VIRGIN ISLANDS NATIONAL PARK

FINAL
ENVIRONMENTAL ASSESSMENT

Sustained Reduction Plan
For
Non-native Goats and Sheep
Within
Virgin Islands National Park

DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
SOUTHEAST REGION

JULY 2004

This Final Environmental Assessment (EA) evaluates impacts, alternatives and associated effects for control of non-native goats and sheep within Virgin Islands National Park.

Comments and Availability

Comments on this Final Sustained Reduction Plan for Non-native Goats and Sheep within Virgin Islands National Park Environmental Assessment should be postmarked by JULY 30, 2004 and addressed to:

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Virgin Islands National Park
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The Final EA is available for public review at the following locations:

Elaine I. Sprauve Public Library
St. John, VI

Enid M. Baa Public Library
St. Thomas, VI

VINP Visitor Center
Cruz Bay; St. John, VI

National Park Service Headquarters
Christiansted NHS; St. Croix, VI

The Final EA may also be viewed at www.nps.gov/viis or www.friendsvinp.org. Printed copies of the Final EA can be requested from the National Park Service at the address above; electronic copies can be requested by contacting Rafe_Boulon@nps.gov.

Important Notice. Reviewers should provide the National Park Service (NPS) with their comments during the review period for the Draft EA. This will allow NPS to analyze and respond to the comments at one time and to use information acquired in the preparation of a Final EA, thus avoiding undue delay in the decision-making process. Reviewers have an obligation to structure their participation in the National Environmental Policy Act process so that it is meaningful and alerts the agency to the reviewer's position and contentions. Vermont Yankee Nuclear Power Corp. vs. NRDC 435 U.S. 519.533 (1978). Environmental objections that could have been raised at the draft stage may be waived if not raised until after completion of the Final EA. City of Angoon vs. Hodel (9th Circuit, 1966) and Wisconsin Heritages, Inc. vs. Harris 490f. Supp. 1334, 1338 (E.D. Wis. 1980). Comments on the Draft EA should be specific and should address the adequacy of the analysis and the merits of the alternatives discussed (40 CFR 1503.3).

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historic places, and providing for enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to assure that their development is in the best interests of all. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

SUMMARY OF THE FINAL ENVIRONMENTAL ASSESSMENT

Introduction

St. John Island, the smallest of the three U. S. Virgin Islands is located near the Tropic of Cancer in a group of islands known as the Lesser Antilles that separate the Caribbean Sea from the Atlantic Ocean, and lies 70 miles to the east of Puerto Rico. Virgin Islands National Park is located on the island of St. John. Within the Park, three plants and five animals are listed as endangered or threatened under the Endangered Species Act. Twenty-five of its plants and one of its animals are listed as threatened or endangered under the Virgin Islands Endangered and Indigenous Species Act of 1990. It is this uniqueness that makes St. John a bastion of biological diversity. To date, 22 recorded archeological sites associated with the Prehistoric Indian cultures have been located on St. John. A systematic and thorough archeological survey of the entire island, however, would result in the discovery of many additional sites. An estimated twenty-percent of the island is listed in the National Register of Historic Places for its archeological significance. Virgin Islands National Park was established in 1956 to protect and preserve these nationally significant resources.

Non-native, exotic species introduced to St. John Island throughout the last 500 years have caused extensive damage to the rich resources of the island. Without aggressive management actions to reverse the tide of degradation caused by introduced exotic animals and plants, the rare biological and archeological resources of St. John are in peril of being lost forever.

This primary restoration plan proposes actions to:

1) Substantially reduce non-native goats and sheep within VINP,
2) Sustain a population near-zero through fencing, monitoring and periodic removal,
3) Promote the conservation and recovery of plant and animal species and habitat, and
4) Reduce disturbance of archeological and historical resources.

Description of the Alternatives

The two alternatives considered in this Final EA include: (1) No Action, Maintain Current Management Level; and (2) the Preferred Alternative, Reduce Goats and Sheep Within VINP and Sustain a Near-zero Population. Five additional alternatives were considered but eliminated form detailed analysis (page 29).

Alternative 1 – No Action: Maintain Current Management Level

Under this alternative, no reduction efforts would be used on the non-native goats and sheep within the boundaries of Virgin Islands National Park. Their population numbers would continue to rise and fall with the seasonal and long-term availability of food resources. Goats and sheep would continue to impact Park vegetation and wildlife including endemic and Federally and Territorially listed plant and animal species.

If left unchecked, goat and sheep populations would be expected to increase in size and area throughout the Park. In 1998, goats and sheep were found in several VINP areas, including Brown, Leinster, Bordeaux Mountain, Ram Head, Maho, Hawksnest, Reef, Lameshur watersheds and Hassel Island. During the next three years they immigrated or were intentionally introduced into the Cinnamon, Mary's

Point and Lind Point areas of the Park. From these new locations, goats and sheep have readily moved into adjacent watersheds, causing damage to sensitive natural and cultural resources. Goats and sheep also pose threats to public health and safety. This alternative is inconsistent with Federal mandates to protect water, plant, animal, cultural resources and visitor safety, and as well as similar Territorial regulations.

Alternative 2 – Environmentally Preferred Alternative: Reduce Goats and Sheep within VINP and Sustain a Near-zero Population

The program goals for the Preferred Alternative include:

1) Substantially decrease the goat and sheep populations throughout the Park to a near-zero level; and
2) Monitor and remove goats and sheep periodically, and install and maintain fences indefinitely, and
3) Minimize future wildlife encroachments through education, public outreach and partnerships.

Under this Alternative, the reduction program would occur in three phases:

1) Administration, infrastructure acquisition and selective fencing;
2) Collection using primarily baits, traps and contract hunters; and
3) Monitoring and periodic removal of remnant goats and sheep, resource education, community outreach, information dissemination, record keeping, fence maintenance and partnership renewal.

The preferred alternative would reduce ecosystem and archeological site disturbance and promote native species recovery. A population reduction effort by professional wildlife reduction experts through standard baiting, trapping and collection techniques would remove non-native goats from Virgin Islands National Park. Long-term monitoring and maintenance would sustain a near zero population because eradication is unfeasible.

	Alternative 1 A.1	Alternative 2 A.2
Alternative Features	**Goat and Sheep Control** No Action	**Goat and Sheep Control** Environmentally Preferred Alternative: Trapping, Shooting and Fencing
Goat and Sheep Reduction Goals	No reduction strategy would be implemented.	Substantially reduce goats and sheep populations throughout the Park. Monitor and remove immigrant goats and sheep, indefinitely.
Fence Construction	0 mile.	2 to 3 miles.
Duration of Program	0	1 year – planning; 2 to 3 years removal; monitor for and remove immigrant goats and sheep; indefinitely.

Summary of Environmental Impacts

For each alternative action, the Park analyzed the potential environmental impacts that would likely occur. Environmental impacts were divided into the following categories: Native Plant Communities, Rare and Listed Plants and Animals, Non-native Plants, Native Island Fauna, Non-native Island Fauna, Soil and Water Resources, Cultural Resources, and Human Uses.

The Preferred Alternative is Alternative 2: Reduce Goats and Sheep within VINP and Sustain a Near-zero Population. This action would be accomplished through selective fencing, baiting, trapping, shooting and periodic goat and sheep removal. Under this alternative, there would possibly be minor short-term impacts to native flora, fauna, soils, waters, cultural resources, and human uses due to the activities associated with feral goat and sheep reduction. However, following initial reduction of non-native goats and sheep, protection of Park resources would be immediate.

Native Plant Communities

Alternative 1 – Non-native goats and sheep would continue impacts on vegetation through grazing, accelerated soil erosion, seed dissemination, understory removal, exotic plant proliferation and trail creation.

Alternative 2 - The reduction of goats and sheep would have substantial positive effects on native plant communities.

Rare and Listed Plants and Animals

Alternative 1 - Non-native goats and sheep would continue to impact all known populations of listed plant species.

