabao removal through giveaways has been conducted on NBG NMS in the past. Recreational hunts for pigs and deer occurred on NBG TS between 1990 and 1997, but are no longer conducted for safety reasons.

The following sections present the approach, steps, schedule, and estimated costs for implementing ungulate management and control methods presented in this plan.

6.1 Community Outreach and Education

Knowledge levels regarding invasive species and the harm they can cause is relatively low among the general public (Conover 2002). Recreational hunting is an important part of life for many people on Guam and control of deer, pig, and carabao could still be misunderstood by many who don't understand, or agree with the threat to the land caused by these animals.

Therefore, it is important that the NBG Public Affairs Office develops a Public Affairs Plan pertaining to management of ungulates, particularly carabao, as the species remains an important cultural symbol for the people of Guam.

Plans for the management of carabao need to be presented to the public well in advance of planned management activities. It is especially important that the need for management of carabao be presented and explained in a manner that clearly presents impacts of the animal on native habitats and infrastructure on NBG NMS, but also conveys an understanding of the cultural importance of the carabao to the people of Guam. Support for a carabao giveaway program in cooperation with the Guam Mayor's Council and GDAWR could help to reduce overall opposition for the need to manage carabao on NBG NMS. Consideration of the viability of conducting a carabao giveaway program as part on ongoing management of ungulates on NBG should be assessed and, if determined feasible, promoted and presented as part of public outreach.

NBG 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 being implemented to control ungulate numbers, and the long-term goal for control on NBG. Public awareness regarding an ungulate reduction program will be promoted whenever possible. NBG personnel will work with community leaders in an effort to maintain communication avenues and resolve issues should they arise.

6.2 Ungulate Management Areas

This plan divides NBG into 18 ungulate management areas (UMAs) located on NBG NMS, NBG TS, and NBG MB to refine control actions. Eight UMAs have been designated on the NBG NMS, 4 have been designated on NBG TS, and 6 have been designated on NBG MB. **Figures 6-1** through **6-3** shows the locations and boundaries of UMAs on NBG NMS, NBG TS and NBG MB respectively. T**able 6-1** provides the acreages of the UMAs on NBG NMS, NBG TS and NBG MB. Where possible, boundaries of the UMAs make use of clifflines, existing fences, and other features that restrict ungulate movements. Temporary fences may be added to augment the permanent structures. The UMAs are intended to help facilitate control and can be adapted as needs change.

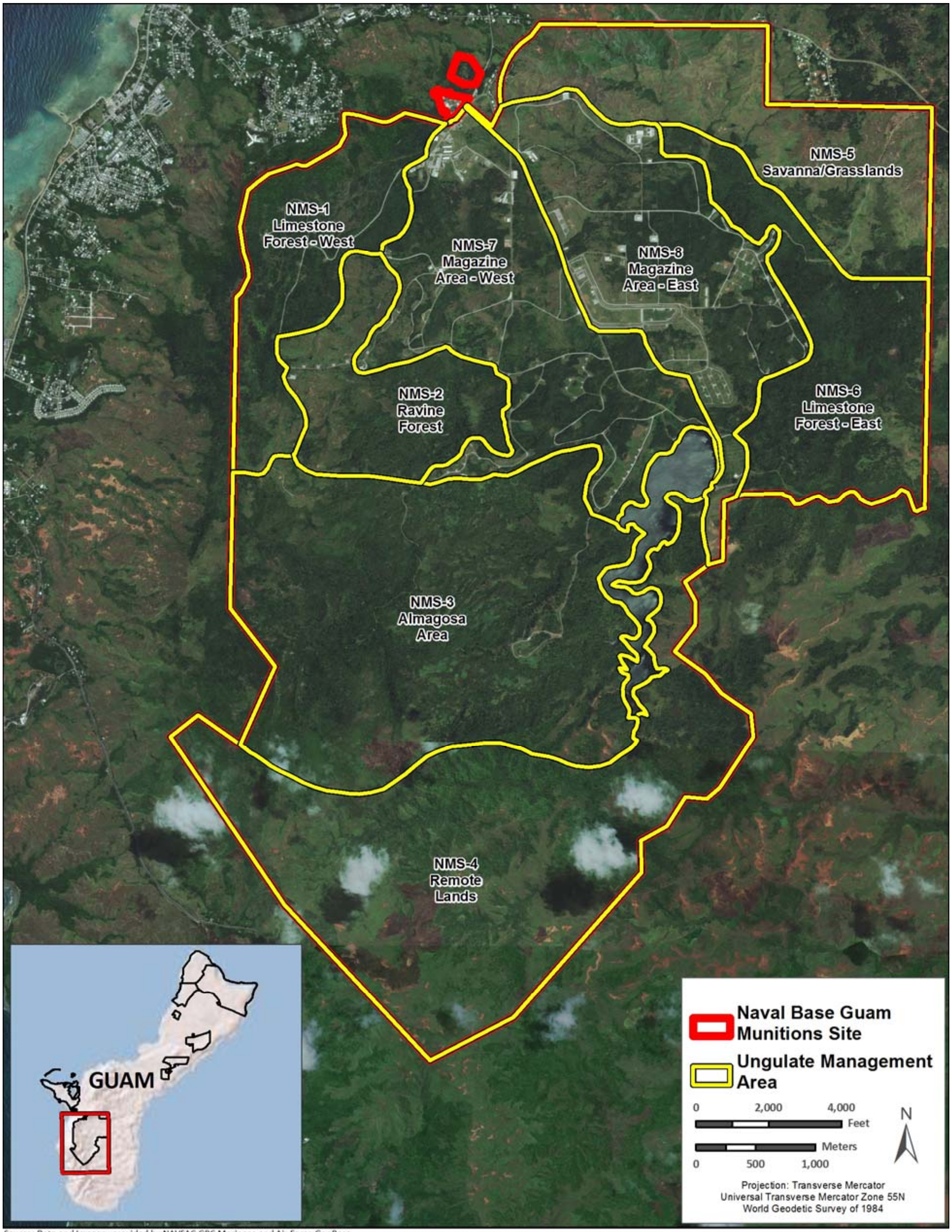
None of the UMAs designated on NBG are permanently fenced and placement of permanent fences in the NBG NMS is restricted. Permanent fencing is planned along the boundary of NBG MB on Marine Corps Drive. Placement of the fence along Marine Corps Drive will restrict further movement of ungulates onto NBG MB. Feral pigs are the only ungulates that currently occur on NBG MB and placement of the fence will allow for the eventual complete removal of the pigs from the installation. NBG MB will continue to be monitored for feral pig sign to document their presence or absence. If pig presence is observed, control will resume until eradication is confirmed. In unfenced UMAs, removal of deer, pigs, and carabao 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.

Management actions on NBG TS will be coordinated to occur at the same time as management actions in the Red Horse Squadron (RHS) Quarry UMA on AAFB. The two areas are contiguous and are not fenced.

6.3 Permanent and Temporary Fencing

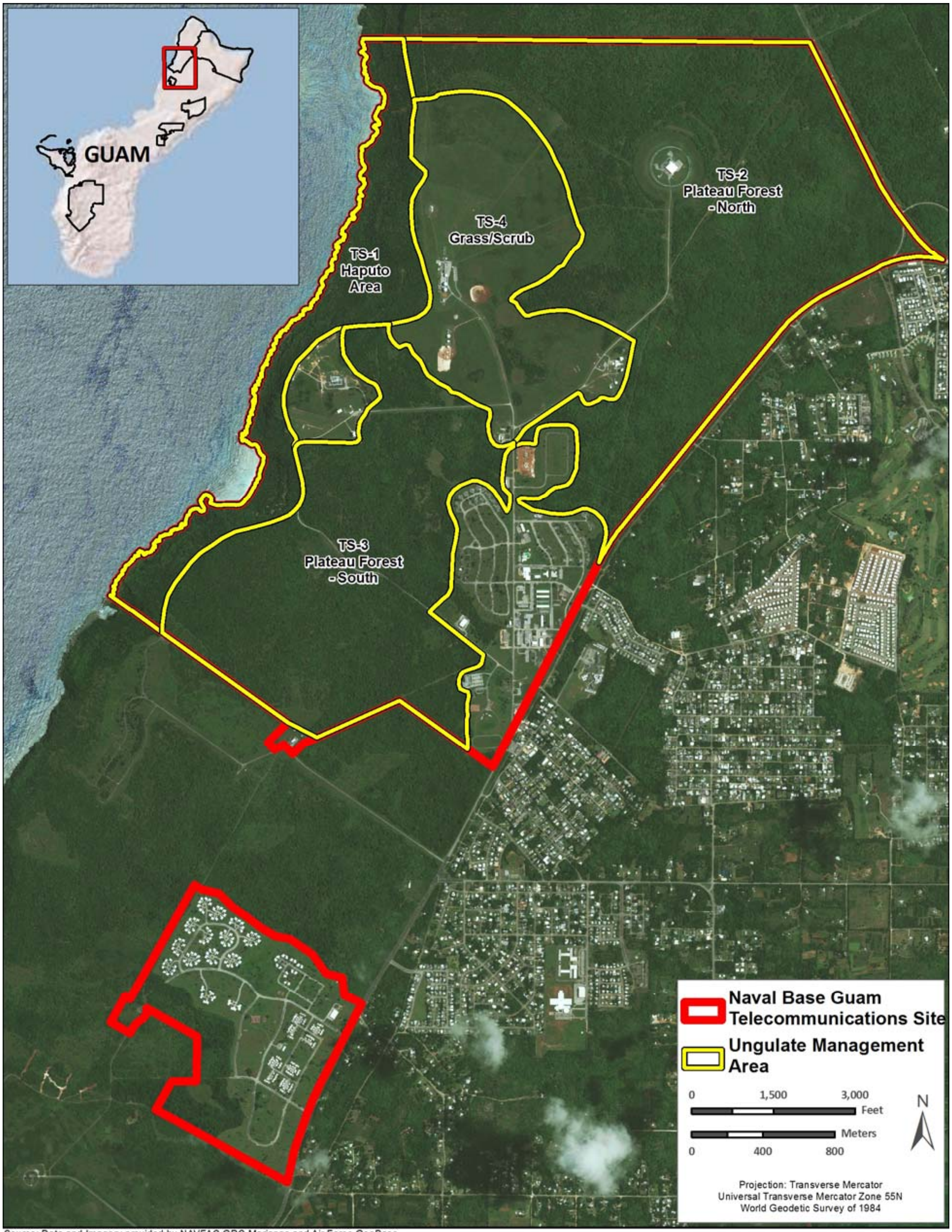
None of the UMAs on NBG are currently fenced. As discussed in **Section 5.9**, fencing of an area followed by eradication of ungulates within the fenced area is the most efficient method of management and reduces long-term costs. Restrictions on the use of permanent fences in the Explosive Arcs on NBG NMS limit their use in these areas. Remoteness of some areas also limits viability for construction and maintenance of permanent fences.