Alternative 2 - The three listed plant species and numerous rare plants would all benefit from the reduction of goats and sheep.

Non-native Plants

Alternative 1 - Non-native plants would continue to benefit from the ground disturbance activities of non-native goats and sheep.

Alternative 2 – A large reduction of the goat and sheep populations and their disturbances would substantially reduce long-term establishment and spread of non-native plants.

Native Island Fauna

Alternative 1 - Non-native goats and sheep would continue to directly and indirectly impact native wildlife through destruction of habitat, competition for food, and supporting enhanced populations of predators.

Alternative 2 - Goat and sheep reduction would reduce direct competition for food on many island animal species. Loss of habitat would also decrease wetland waterfowl and near-shore marine communities would be enhanced.

Non-native Island Fauna

Alternative 1 - Without reduction, non-native goat and sheep populations would continue to increase in the Park.

Alternative 2 – Within three years of implementation, goat and sheep populations would be considerably reduced within the Park.

Soil and Water Resources

Alternative 1 - Non-native goat and sheep grazing and herbivory would continue to reduce plant cover and greatly increase soil erosion, sedimentation and nutrient-loading (eutrophication) of ephemeral streams, salt ponds and ocean runoff.

Alternative 2 - Reduction of goats and sheep would greatly reduce soil disturbance, destruction of cryptobiotic crusts, and lessen soil erosion, ephemeral stream, salt pond and ocean sedimentation and eutrophication. Cyano-bacteria make up the majority of the micro-biotic crusts but lichens, mosses, green algae, micro-fungi and bacteria are present as well.

Cultural Resources

Alternative 1 - Non-native goats and sheep would continue to destroy irreplaceable archeological sites, historical resources, and would degrade and destroy the scientific values of these sites.

Alternative 2 – One of the secondary impacts of archeological and historical sites, goat and sheep populations would be reduced in approximately three years, thereby reducing their detrimental impacts to these sites on St. John and Hassel Island.

Human Uses

Alternative 1 - All NPS areas prohibit hunting unless it is specifically authorized in the enabling legislation. Human uses would change "free-roaming" grazing practices. The aesthetics of visits to the Park would be lessened due to reduction of native wildlife, reduction of plant cover, and destruction of archeological and historic sites. The scientific value of the Park's natural and cultural resources would decrease. Public health and safety would continue to deteriorate.

Alternative 2 - Visitor use and access would be limited in some areas while goat and sheep reduction occurs in selected areas. Reduction of goats and sheep would improve Park aesthetics, scientific values of natural and cultural resources, and recreational opportunities. A small number of persons would have the opportunity to register as NPS Volunteers (VIP's) and participate on a restricted basis with the reduction program. NPS would continually work with goat and sheep owners to keep goats and sheep at home, and perhaps assist with the control program implementation. Goats and sheep would no longer serve as co-hosts with native wildlife and livestock for infectious and parasitic diseases. Ranchers would continue to graze their livestock on non-Park land (approximately 48 percent of the island of St. John); about 25 percent of private lands are within the NPS boundary. Public health and safety would increase.

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I. CHAPTER I. PURPOSE AND NEED FOR ACTION

I.A. INTRODUCTION

The purpose of this document is to evaluate the short-and long-term environmental consequences of a control program for non-native Domestic Goats (*Capra hircus*) within Virgin Islands National Park (VINP), St. John, U. S. Virgin Islands. Non-native Domestic Sheep (*Ovis aries*) would be similarly collected from VINP as an ancillary part of the goat reduction program. Collectively their impacts to vegetation and wildlife are similar and this document focuses on goat impacts and the environmental consequences of a no action and preferred alternative. NPS would also be implementing a non-native wild hog sustained reduction program (Sustained Reduction Plan for Non-native Wild Hogs within VINP EA, NPS 2003) during the same time period to reduce costs and address similar impact types.

Animals, which are introduced or released by humans, either wild (e.g. deer), or domestic (e.g. cats), are considered non-native by conservation biologists throughout the world. Exotics (e.g. deer) are generally more frightened of humans, while feral animals (e.g. burros) can be very friendly to people. Each of these species disrupts complex native ecological communities, jeopardize endangered and native plants and animals, and degrade natural habitats.

Seventy-five percent of St. John is within the authorized boundary of VINP; however, the Federal land comprises only 52 percent of the island. Therefore, approximately 25 percent of the land is privately owned within the Park boundary. Because fencing and gating the entire Park is financially and logistically unfeasible, complete removal of any of the 12 introduced mammals from the Park is unrealistic. The next-best alternative is to substantially reduce the populations of the most detrimental species and take ongoing actions to sustain the near zero or minimal populations.

As described in Section II.B, the National Park Service and the United States Department of Agriculture (USDA), Animal Plant Health Inspection Service (APHIS) Wildlife Services (WS) Division, as lead agencies would conduct the reduction of non-native goats and sheep from VINP (Alternative 2). Each agency would have a Program Coordinator and this team would manage and supervise the program. The Virgin Islands Department of Planning and Natural Resources, Division of Fish and Wildlife (VIDPNR) would play an advisory role for the program.

A Memorandum of Understanding (MOU) was developed between the NPS and Virgin Islands Department of Agriculture (VIDA) and authorizes them to trap and remove goats and sheep from VINP (Appendix D). Both VIDA and NPS would aggressively promote the Animal Registration and Impoundment Program throughout the U.S. Virgin Islands. Additionally, VIDA would play an advisory role for the program.

All personnel involved with this program would follow the mitigation measures described in this document for the protection of resources. These actions have been determined to be the most successful actions available to abate on-going resource degradation and recover unique island resources.

The sustained population reduction effort would require the use of standard wildlife capture and removal methods including the possible use of fencing, baits, traps, snares, rifles, dogs and Judas goats (animals with radio-collars attached). Because goats and sheep are highly social animals, an animal equipped with

a radio transmitter can lead field personnel to remote locations where goats and sheep congregate. Goats used in this fashion are called Judas goats. The program goals include the reduction of goats and sheep throughout the Park to zero or near-zero, monitoring and periodic removal to sustain this reduction. Because eradication is impossible, the sustained reduction too near-zero is believed feasible. National Park Service guidelines for compliance with the National Environmental Policy Act (NEPA) require an analysis of potential effects of the proposed activity on the affected environment. This Environmental Assessment reviews these potential impacts and the actions necessary to prevent or mitigate any adverse effects.

I.B. PURPOSE AND NEED

The purpose of the Environmentally Preferred Alternative is to undertake a control program for non-native goats and sheep within Virgin Islands National Park (the Park). By reducing their populations inside the Park, adverse impacts to visitors, residents, and natural, cultural and marine resources would decrease. Collectively, goat and sheep populations pose a very large threat to the native natural resources, long-term resource management programs of the Park, cultural resources, and visitor health and safety.

People have accidentally or intentionally introduced hundreds of non-native species into natural communities worldwide, and while many die out, some persist and become permanent pests (Stone and Loope 1996). It is now widely accepted that the current rates of native species extinctions are dramatically higher than background rates; most current extinctions can be directly attributed to human activity. Human-caused extinctions can be roughly divided into four broad categories: non-sustainable use of resources, habitat destruction, pollution, and introduced non-native species (Soule 1990).

Introduced species are responsible for 39 percent of all recorded animal extinctions since 1600 for which a cause could be attributed (Treshy and Croll 1994). Thus, some impacts of introduced species are irreversible and at least as devastating as the other categories. Once established, introduced species often become permanent unless intentionally removed (Treshy and Croll 1994).

Native wildlife, however, in island ecosystems are particularly vulnerable to the impacts of introduced species. Of the 484 recorded animal extinctions since 1600, 75% have been island endemics. Introduced species were completely or partially responsible for 67% of these extinctions (based on the 147 island species for which the cause of extinction is known, calculated from the World Conservation Monitoring Centre 1992).