Despite logistical difficulties, fencing will be considered as part of the ungulate control program. Priority will be given to areas with significant natural resources, such as native forests. Fencing of small management units within UMAs will also be evaluated. Smaller areas are easier to manage and cheaper to fence and maintain. Dense cover and rugged topography typically require smaller management units for removal actions to be successful. Evaluation of areas for fencing will be conducted as part of initial surveys of ungulate density and vegetation condition. Results of the initial surveys will provide information that will be useful in determining locations for fencing that will have high potential for successful reduction in ungulate numbers and enhancement or re-establishment of native habitat. Temporary fencing (polypropylene deer mesh) will be used, where determined feasible, to limit access to areas during management activities. Use of temporary fencing will be used to limit access of pigs to the Orote Peninsula (MB-1) during management activities, if determined to be feasible. Following eradication of pigs from other areas on NBG MB the fencing could be removed.



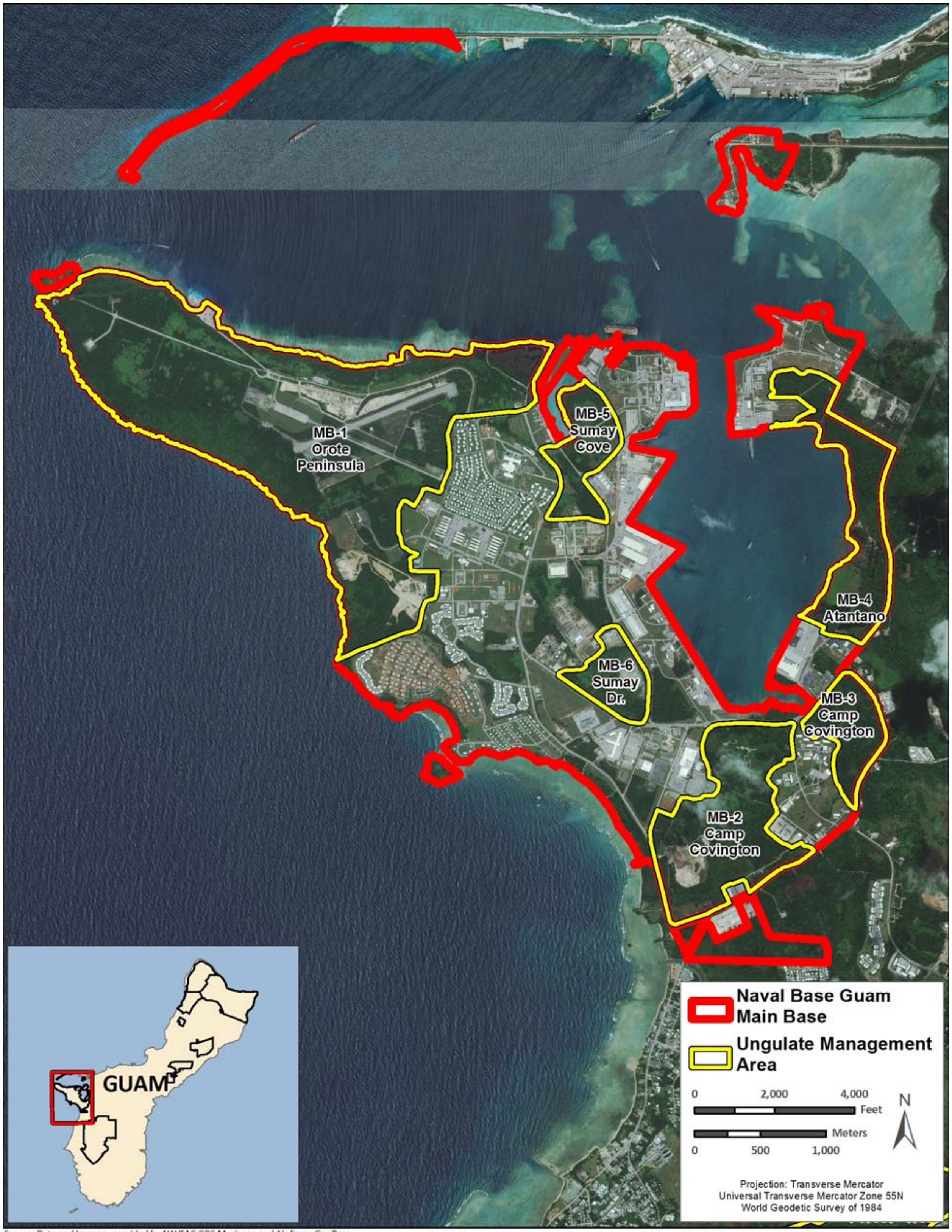
Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 6-5. Ungulate Management Areas on the Naval Munitions Site



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 6-2. Ungulate Management Areas on the Naval Base Guam Telecommunications Site



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 6-3. Ungulate Management Areas on the Naval Base Guam Main Base

Table 6-1. Ungulate Management Area Locations and Acreage

Location	Ungulate Management Area	Acreage
NBG NMS	Limestone Forest-West (NMS-1)	579
	Ravine Forest (NMS-2)	501
	Almagosa Area (NMS-3)	1,925
	Remote Lands (NMS-4)	1,842
	Savanna/Grassland (NMS-5)	848
	Limestone Forest-East (NMS-6)	757
	Magazine Area-East (NMS-7)	1,062
	Magazine Area-West (NMS-8)	953
NBG TS	Haputo Area (TS-1)	250
	Plateau Forest-North (TS-2)	911
	Plateau Forest-South (TS-3)	581
	Grass/Scrub (TS-4)	376
NBG MB	Orote Peninsula (MB-1)	935*
	Camp Covington (MB-2)	259
	Camp Covington (MB-3)	80
	Atantano (MB-4)	179
	Sumay Cove (MB-5)	90
	Sumay Drive (MB-6)	66

* Does not include 110 acres encompassing the airfield area.

6.4 Monitoring to Determine Levels of Ungulate Control

Successful long-term control of ungulate numbers within a designated area requires continuous review and refinement of management practices (Gogan et al. 2001). Pre- and post-management surveys to determine ungulate densities will be conducted. Methods to document reduction in ungulate densities and vegetation recovery will be determined by the NBG Natural Resources staff in conjunction with the contractor. Distance sampling, strip sampling, ungulate sign transects, and permanent vegetation monitoring plots are possible options NBG can use to determine when animal densities are reduced to levels that foster vegetation recovery. Small, ungulate-proof fenced control plots could also be used for comparison with areas where ungulates have not been eradicated. These surveys will be conducted in conjunction with ungulate removal to give near real-time feedback on management efficacy.

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 on vegetation.

6.4.1 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.stand.ac.uk/distance/). Visual surveys are made from a road or transect and 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. NBG natural resources staff will evaluate and consider use of radio transmitters to track dispersal and movement patterns.

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.

6.4.2 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 UMA, permanent photo-points and vegetation transects will be established. These sites will be revisited over time to measure changes in response to ungulate control. 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 3 to 5 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 within the management areas. Most of the areas within the NBG UMAs are not fenced and immigration from off-installation and from adjacent UMAs 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; 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.

6.5 Ungulate Control

The combination of ground shooting, trapping, and snaring by ungulate-control specialists is the most efficient method to control all three ungulate species on NBG. When compared to other techniques, shooting, trapping, and snaring are less labor-intensive and have the highest probability of adequately reducing numbers of ungulates within the shortest time period.