Islands are important for the conservation of biodiversity for four reasons: 1) a large percentage of their biota are endemic species and subspecies; 2) they are important breeding areas for seabirds, pinnipeds, and sea turtles, which forage over thousands of square kilometers of ocean but are dependent on relatively small amounts of protected land on islands for breeding and nesting; 3) many islands are sparsely inhabited or uninhabited by humans, keeping socioeconomic costs of protection low; 4) the species and ecological communities on islands have evolved in natural fragments, making them more susceptible than continental species to the problems of habitat fragmentation caused by small reserve size. Therefore, restoring and protecting islands, functioning unmanaged ecosystems can be maintained without large expenditures or significant conflict with local human populations (Treshy and Croll 1994).

Because the Park boundary is entirely inter-mixed with private or territorial lands, both small and medium-sized mammals readily enter from adjacent lands and establish breeding populations. Also, dozens of private inholdings exist within the boundary throughout the Park. For these reasons, the permanent elimination (eradication) of non-native goats and sheep from the Park would be very difficult.

The National Park Service Organic Act (16 U.S.C. 1 *et seq* [1988], August 25, 1916, sc. 408, 39 Stat. 535) mandates the parks to "conserve the scenery and the natural and historic objects and the wildlife therein...{to} leave them unimpaired for the enjoyment of future generations." Changes to the natural communities from human actions in the parks, including the continuous and unabated invasion of exotic and feral species, are contrary to the intentions of the Act. The Redwoods Act of 1978 (16 U.S.C. 1a-1) reaffirms this principle. In general, these two statutes confer upon the Secretary of the Interior the discretion to determine how best to protect and preserve park resources. Additionally, the NPS Organic Act, especially 16 U.S.C. 3, authorizes the Secretary of the Interior to destroy animals that may be detrimental to parks; therefore comprehensive control of exotics and their effects in the NPS is therefore incumbent on the agency.

On August 2, 1956, Congress established a portion of the U.S. Virgin Islands, "containing outstanding scenic and other features of national significance" as the Virgin Islands National Park, to be "administered and preserved...in its natural condition for the public benefit and inspiration..."(70 Stat. 940). In October 1962, Congress expanded the park's boundaries to include offshore areas "in order to preserve for the benefit of the public significant coral gardens, marine life, and seascapes..." (76 Stat. 746). The act also specified that there was no intent to limit customary uses of or access to offshore areas "for bathing and fishing, subject to regulations as the Secretary of Interior may find reasonable and necessary for protection of natural conditions and prevention of damage to marine life and formations." In 1978, Hassel Island, which is located in St. Thomas harbor, was added to the Park and not more than $1 million was authorized to be spent to restore and rehabilitate historic structures and develop public facilities on the island.

NPS Natural Resources Management Guidelines (1991, Chapter 2, Page 286) require that for each exotic or non-native species present within a National Park Service unit, an individual management and monitoring program be tailored to the particular park setting. This program includes a species evaluation, development of an information base, monitoring, initiation of management action, and establishment of an institutionalized follow-up program.

NPS is mandated to control/remove animals determined injurious to native flora and fauna. Management of populations of exotic plant and animal species, up to and including eradication, will be undertaken whenever such species threaten Park resources or public health. High priority will be given to the management of exotic species that have a substantial impact on Park resources and that can be expected to be successfully controlled (NPS Natural Resources Management Guideline 1991, Chapter 2, Page 286; NPS Management Polices 2001, Page 37).

National Park Service is required to identify and promote the conservation of all Federally listed threatened, endangered, or candidate species within park boundaries and their critical habitats. The National Park Service is also required to protect all state and locally listed threatened, endangered, rare, declining, sensitive, or candidate species that are native to and present in the parks, and their critical habitats. All management actions for protection and perpetuation of special status species will be determined through the Park's Resource Management Plan (NPS Management Policies 2001, Chapter 4, and Page 11). Management and monitoring programs should be coordinated with other state and Federal agencies.

Guidelines for management of species Federally listed as threatened, endangered or candidates for listing are found in NPS Management Policies and Natural Resources Management Guidelines, National Park Service Management Policies (NPS 2001) and guidelines for natural resources management (NPS 1991) establish the affirmative responsibility of NPS, and the individual Park, for managing both listed and candidate species. They also stress that management actions should emphasize removal of threats, but

also active recovery efforts and that management should be done in an ecosystem context.

The Endangered Species Act (ESA) requires actions authorized, funded or carried out by Federal agencies not jeopardize the continued existence of listed species. Under section 7(a)(2) of the ESA (16 USC section 1536), Federal agencies are required to consult with the U. S. Fish and Wildlife Service (USFWS) on actions which may affect listed species or critical habitat. Because this primary restoration plan proposes actions that may affect the 2 Federally listed plant species and 5 Federally listed wildlife species on St. John Island, NPS would consult with USFWS on likely effects to those species (Appendix A and C). The St. Thomas Lidflower and Prickly-ash Recovery Plans stipulate that trampling and grazing by non-native goats and sheep were a factor in the decline of each of these species and should be removed from the island to prevent continuing habitat degradation on St. John (USFWS 1988). The USFWS determined that this proposed action would have no impact on listed species or migratory birds; in fact, it would most likely greatly benefit them (see Appendix C).

National Park Service management also seeks to preserve and foster appreciation of cultural resources in NPS custody through appropriate programs of research, treatment, protection, and interpretation (NPS 2001). Guidance for cultural resources management in NPS units is found in National Park Service Management Policies (NPS 2001) and Cultural Resources Management Guidelines (NPS-28). Management of cultural resources in NPS units is subject to the provisions of the National Historic Preservation Act (16 USC 470 *et seq.*), the National Environmental Policy Act (42 USC 4371 *et seq.*), the American Indian Religious Freedom Act (42 USC 1996), the Advisory Council on Historic Preservation's regulation regarding "Protection of Historic Properties" (36 CFR 800), the Secretary of the Interior's "Standards and Guidelines for Archeology and Historic Preservation (FR 48:44716-40) and "Federal Agency Responsibilities under Section 110 of the National Historic Preservation Act" (FR 53:4727-460).

With the exception of bats, the Virgin Islands National Park is presently inhabited by numerous species of non-native mammals that have produced severe impacts on many indigenous species of plants and animals and threats to visitor safety (Appendix B). Feral or wild mammals include the white-tail deer (*Odocoileus virginianus*), donkey (*Equus asinus*), domestic goat (*Capra hircus*), wild hog (*Sus scrofa*), domestic sheep (*Ovis aries*), cattle (*Bos taurus*), West Indian mongoose (*Herpestes auropunctatus*), tree rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), house cat (*Felis catus*), domestic dog (*Canis familiaris*), and house mouse (*Mus musculus*). Some of these species also threaten visitor experience and safety. Increasing populations of these species are seriously affecting native species of plants and animals. Additionally, introduced species of birds, amphibians, reptiles, insects and plants are impacting the fragile environment (see Appendix B, List of Introduced Animals to St. John Island).

Non-native domestic goats (*Capra hirus*) and domestic sheep (*Ovis aries*) are ungulate species not native to North America or South America; but are from South West Asia (Gordon Luikart *et. al.* 2001). In Europe, the domestic goats came from South West Asia already domesticated. Christopher Columbus first brought goats and sheep into the West Indies in 1493. The Danes brought non-native goats and sheep to St. John in 1718 when they colonized the island. Goats and sheep have established non-native breeding populations in many areas and all habitat types of the Virgin Islands National Park.

A few residents say all goats and sheep have owners, and many people keep goats or sheep in herd sizes ranging from a few animals to several dozen. Many residents believe that "free-ranging" goatherds in the Park are not owned by ranchers. The Park has experienced goat and sheep grazing since it was established in 1956. The original areas of goat encroachment included: portions of Leinster Bay near the Johnny Horn Trail; Bordeaux Mountain area above and including much of the Lameshur watershed; the East End near the NPS Firing Range; the upper-eastern portion of Hawksnest Bay; and the Ram Head area. By the early 1990's, free-ranging goatherds were established in each of these areas, Mary's Point and Brown Bay. In 1999, 5 goats were abandoned at the former seaplane ramp at Lind Point. Finally, in

the summer of 2000, approximately 12 goats were abandoned on the North Shore Road immediately inside the Park boundary above Cruz Bay.