Ungulate-control techniques will consist of ground shooting, trapping, snaring, and baiting as appropriate. Hunting dogs, radio telemetry, and other methods will be used as needed. The use of hunting dogs will be considered because it can significantly increase hunting success as ungulate densities decrease.

Control actions will be conducted to fulfill the agreed mitigation requirements to reduce the number of ungulates in unfenced areas to levels that allow for forest regeneration and self-sustaining populations of native animals. An assessment of UMAs will be conducted to determine if there are areas that are viable for the placement of permanent fencing. Where possible, fencing projects will be undertaken in areas with significant natural resources, or threatened and endangered species. Total eradication of ungulates by ungulate-control specialist will occur within the fenced areas. Fences will be maintained in perpetuity to prevent reestablishment of feral ungulates in the fenced management units.

Within unfenced areas, removal of pig, deer, and carabao by ungulate-control specialists will continue indefinitely to maintain feral ungulate densities at levels that allow for recovery of the vegetation communities. These levels will be determined by ongoing research and monitoring of the response of vegetation to ungulate density reductions. The level of control will ensure that adverse impacts on resources are acceptable. Once started, ungulate control will be continued on a consistent basis with at least yearly monitoring of results. Frequency of maintenance hunts will depend on the level of control needed to allow for recovery of the native vegetation, but monthly (or more frequent) hunts of each management unit will most likely be necessary in the first several years of the control effort.

Operational actions of NBG preclude recreational hunting from occurring in UMAs during control. Recreational hunting on NBG is not compatible with ungulate-control programs for safety, security, and regulatory reasons. Recreational or volunteer hunters make ungulates wary of humans and more difficult to hunt and trap. This can significantly increase the time, effort, and cost to reduce ungulate densities to acceptable levels. No volunteer or recreational hunting will be employed on NBG as part ungulate management.

Control will be conducted by one or more professional ungulate-control company that will be contracted specifically for this work. An ungulate-control specialist is a full-time employee of a fully insured business entity, non-profit group, or government agency (contractor) engaged in wildlife management activities that include trapping, snaring, immobilization, 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 specialist will possess all necessary licenses for firearms possession and use, firearms safety training, permits, and base access documentation. Ungulate-control specialists will be required to demonstrate their 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). The ungulate-control specialists will also be proficient at using archery so they can hunt animals safely in restricted areas, and will have working knowledge and experience using ungulate-control methods other than hunting. The contractor will be responsible for ensuring their employees meet these requirements.

6.6 Carabao Giveaway

Implementation of a carabao giveaway program will be included, if determined feasible, as part of ungulate management in the NBG NMS. The carabao is an important cultural symbol on Guam and implementation of a giveaway program could help in gaining local public support for ungulate management needs on NBG. Viability of conducting a carabao giveaway program will be assessed as an initial action of implementing the NBG Ungulate Management Plan. Community outreach as discussed in **Section 6.1** will also be initiated early on in plan implementation prior to management actions and will be conducted as an ongoing effort over the extent of management activities.

6.7 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.

Experience in the Mariana Islands has shown that the general public is comfortable with killing animals for consumption; however, throwing away meat is seen as a needless waste (S. Vogt, NAVFACPAC, personal communication). Carcass disposal or distribution will be determined by installation commanders. Deer and carabao carcasses can be donated to charity or to the Government of 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, nonnative deer and carabao are not covered by mandatory inspection and their meat may be donated if deemed acceptable by local 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**).

Meat donations from culled deer and carabao are possible if donations meet a strict set of guidelines. Prior to any meat donations, Navy Legal Counsel's office will need to ensure that it complies with current DOD policy. Donations will have to be in compliance and acceptable to local territorial governing officials. Carcasses will have to be quickly retrieved and given away before meat becomes tainted and unsafe to eat. This will prove impossible in remote and rugged areas of NBG and is compounded by year-round conditions of high heat and humidity. Logistics and physical constraints of moving a large animal in roadless areas (where much of the management will occur), financial and manpower constraints, and regulatory/legal factors will determine if, or how many, animals NBG is able to donate to public or non-profit charitable entities. Installation commanders will determine the final method for disposition of culled animals.

6.8 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 will be conducted by experienced professional ungulate control specialists specifically trained in deer, pig and carabao 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 ungulate control specialists 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 ungulate control specialists can deliver a lethal first shot to target animals and will 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 above requirements. 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, under all management alternatives to “reduce pain and distress to the greatest extent possible during the taking of an animal’s life” (AVMA 2007).