A conservative non-native domestic goat estimate within Virgin Islands National Park is from 600 to 1000 animals, and the present area of impact is essentially 95% of the Park, including the most sensitive and rare forest habitat types found in the Caribbean region. A conservative non-native domestic sheep estimate within the Park is approximately 50 animals. These estimates include animals that live in the Park and omit animals that graze the Park routinely, but live outside the Park, a situation that occurs at Bordeaux Mountain and the East End portion of the Park. Moreover, because of the dramatically increased herd size at Ram Head/Lameshur, and Brown Bay/Leinster, natural resource degradation would continue at an accelerated rate. In addition, perhaps the worst aspect is the new introductions at Lind Point and along the North Shore area, because goats could be impacting as much as 100% of the terrestrial Park, within a few years.

Goats and sheep are selective browsers, which mean they select for their favorite foods, and then only browse them (Coblentz 1974, 1977, 1978, and 1980). Goats and sheep tend to graze small shrubs and grasses very close to the ground and may even tear the roots from the substrate, preventing regeneration. The most fragile forest community on the island is the dry forest, which predominates, in the southeastern portion of the island. These communities may have the smallest possibility for recovery, and both their species composition and total individual numbers are low. In addition, steep semi-barren cliffs dominate this area, making a perfect habitat for the sure-footed goat. Precious topsoil is lost and degrades the coral reefs below the cliffs. Some individuals from the main Ram Head herd frequent the Lameshur Bay watershed, perhaps in search of water in the moist forest found there. This occurs on an almost daily basis and has continued unabated for the past several years. This is especially devastating because the Lameshur watershed forms a very large portion of the core area of the Virgin Islands National Park Biosphere Reserve.

Goat and sheep herds are capable of denuding large areas of all vegetation, including trees (through bark stripping) and cactus (Katahira and Stone 1982; Mueller-Dombois and Spatz.1975). The VINP represents possibly the largest and best example of dry tropical forest remaining in the Caribbean and these exotic species are having a serious impact on its health and sustainability. The spread of many non-native weed species is greatly facilitated by the transport of their seeds by animals and the presence of bare, unvegetated ground. Goats and sheep feed on the seed heads of annual exotic grasses and other weeds. The seeds emerge from the animal's digestive system intact and able to sprout. Goats and sheep also carry seeds in their coats, having the ability to transport seeds many miles from the source point. Further, the grazing and trampling by goats and sheep removes vegetative cover and creates bare ground for establishment of non-native plants (Yocum 1967).

Their hooves and browsing activities create trails and cause erosion precious topsoil from steep hillsides into adjacent wetland and marine environments. The sediments smother coral reef and sea grass ecosystems and reduce sunlight necessary for photosynthesis. The nutrients carried with the sediments cause algal and bacterial blooms that rapidly deplete the oxygen. The eutrophic result causes animals to move or remain and perish.

The only other wildlife that may be affected by changes in habitat created by goat and sheep browsing and grazing are the native and migratory birds. Nesting habitat in the native forests may be slowly and subtly changed (Scowcroft and Hobdy 1987). Food sources may also be changing as native plant species change in abundance and composition, and exotic plant species are introduced and spread (Stone *et. al.* 1992).

Goat/vehicle collisions within the Park are also a concern of managers and the public. These accidents usually caused inconvenience to the driver and passengers of the vehicles and led to vehicle damage. Drivers and passengers have been injured and some require a trip to the hospital. National Park Service Management Policies (4:6) authorizes control of animal populations "when they present a direct threat to visitor safety."

St. John Island contains a rich archeological record of the Prehistoric Indian culture contained in 22 recorded sites, with the earliest human occupations dating nearly 4,000 years ago. A systematic and thorough archeological survey of the entire island, however, would likely result in the discovery of many additional sites. Sites range from isolated artifacts to huge, stratified sites spanning a period of 4,000 years. The large number, diversity and relatively undisturbed nature of the island sites provide excellent research opportunities for archeological investigations into human adaptation in a context of changing environments and cultural conditions. Goat and sheep grazing has damaged a number of island sites, such as Cinnamon and Reef bays. The information potential of some shallow sites and surface scatters has been completely destroyed by goat and sheep grazing.

Goat and sheep grazing in the upper layers of deeper, more complex stratified sites profoundly disturbs time and spatial relationships and destroys the context of the information contained in these sites. Continued goat and sheep grazing of archeological sites on the island would likely result in the loss of integrity, and ultimately loss of the values which make these archeological sites eligible for inclusion in the National Register of Historic Places.

The long history of grazing by non-native ungulates has greatly accelerated erosion of soils on St. John. Large areas have been denuded of vegetation and are eroded down to bedrock. Trampling by goats and sheep exposes substantial sections of land to erosion by water and wind. This ensures that the native plants would not be able to recover, and also floods reefs with choking silt. Erosion and trampling cause disturbance to archeological sites that have long been protected from erosion by vegetation.

Program Objectives: Park-wide Sustained Reduction. The NPS proposes to implement a goat and sheep management program for Virgin Islands NP. The overall objective of the goat and sheep management program is to manage the Park according to NPS mandates and guidelines. This can be accomplished by preventing goat and sheep from interfering with the natural processes and perpetuation of natural features and native species, halting range expansion of goats and sheep, and preventing the threat to public safety from these species on the roadways within the Park.

The Virgin Islands National Park General Management Plan (1983) and Resources Management Plan (1999) identified the need to remove non-native animals and exotics from VINP. The objectives for management of non-native goats and sheep within Virgin Islands National Park include:

1. Protect the native species and natural processes of the Park ecosystems by reducing the impacts of goats and sheep on these species and processes.

2. Protect rare, endangered, or threatened species, and their habitat, by reducing goat and sheep populations and impacts on areas species and ecosystems.

3. Protect wetland, saltpond, freshwater and marine ecosystems, and their native inhabitants, by reducing goat and sheep populations and their sedimentation and nutrient-loading impacts.

4. Ensure the opportunity for visitor experience of undisturbed natural processes by reducing the effects of goat and sheep activity upon aesthetic and wilderness values of the Park.

5. Protect public health by monitoring goat and sheep populations and collected animals for possible diseases communicable to humans, livestock or wildlife.

6. Minimize adverse effects of goats and sheep, and control methods upon resources adjacent to the Park.
7. Conserve archeological sites threatened by accelerated erosion by goat and sheep trampling.
8. Initiate conservation and restoration of soil and wetland resources damaged by the activities of goats and sheep.
9. Control and reduce the spread of invasive, non-native plants caused by the activities of goats and sheep.

I.C. PARK LOCATION AND SETTING

Virgin Islands National Park is located near the Tropic of Cancer in a group of small islands known as the Lesser Antilles that separate the Caribbean Sea from the Atlantic Ocean. The most northwesterly of this clustered island chain are the Virgin Islands of the United States and Great Britain, and approximately 113 kilometers (70 miles) to the west, the U. S. Commonwealth of Puerto Rico. The U.S. Virgin Islands, made up of three main islands and 57 smaller, mostly uninhabited islands and cays, are found near the crossing of 18 degrees north latitude and 64.5 degrees west longitude. The island of St. John (52 square kilometers or 20 square miles) is the smallest and least developed of the three main U.S. owned Virgin Islands. St. Croix (218 square kilometers or 84 square miles) lies approximately 64 kilometers (40 miles) to the south of St. John, and St. Thomas (83 square kilometers or 32 square miles), lies about 4 kilometers (2.5 miles) to the west.

Virgin Islands National Park comprises 52 percent (2,816 hectares or approximately 10 square miles) of the island of St. John. Established in 1956, the park was expanded in 1962 to encompass 2, 287 hectares (8.7 square miles) of the surrounding waters. Of the NPS land on St. John, either private interests or the Virgin Islands government owns three square miles. In 1978, Congress authorized the addition of approximately 135 acres on Hassel Island in the Charlotte Amalie harbor, St. Thomas to the Park. The NPS has acquired most of the land on Hassel Island and has limited first right to match any offers on most of the remaining private properties. The Virgin Islands government also owns small parcels of land on Hassel Island. Also, on St. Thomas, approximately 15 acres in the Red Hook area are under park jurisdiction and, until recently, served as the Park's administrative purposes; and approximately five acres at Wintberg for administrative purposes.

Because of the internationally significant natural resources, Virgin Islands National Park was designated an international biosphere reserve in 1976, by the United Nations Educational, Scientific and Cultural Organization; and is among the few biosphere reserves with both marine and terrestrial resources. The Park was included in the United Nations Biosphere Reserve System as a representative example of Lesser Antillean cultural and natural ecosystems.

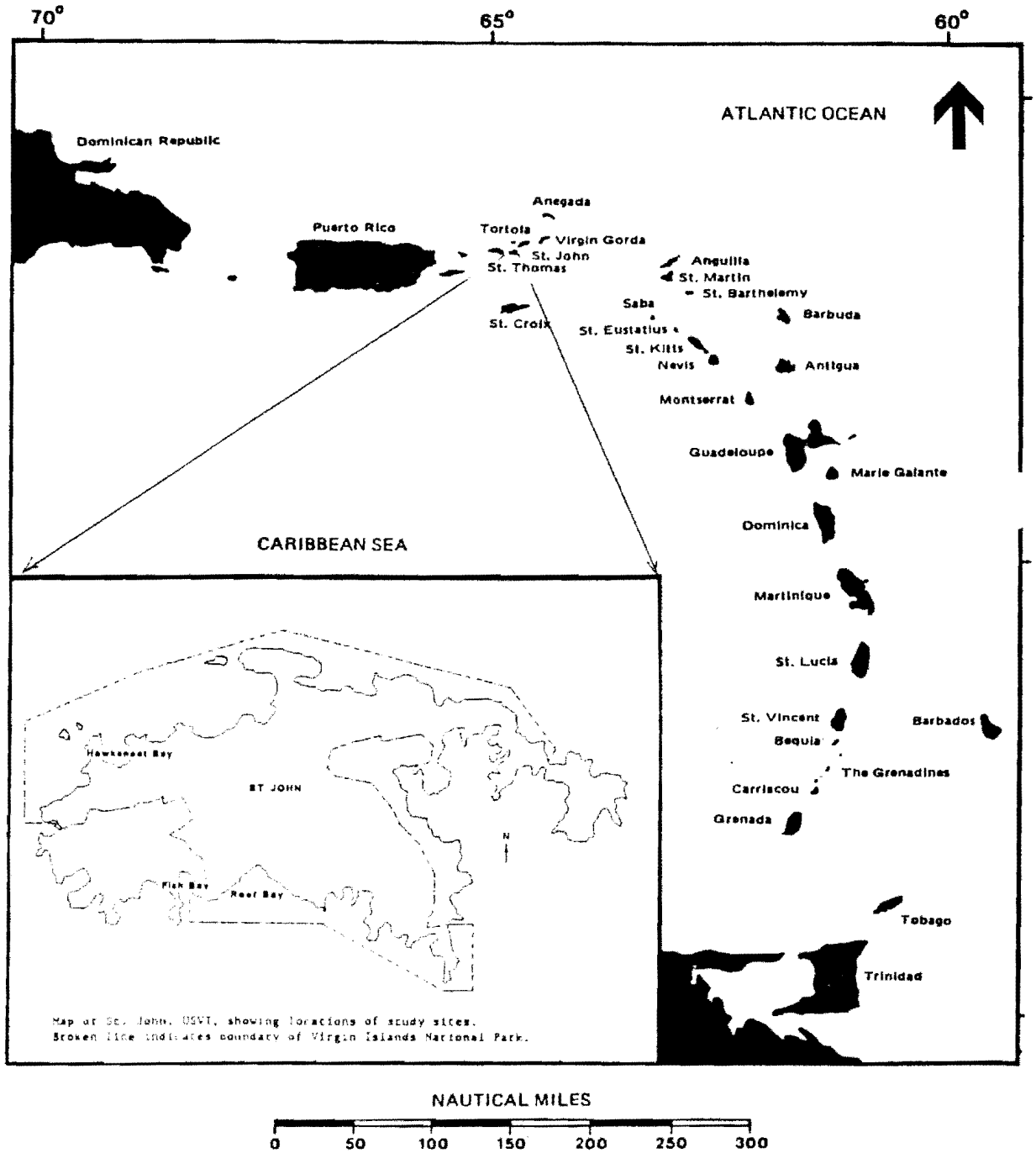
Virgin Islands National Park contains examples of most tropical Atlantic terrestrial, coastal and marine ecosystems. These include various examples of subtropical dry to moist forest, salt ponds, beaches, mangroves, seagrass beds, corral reefs and algal plains. Terrestrial topography is quite dramatic with average slopes being 30 percent. The highest elevation at Bordeaux Mountain (1,277 feet) plunges sharply to the sea over a distance of three-quarters of a mile. Rock petroglyphs, middens and three settlements are several of the remains of prehistoric cultures found to date. European settlement patterns and plantations systems significantly altered St. John's biology and ecology by removing native forests, mining corals for construction, building structures, terraces, rock walls and roads, and importing vegetation and mammals. The plantation settlements took advantage of the labor of enslaved Africans.

For most of the year temperatures are in the seventies and range from the mid-sixties in the winter months

(November-February) to the high eighties in the summer months (July- September). All precipitation is in the form of rainfall. The average annual rainfall in the Virgin Islands is only about 41 inches, but variation from year to year is considerable. The average on St. John is from 35 inches of rain on the south and east end to 41 inches in the interior. During the year rainfall pattern show an erratic distribution. It varies from a fraction of an inch in a dry month to as much as 18 inches in a single event. Unlike other tropical regions, the Virgin Islands do not show marked climatic seasons except perhaps more precipitation in the rainy season (May and June and September through November). Water conservation is a way of life in the Virgin Islands. The prevailing winds for most of the year are the South East Trades. The winds from this direction allow for slightly more precipitation on the north side of the island than the south side and favor higher lands.

The last four decades have brought considerable change on St. John through the development of vehicular transportation and roads, resorts, and other tourist facilities. In terms of visitor attractions, scenery, beaches and spectacular marine gardens are the most significant features of Virgin Islands National Park. However, there are an estimated 250 historic structures within the Park, most of them remnants of the Danish sugar plantation era, which are increasingly popular with visitors. Over the past ten years, visitation to the Park has averaged approximately 942,800 persons annually.

Figure 1. Location of St. John, U. S. Virgin Islands



II. CHAPTER II. DESCRIPTION OF THE ALTERNATIVES

The alternatives address the management of domestic, non-native goats and sheep within Virgin Islands National Park. Alternatives were derived through the public scoping process and in cooperation with the Virgin Islands Department of Agriculture (VIDA) and the U.S. Department of Agriculture's (USDA) Wildlife Service program (AHPHIS). The National Environmental Policy Act (NEPA) requires that a reasonable range of alternatives be developed to provide decision-makers and the public with a clear basis for choice (*40 CFR 1502.14*). Case law has determined that reasonable alternatives include those that are technically and economically practicable and feasible, using common sense, rather than those that are simply desirable (*46 CFR 18027, Forty Most Asked Questions Concerning CEQ's NEPA Regulations*).

The alternatives detailed below were developed to focus on issues identified by NPS resource specialists, goat and sheep reduction experts and other control experts, government regulatory agencies, and the general public. Chapter VI, Consultation and Coordination, lists all agencies and organizations that may have provided input regarding the proposed action.