6.9 Prioritization of Management

Prioritization of management is an important component of implementation and takes into consideration impacts caused by ungulates to native wildlife habitat and infrastructure, quality of existing habitat, potential for successful management, accessibility, and available annual funding. Prioritization of management can change based on initial monitoring and survey actions, and as a result of available funding.

NBG NMS

The UMAs on NBG NMS comprise approximately 8,467 acres. The Magazine Area–West (NMS-7) and Magazine Area-East (NMS-8) UMAs have been heavily impacted primarily by pigs and carabao (see **Figures 4-2** and **4-3**). Rooting in mowed areas along road sides and on bunkers by pigs, has removed vegetation cover resulting in increased soil erosion and associated impacts to downstream waters. Carabao hooves shred grass cover on bunkers causing soil erosion and preventing grass re-growth. Impacts by ungulates also results in the need for costly repairs to infrastructure within the magazine areas. The NMS-7 and NMS-8 UMAs are both readily accessible with a high potential for successful management. The NMS-7 and NMS-8 UMAs are considered to have a high priority for initiation of management efforts.

The Limestone Forest-West (NMS-1) and Limestone Forest-East (NMS-6) UMAs are characterized by some of the best native limestone forest habitat in the NBG NMS. Successful management of ungulates in these UMAs should result in enhancement and re-establishment of native limestone forest vegetation and habitat for native wildlife including threatened and endangered species. The NMS-1 and NMS-6 UMAs are considered to have a high priority for initiation of management efforts.

Initiation of ungulate management in the Ravine Forest (NMS-2) and Almagosa Area (NMS-3) UMAs will follow initiation of management in the magazine and limestone forest UMAs. Accessibility to these areas is limited and implementation of management efforts is expected to be more difficult. It is possible that ungulates that move out of the magazine and limestone forest UMAs as a result of management efforts in those areas, will move into adjacent areas within the NMS-2 and NMS-3 UMAs. Follow on management in these UMAs is considered important for the overall reduction in ungulates within the magazine and limestone forest UMAs and the rest of the NBG NMS.

Approximately 2,690 acres of the NBG NMS are included in the Remote Lands UMA (NMS-4) and the Savanna/Grasslands UMA (NMS-5). Access to these areas is very limited making management very costly and difficult with limited potential for success in controlling ungulate numbers. The intensity of management in these areas will be limited. For these reasons management of NMS-4 and NMS-5 is not considered as a high priority for initial management efforts and management, if determined to be feasible, will occur following management of the remaining UMAs on the NBG NMS.

NBG NMS

The UMAs on NBG TS comprise approximately 2,118 acres. The northern boundary of NMG TS borders the southern boundary of the Red Horse Squadron (RHS) Quarry UMA on AAFB (see the 2012 JRM AAFB Ungulate Management Plan). The boundary between the Haputo Area (TS-1) and Plateau Forest-North (TS-2) UMAs on NBG TS and the RHS Quarry UMA is not fenced. Management actions on the NBG TS will be coordinated to occur at the same time as management actions in the RHS Quarry UMA on AAFB. Coordination of ungulate management between the two adjacent management areas will increase potential for successful reduction in ungulate numbers in the two management areas.

NBG MB

The UMAs on NBG MB comprise approximately 1,609 acres. Approximately 110 acres of the Orote Peninsula (MB-1) UMA are within the airfield area and are not considered part of the total acreage of management areas on NBG MB. Pigs are the only ungulates that occur on NBG MB, but currently no pig survey data available for the area. Pigs do occur in the Orote Peninsula (MB-1) UMA and some trapping occurs in the management area. Accessibility to most of the MB-1 UMA is good and there is potential for limiting access for pigs to areas in the UMA by using temporary fencing. As a result there is good potential for successful management of pigs in the MB-1 UMA. Much of MB-1 is characterized by limestone forest and successful management of pigs in the UMA would result in enhancement and re-establishment of native limestone forest vegetation and habitat for native wildlife including threatened and endangered species. The Orote Peninsula UMA is considered to have a high priority for initiation of management efforts.

Pigs occur over most of NBG MB, but the density and numbers occurring in the UMAs is not known. Management efforts in the Camp Covington (MB-2), Camp Covington (MB-3), Atantano (MB-4), Sumay Cove (MB-5) and Sumay Drive (MB-6) UMAs will be prioritized based on initial ungulate density surveys and vegetation monitoring.

6.10 Schedule

The following table (see **Table 6-2**) provides the proposed schedule for implementing the management actions developed in this Ungulate Management Plan. Table 6-2. Schedule for Implementing Ungulate Management Actions

Management Action	Management Area (UMA)	Start Date	Notes/Follow Up Actions	End Date
Community Outreach	**NBG**			
	All UMAs	FY 13	Initiated in advance of management actions	Conducted throughout management
Carabao Giveaway	**NBG NMS**			
	All UMAs in NBG NMS	FY 13	Assess viability and coordinate carabao giveaway, if determined feasible	Conduct throughout management if determined to be feasible during FY 13 assessment
Pre-control Surveys: deer density, pig sign, vegetation, photo points	**NBG NMS**			
	NMS-7 Magazine Area-West	FY 13	Following control actions, ongoing ungulate density surveys and vegetation monitoring will be used to determine follow on management levels and locations	FY 13
	NMS-8 Magazine Area-East	FY13	See NMS-1 Note	FY 13

Management Action	Management Area (UMA)	Start Date	Notes/Follow Up Actions	End Date
	NMS-1 Limestone Forest-West	FY 13	See NMS-1 Note	FY 13
	NMS-6 Limestone Forest-East	FY 13	See NMS-1 Note	FY 13
	NMS-2 Ravine Forest	FY 14	See NMS-1 Note	FY 14
	NMS-3 Almagosa Area	FY 14	See NMS-1 Note	FY 14
	NMS-4 Remote Lands	TBD	See NMS-1 Note	TBD
	NMS-5 Savanna/Grasslands	TBD	See NMS-1 Note	TBD
	NBG TS			
	TS-1 Haputo Area	FY 14	Coordinate with AAFB RHS Quarry Surveys (see 2012 AAFB UMP)	FY 14
	TS-2 Plateau Forest-North	FY 14	See TS-1 Note	FY 14
	TS-3 Plateau Forest-South	FY 14	See TS-1 Note	FY 14
	TS-4 Grass/Scrub	FY 14	See TS-1 Note	FY 14
	NBG MB			
	MB-1 Orote Peninsula	FY 13	Following control actions, ongoing ungulate density surveys and vegetation monitoring will be used to determine follow on management levels	FY 13
	MB-2 Camp Covington	FY 15	See MB-1 Note	FY 15
	MB-3 Camp Covington	FY 15	See MB-1 Note	FY 15
	MB-4 Atantano	FY 15	See MB-1 Note	FY 15
	MB-5 Sumay Cove	FY 16	See MB-1 Note	FY 16
	MB-6 Sumay Drive	FY 16	See MB-1 Note	FY 16
Evaluation for Fencing Areas	**NBG NMS**			
	NMS-7 Magazine Area-West	FY 13	-	FY 13
	NMS-8 Magazine Area-East	FY 13	-	FY 13
	NMS-1 Limestone Forest-West	FY 13	-	FY 13
	NMS-6 Limestone Forest-East	FY 13	-	FY 13
	NMS-2 Ravine Forest	FY 14	-	FY 14
	NMS-3 Almagosa Area	FY 14	-	FY 14
	NMS-4 Remote Lands	TBD	-	TBD
	NMS-5 Savanna/Grasslands	TBD	-	TBD
	NBS TS			
	TS-1 Haputo	FY 14	-	FY 14
	TS-2 Plateau-North	FY 14	-	FY 14

Management Action	Management Area (UMA)	Start Date	Notes/Follow Up Actions	End Date
	TS-3 Plateau-South	FY 14	-	FY 14
	TS-4 Grass/Scrub	FY 14	-	FY 14
	NBG MB			
	MB-1 Orote Peninsula	FY 13	-	FY 13
	MB-2 Camp Covington	FY 15	-	FY 15
	MB-3 Camp Covington	FY 15	-	FY 15
	MB-4 Atantano	FY 15	-	FY 15
	MB-5 Sumay Cove	FY 16	-	FY 16
	MB-6 Sumay Drive	FY 16	-	FY 16
Control	**NBG NMS**			
	NMS-7 Magazine Area-West	FY 14	Ongoing ungulate density surveys and vegetation monitoring will be used to determine follow on management levels and locations	Indefinite to maintain ungulate levels that allow recovery of native vegetation communities
	NMS-8 Magazine Area-East	FY 14	See NMS-1 Note	See NMS-1 End Date Note
	NMS-1 Limestone Forest-West	FY14/15	See NMS-1 Note	See NMS-1 End Date Note
	NMS-6 Limestone Forest-East	FY 14/15	See NMS-1 Note	See NMS-1 End Date Note
	NMS-2 Ravine Forest	FY 15/16	See NMS-1 Note	See NMS-1 End Date Note
	NMS-3 Almagosa Area	FY 15/16	See NMS-1 Note	See NMS-1 End Date Note
	NMS-4 Remote Lands	TBD	See NMS-1 Note	TBD
	NMS-5 Savanna/Grasslands	TBD	See NMS-1 Note	TBD
	NBS TS			
	TS-1 Haputo	FY 14/15	Coordinate with AAFB RHS Quarry Control actions (see 2012 AAFB UMP)	Indefinite to maintain ungulate levels that allow recovery of native vegetation communities
	TS-2 Plateau-North	FY 14/15	See TS-1 Note	See TS-1 End Date Note
	TS-3 Plateau-South	FY 14/15	See TS-1 Note	See TS-1 End Date Note
	TS-4 Grass/Scrub	FY 14/15	See TS-1 Note	See TS-1 End Date Note