This chapter describes the alternatives that were analyzed in this Environmental Assessment for reduction of non-native goats and sheep within Virgin Islands National Park. Following a brief description of control techniques for implementation (II.A.1), the alternatives for goats and sheep are (1) no action; and (2) reduce goats and sheep within VINP and sustain a near-zero population, the Environmentally Preferred Alternative.

The comprehensive sheep and goat management program is outlined in three phases, which are detailed below and comprise a range of alternatives. Several methodologies are necessary to accomplishment management goals efficiently and humanely throughout the remote and challenging park and indefinite time period. Initial actions focus on humane goat and sheep removal from VINP, the later actions focuses on preventing additional encroachment. The action would be accomplished primarily through, baiting, trapping and limited shooting. Secondary techniques for possible future control consideration include use of tracking "baying" dogs, snares, and radio-telemetry for "Judas" goat collection alternatives. Partnership renewal focusing on ongoing education to minimize new goats or sheep from entering VINP is of paramount importance. The description of the Environmentally Preferred Alternative is located in the document after Alternative 2. A majority of goats and sheep removed from VINP would be donated to wildlife ranches or donated for general utilization. All aspects are thoroughly described in appropriate sections of this document.

As required by NEPA, Alternative 1 is included as a "No Action" alternative, serving as benchmarks against which other action alternatives can be compared. This alternative represents the state of the management of these non-native wildlife populations within Virgin Islands NP at the time. Chapter II.A.2 contains a section that explains the rationale for dismissing other methods or alternatives from consideration and detailed comparative analysis.

II.A. Non-native Goat and Sheep Control Alternatives

II.A.1. Non-native Goat and Sheep Implementation Plan

This section describes available control and related techniques and methodologies for non-native goat and sheep control in the Park, including fencing, shooting, baiting, trapping, snaring, dogs, chemical restraint and radio-telemetry. Limited use of field volunteers for goat and sheep collection is addressed. Final disposition of collected animals including land burial and charitable meat donation are included. The section concludes with a section describing public outreach, information and education. The term collect as used in this document refers to a captured or dispatched animal.

Request Goat and Sheep Owners to Remove Stray Animals

Prior to implementing a plan to reduce goats and sheep from the Park, owners of goat and sheep herds would be requested by letters and press releases to remove their livestock from within the boundaries of Virgin Islands National Park. Owners would be required to remove their animals within 60 days of the start of the reduction program. At the close of this sixty-day period, any goats and sheep within the Park would be considered abandoned property, and collected to protect Park vegetative communities from the negative effects of grazing by goats and sheep (Code of Federal Regulations, Title 36, Part 2.15(5)(c): pets or feral animals). The Virgin Islands Code, Title 19, Section 2616 (a): "any animal found running at large, or tied on public property or on private property without the consent of the owner of said property, shall be taken up by animal wardens and impounded in an animal shelter, and there confined for disposition in accordance with the provisions of this subchapter."

Fence Existing Long-term Vegetation Monitoring Plots

Fencing is expensive but perhaps feasible for small areas, therefore, existing long-term vegetation monitoring plots (research exclosures) would possibly be fenced. Currently, at least 26 special protection areas in VINP have been identified but remain unfenced. A network of long-term ecological monitoring plots, representing a range of plant community stand ages and land-use histories, has now been established in each of the following forest types on the island: upland moist, gallery moist, dry evergreen woodland and dry evergreen scrubland. Peter Weaver (1999) has established 16 plots in the dry evergreen and moist forest of the Cinnamon Bay watershed; the New York Botanical Garden has three plots covering upland moist, gallery moist and dry evergreen woodland; and the Smithsonian has two plots covering dry evergreen woodland and dry evergreen scrubland. In addition, the USDA-NRCS has five long-term plots in the Lameshur and Cinnamon Bay watersheds to measure soil temperature and moisture. Information on forest regeneration, tree seedling growth, changes of species composition and forest structure are gathered by researchers through Memorandums of Understanding, Cooperative Agreements and direct National Park Service funding.

Fencing these long-term monitoring plots would provide an immediate protection solution, but must be regularly monitored and maintained protect them from encroachment by wildlife, vegetation or human encroachment or storm damage. Other endangered, rare or unique concentrations of plants or animals would be identified for protection as warranted. The need for special protection fencing depends on the size, location and long-term plan for the existing research area. Careful consideration must be provided to ensure: 1) archeological clearances, 2) appropriate, environmentally sensitive installation, and 3) accurate maintenance funds are obligated.

Fencing would be constructed from vinyl-coated galvanized chain-link fence with 7-foot metal spade posts manually driven 2 – 3 feet into the substrate and appropriately spaced. Diagonals near gates would provide stability and the use of cement would be minimal.

Fence Selected Areas of the VINP Boundary

Ungulate-proof fences would be considered for installation to permanently restrict their access to park land immediately adjacent to Herman Farm, L' Esperance and Catherineberg, and within portions of Brown, Reef, Lameshur, Cinnamon, Hawksnest and Francis bays, the NPS Range, Rams Head and Hassel

Island. These locations have been historically breached by goats or sheep, and allow easy entry into VINP. Where necessary restricted-access, ungulate-proof gates would be installed and maintained; these gates would not change human access to park lands. During fence installation the opportunity would be used to collect subsurface archeological information on a systematic basis by mapping and shovel-testing the post holes as they are dug. NPS may provide money to assist ranchers with fence installation or repair to reduce non-native animal encroachment of NPS lands.

Fence installation would follow consultation with goat and sheep ranchers, and VIDA would typically be consulted. Their assistance and cooperation would be solicited and encouraged throughout the ongoing goat and sheep reduction program. Enhanced community outreach through numerous governmental and non-governmental organizations would continue to be an essential and ongoing component.

In arid and semi-arid regions, goats need freestanding water to drink and they occasionally congregate around watering holes. By taking advantage of this they can be trapped with fences surrounding the watering hole using a one-way entrance.

Use of Local Field Volunteers

The Volunteers-In Parks (VIP) program would be used to involve St. John and St. Thomas residents to share their knowledge, labor and hunting skills to assist with specific goat and sheep collection activities. Local knowledge would be gathered from island residents regarding trap design, manufacture, placement, seasonality, fruiting cycles, movement patterns, and bait choice. This program responds to a cultural tradition which includes a long history of goats and sheep on the island, and what is known archaeologically about enslaved African Americans, and others, supplementing their diets, (at least in some areas of the Americas), through hunting, fishing, and trapping (Olwig 1985).

VIP's authorized by VINP would participate under the exclusive direction and authority of the Park Superintendent (or his designee); such VIP's would be prohibited from using firearms and must participate within the guidelines established by the NPS and USDA Program Coordinators. VIP's may be used to install and maintain fences near the VINP boundary or selected vegetation monitoring plots.

Baiting

Baiting would take place with careful monitoring to ensure consumption by target species. Small bait stations would be established in various locations within the Park. A single aged ram generally leads a herd. If he can be removed, the remaining animals can often be readily collected. However, lead rams are often challenging to collect. Bait stations may or may not operate concurrently depending on available personnel, placement and climatic conditions. Temporary bait stations would be initially established within or near areas of high goat and sheep concentrations as determined by field observations, track and scat data. No specific bait is considered ideal for goats or sheep; therefore, traps would be initially baited with shelled corn, although other baits, including water, would be tested. As animal concentrations change and move within a watershed, bait station locations would also change. Because goats and sheep are mobile between wet and dry seasons, temporary and non-fixed bait stations would be employed. Goats and sheep may not bait into an area, but through baiting efforts, they may become concentrated in an area.

During the bait station acclimation period, field observations, scat and track analysis would allow field personnel to estimate the population size using the bait station. As animals are removed from the surrounding area, those numbers could be compared with the initial population estimate to determine the reduction percentage for the general area. Careful data collection and record keeping would be supplemented with photography.

Traps and Snares

Initially, trap usage might represent the highest number of animals collected for the least amount of human effort. Therefore, a few different models or techniques would be employed to collect goats and sheep, including single box and multiple corral-style live traps, drop nets, and snares. Trap success is a function of natural food availability, environmental conditions, goat and sheep population densities and distribution, trap placement, trap design, age and previous trapping activity (Fox and Pelton 1977). Portable, chain-link single-catch traps have been the most practical and efficient traps for capturing goats and sheep in many areas. These may be constructed for remote use in this program, in addition to the multiple-catch corral trap envisioned to capture the majority of trapped goats and sheep. Live-capture traps may be assembled in the field and dismantled for movement to a new site. While live capture traps are more expensive to obtain and use, they are preferred over kill traps. VIDA employs multiple-catch corral traps relatively effectively throughout the territory for capturing goats and sheep.

Rigid, heavy-gauge welded wire panels measuring 4 x 8 feet would be wired together and fastened to an independent, one-way door. Three panels form a triangular corral trap capable of holding several animals. Additional panels may be joined to increase the corral size. Pre-baiting with no door may be necessary.

Although trapping is an effective control method and might remove many goats and sheep from the Park, it has some limitations. For example, some animals may be or would become "trap shy" and may avoid traps regardless of bait type or trap location. In addition, it is difficult to transport traps to some areas of the Park due to the remote, rugged and steep terrain or without causing serious impacts to natural or sensitive areas. Finally, in terms of time, trapping is extremely labor-intensive. Therefore, the most cost-effective method for controlling goats and sheep in the Park is a combination of trapping and shooting.

Live traps are the preferred method of capture; neck snares may be used rarely in conjunction with independent bait stations. Traps and snares would be inspected at minimum 12-hour intervals; many may be checked at smaller time intervals. Initial trapping typically yield the highest ratio of animals collected over time and this value drops over time until trapping in the area is no longer cost effective.

Neck snares would only be considered for deployment under rare circumstances and in remote locations. Neck snares would be constructed using slip-wire and secured close to the ground along established corridors frequented by goats and sheep and remote from human activity. Wildlife conservationists consider these to be live traps for virtually all targeted wildlife captured. However, white-tailed deer sometimes behave erratically and may readily suffocate and quickly (and humanely) die. Neck snares would be employed in selective and remote areas to lead rams. Cost-effective and only in areas where other collection methods have failed. Capture and disposition of nontarget wildlife is addressed in a separate section below.

Guidelines for trapping goats and sheep include:

1. Trap inspection within 12 hours maximum intervals,
2. Trap placement remote from visitors (when feasible),
3. Plot trap locations on topographic maps using global positioning system (GPS), and
4. Coordinate trapping efforts by NPS/USDA program coordinators.

Animal Control Agents

Most goats and sheep would be collected from Brown, Leinster, Reef, and Lameshur bays, Ram Head and Hassel Island. Additionally, goats and sheep would be collected from NPS property throughout St. John and Hassle Island, because they inhabit a majority of VINP.

Trained and certified animal control agents would collect goats and sheep on the ground or from temporary tree stands, with the possible use of the techniques and technologies described below. USDA APHIS and NPS personnel would be qualified and certified for the centerfire rifle or shotgun used to dispatch goats and sheep, a silenced pistol may be employed to safely dispatch some corralled animals. Firearms used for this program would be equipped with telescopic scopes and silenced muzzles (except the shotgun). Transportation of field personnel may include trucks, jeeps, horses, all terrain vehicles and boats. Temporary tent camps may be established in remote areas.

Large-scale wildlife collection operations would be closely coordinated with the public, Virgin Islands Territorial Government officials, in particular VIDA, NPS Law Enforcement, Interpretation Rangers, and Maintenance personnel. Resident and visitor safety is of paramount importance, along with the humane treatment of wildlife during all program operational phases. Direct reduction activities would be well organized by NPS and USDA Program Coordinators and Law Enforcement authorities. NPS Law Enforcement personnel and others would ensure proper closure and visitor clearance from each area, as necessary. Personnel safety would be of greatest concern at all times. Field personnel would be equipped with both a two-way radio and cellular telephone linked through the newly renovated VINP radio system. A full-time NPS dispatcher would ensure smooth communication between all field personnel. Most collections would be small-scale operations using single or corral traps.

Tracking "Baying" Dogs

Use of well-trained and experienced tracking "baying" dogs can be extremely cost effective when seeking to remove a small number of trap-shy individuals. Use of dogs would be considered for humanely collecting individuals where other alternatives have failed. The removal of goats or sheep from remote, densely vegetated locations would possibly require the use of trained tracking dogs. These specialized animals would be brought in from the U.S. mainland and maintained under strict control at all times. Dogs would be under the control and guidance of USDA Program Coordinators and visitor safety would be foremost in all operations.

Every successful NPS goat and sheep reduction program on an island or the mainland environment has relied upon the use of tracking dogs to locate goats or sheep. Tracking dogs are being used at Hawaii Volcanoes and Channel Islands National Parks to locate goats in steep terrain, and in dense brush and forest. They would only be used to locate goats and not contact the goats. As they would be under strict control at all times, they would produce no impacts to ground-nesting birds. Dogs, prior to being allowed in the Park, would be vaccinated for all common canine diseases. The USDA would be required to submit inoculation documentation.

Chemical Restraint and Radio-telemetry

Because goats are highly social animals, one equipped with a radio transmitter can lead field personnel to remote locations where goats congregate (Taylor and Katahira 1988; White and Garrott 1990). A goat used in this method is termed a "Judas" goat. Before fitting an adult goat with a radio transmitter, the animal must first be captured and restrained through injection of chemical sedatives. The fastest, safest and most humane method to restrain goats for attaching a radio collar is through chemical restraint. Standard large-animal restraint drugs would be used to temporarily sedate trapped goats. USDA-APHIS personnel have extensive training in the preparation and use of chemical restraint and immobilization drugs for large (and small) animals throughout North America (Kreeger 1997). Their experience includes many successful goat and sheep reduction or eradication programs.

Telazol is a combination of tiletamine and zolazepam and would be used in conjunction with Rompun to reduce nausea (Kreeger 1997). Goats and sheep are particularly susceptible to overheating and would be kept in the shade with provisions for wetting them down as necessary (IWVS 1991) Intramuscular

Telazol injections would be administered by either a jab stick, blow gun or CO2 pistol to captive individuals in corral or box traps. Fewer than five goats would be collared in each watershed. Immobilization drugs and drug delivery equipment would be restricted to employees responsible for goat management under the direct field supervision of the Program Coordinators. These employees must have completed a Wildlife Immobilization Practitioner Course as required by NPS-77-4. Immobilization drugs would be stored in a locked safe and records would be maintained to include the date, amount used, purpose, and signature of the user. Since Telazol and Rompun are listed as a Class II substances, all guidelines for use and storage specified by the Drug Enforcement Administration would be followed (Fowler 1978). Radio-collared animals would be monitored at least twice a year to detect and remove ingress animals into the control units (Hegdal and Colvin, 1986; Kreeger 1997). Following a maximum three-year term, "Judas" goats would be humanely collected.

Capture and Disposition of Non-Target Wildlife

The live capture and snare traps proposed for use in this program is relatively species specific. Moreover, they are widely considered live traps; which means the majority of trapped animals are found alive. Both target and non-target species are generally found uninjured or only moderately injured in the snare. A minor amount of injury is impossible to avoid, while every reasonable measure would be employed to reduce injury and suffering of both target and incidental wildlife captured throughout the reduction program. Live traps and neck snares are considerably more expensive to obtain and use, but are preferred to use of leg snares or kill traps, because they are more humane when used properly. The nontarget wildlife that might become incidentally captured includes the following non-native species: white-tailed deer, hogs and burros. These three exotic species have been selected for extensive population reduction programs. The sustained hog reduction program is currently underway, and captured hogs will be humanely collected. Few (if any) white-tailed deer are expected to be captured; however, these would be humanely collected. Donkey capture would be extremely rare and those would be released. Other non-native species would be humanely collected.