Management Action	Management Area (UMA)	Start Date	Notes/Follow Up Actions	End Date
	NBG MB			
	MB-1 Orote Peninsula	FY 14	Ongoing density surveys and vegetation monitoring will be used to determine follow on management levels	TBD based on ungulate occurrence
	MB-2 Camp Covington	FY 16	See MB-1 Note	See MB-1 End Date Note
	MB-3 Camp Covington	FY 16	See MB-1 Note	See MB-1 End Date Note
	MB-4 Atantano	FY 16	See MB-1 Note	See MB-1 End Date Note
	MB-5 Sumay Cove	FY 17	See MB-1 Note	See MB-1 End Date Note
	MB-6 Sumay Drive	FY 17	See MB-1 Note	See MB-1 End Date Note
Ungulate Movement Studies (Optional)	**NBG NMS**			
	TBD	TBD	Radio collar deer (number TBD)	TBD

6.11 Costs

Estimate of the cost for management is based on the use of two or four ungulate control specialists employed full time to reduce ungulate densities to the desired levels. It is estimated it would cost approximately $120,000 per ungulate control specialist per year (salary plus other expenses such as insurance and overhead) for a total of $240,000 to $480,000 per year to hire the ungulate control specialists. In addition to the cost of the ungulate control specialists, it is estimated that approximately $100,000 in start-up costs will be required in the first year to purchase equipment, conduct training, and obtain necessary permits. After the first year, it is estimated that equipment and supplies would cost $50,000 per year. Based on this estimate it will cost between $340,000 and $580,000 for the first year of control management depending on whether 2 or 4 ungulate control specialists are used. Following the first year of control management it is estimated that costs would range from $290,000 to $530,000 per year depending on the number of control specialists used.

The costs of $290,000 to $530,000 a year would continue indefinitely in unfenced areas where complete removal of ungulates is not achieved. Fenced areas that have all ungulates removed would have lower costs, as control efforts would be greatly reduced (checking fences, repairing damages, and making sure no new ungulates have entered the exclosures). Total long-term financial outlay of the program could be significantly reduced if areas 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, the fences could also serve security purposes and reduce illegal access to NBG properties.

Table 6-3 presents the cost data in table format. It shows the annual cost breakdown for the first year and the next 9 years, and the totals for a 10-year program. Minimum and maximum costs are based on use of 2 or 4 ungulate control specialists. The minimum cost for year one is for two ungulate control specialists plus $100,000 start-up costs. The maximum cost is based on four ungulate control specialists plus start-up costs. Costs for years 2 through 10 are based on 2 ungulate control specialists plus $50,000 in equipment costs per year (minimum cost), or 4 ungulate control specialists plus $50,000 in equipment cost per year (maximum costs).

Total costs for 10 years of a professional ungulate management program would range from approximately $2,950,000 to $5,350,000.

Table 6-3. Estimated Costs Under Two Cost Estimation Scenarios

Activity		Cost for First Year	Annual Costs for Years 2-10	Total Cost for 10 Years
Ungulate control specialists based on $120,000 per specialist per year plus $100,000 for startup for the first year and $50,000 for follow on years	Minimum (2 Specialists)	$340,000	$290,000	$2,950,000
	Maximum (4 Specialists)	$580,000	$530,000	$5,350,000

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7. CONSULTATION AND COORDINATION

Personnel from the following agencies and organizations have been consulted or participated in the preparation of previous versions of this plan and in this updated version:

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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.

FSIS FORM 2630-12 (6/86) EQUAL OPPORTUNITY IN EMPLOYMENT AND SERVICES

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

APPENDIX P

INFORMATION SUPPORTING GROUNDS MAINTENANCE AND LAND MANAGEMENT

APPENDIX Q

INFORMATION SUPPORTING OUTDOOR RECREATION AND PUBIC ACCESS

APPENDIX R

INFORMATION SUPPORTING GEOGRAPHIC INFORMATION SYSTEMS

APPENDIX S

JOINT REGION MARIANAS INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN ENVIRONMENTAL ASSESSMENT