Final Disposition and Use of By-products

Biological data would be collected from all captured goats and sheep. Collected goats and sheep would be turned over to VIDA in a majority of cases, for final disposition with wildlife ranchers or for private utilization (slaughter). In many cases VIDA personnel will be authorized to live-trap goats and sheep directly; all pertinent data will be recorded before final utilization. Some would be donated by VIDA or NPS/USDA to island residents strictly for personal (private) utilization. Only ranchers participating in the VIDA Animal Registration and Impoundment Program qualify to accept livestock.

In extremely remote locations where transport is impractical or impossible (*e.g.* Brown Bay bottom-portion), euthanized goats and sheep may be treated with lime to facilitate decomposition. This treatment would occur a minimum of 50 feet from established VINP trails and an equal minimal distance from drainage guts or saltponds. Lime accelerates the rate of decomposition in the warm, moist subtropical weather; a100-pound carcass often completely decomposes within 5 days. On rare occasions when overland transport is impractical and topography and wetland proximity prevent liming, collected animals may be brought to sea, weighted and released a minimum of one nautical mile from the shore.

VIDA veterinarians are certified by the USDA to inspect livestock for public consumption, for example, for use in a hospital or prison. Livestock consumed by private individuals does not require VIDA or USDA inspection, certification or approval. Residents accepting donated meat from the NPS for private consumption would be required to sign a form stating the guidelines for handling the meat and reiterating its' use for private consumption (not for resale). Because the public has had a long association with capturing and consuming goats and sheep, the NPS has spent considerable energy to ensure collected animals could be legally and safely provided to them (directly) for private consumption, and for public

consumption through VIDA. Field supervisors would ensure personnel involved in data collection or butchering operations wear protective gloves and avoid contact with reproductive tracts or fetuses of female goats or sheep. VIDA concurs with this protocol.

Community Outreach and Education

Public awareness regarding the goat and sheep reduction program would be promoted whenever possible. NPS and USDA personnel would work with community leaders, the Virgin Islands Government, Friends of the VINP, and non-governmental organizations to establish communication avenues, provide education, and resolve problems. The NPS would spearhead a program with these groups to establish and provide general information, and ongoing education through community involvement. This information would systematically be disseminated throughout the community and the park via broadcast, print and the electronic media. General conservation information regarding biology and ecology of introduced animal and plant species; both locally and globally, would be included in this educational outreach campaign.

There is also a need to convey information regarding goat and sheep management to Park visitors. Many visitors are unaware of goats and sheep existing in the Park; nor do they realize the devastating impact goats and sheep have on Park ecosystems. Information and presentations in the form of posters, published articles, bulletin board fliers, exhibits, signs, brochures, and slide and video programs would be used to address goat and sheep biology and management. This work would dovetail well with the projects currently underway to develop a comprehensive non-native animal brochure series whose intended audience is island visitors and residents. A well-placed exclosure may be installed for the public to learn about introduced herbivores and their impacts on vegetation.

Park biologists, interpretive rangers and their counterparts at DPNR and particularly VIDA would work together to routinely educate the community through partnerships with the University of the Virgin Islands Cooperative Extension Service, Friends of VINP, the Environmental Association of St Thomas and St. John and the St. John Community Foundation. The partnership would establish and regularly disseminate information regarding island ecology and the necessity to keep livestock tagged and fenced. The group would recognize and respond to the necessity of public outreach with goat and sheep ranchers.

In concert with VIDA, the Cooperative Extension Service and other partners, the NPS would continually work with goat and sheep ranchers to keep goats and sheep on private property; and emphasize the importance of the Animal Registration and Impoundment Program.

A public meeting was held at the Legislative Conference Room on August 12, 2003. Personnel from VIDA, PNR, Friends of the VINP and the St. Community Foundation were invited. About 40 persons attended the two-hour meeting, which was conducted by Ralf Boulon, Chief of the Resources Management Division, VINP. A comprehensive presentation outlined the VINP feral/exotic mammal control program included rats, cats, mongoose, hogs, goats, sheep, deer and burros. Special attention and emphasis were placed on goats, and the associated problems within the protected lands of VINP. After discussing various control alternatives and others considered but rejected from detailed analysis, Mr. Boulon explained NEPA and the process through which Park managers involved the public and other neighbors, evaluated and finalized alternatives, and gained approval to implement a program to reduce the impacts to the natural and cultural resources of VINP. Questions were addressed at the end of the meeting.

A VIDA veterinarian briefly described the Animal Registration and Impoundment Program (Virgin Islands Code, Act 5911; USVI DOA 2002) implemented last year to tag all livestock, including every sheep, burro, horse, cow and goat within the territory. Number and color combinations are assigned to the individual ranchers to allow for notification of stray livestock owners by NPS (or others). Mr. Boulon

emphasized the ranchers would be given a lengthy period to remove goats and sheep from within NPS property before reductions would commence.

A VIDA official asked if his staff could trap goats or hogs from within NPS property and VINP implemented a Memorandum of Understanding (MOU) with VIDA for 5 years (Appendix D). VIDA may consider trapping hogs or goats from some communities bordering the NPS. This effort may provide additional livestock for ranchers and simultaneously remove individuals from the Park. A majority of attendees spoke favorably about the removal of goats (and other mammals) from all or sensitive areas within VINP. A few ranchers noted seeing more introduced mammals (livestock) throughout the Park now, in comparison with previous times when they were growing up on the island. One questioner asked if the enabling legislation could be changed to allow for sanctioned hunting activities. However, due to the small size of VINP, the large_extent to which fragmentation by roads, trails and inholdings occur, and the high extinction potential of both goats and hogs; the authorization of hunting would not satisfy the program objectives and would be extremely difficult to safely manage and regulate.

One VIDA employee noted a problem with the hog meat donation program. Hog meat from the reduction program is donated to persons strictly for their personal consumption, and NPS would not donate hog or goat meat for institutional use, e.g. the Territorial Prison. However, a hog meat recipient misunderstood this and brought his hog carcass to VIDA for inspection. The VIDA veterinarian, NPS, and USDA-WS agreed to include detailed written instructions for each hog or goat recipients and this along with detailed verbal guidelines should suffice to clarify the final disposition of donated meat.

In concert with VIDA, NPS would continually work with goat and sheep owners to keep goats and sheep on private property; and perhaps assist with the control program implementation.

Ecological Research and Monitoring

Monitoring and assessment of key ecosystem components would be a necessary component of a sustained reduction program for goats and sheep. Pre-reduction surveys for baseline data of goat and sheep damage would be conducted. Post-reduction surveys of affected areas would be conducted in order to measure reduction in damage due to the control of non-native goats and sheep.

During the bait station acclimation period, scat and track analysis would allow field personnel to estimate the sub-population size using the bait station. As animals are removed from the surrounding area, those numbers could be compared with the initial population estimate to determine and approximate reduction percentage for the general area. Careful data gathering and record keeping would be supplemented with photography.

Monitoring programs would focus on the long-term impacts to vegetation, and the disease status of goats and sheep. The presence and status of disease organisms in goats and sheep should be investigated every five years. Fruiting cycle surveys would also be used to monitor food availability and distribution. Results of these surveys would be used to ascertain goat and sheep movement and to aid in developing control strategies, efficiency and cost effectiveness. Long-term monitoring involves the maintenance of permanent goat and sheep exclosures in areas containing long-term vegetation data.

Research efforts would concentrate on the natural history, population dynamics, and impacts of goats and sheep on the Park ecosystem. The 'Judas goat' technique would be evaluated to determine its efficiency when used for localized reduction programs. Future research relating to goats and sheep would be systematically identified and conducted as needs are identified the prioritized. Some disease and parasitism investigations would also be carried out (Stuht 2001). Stuhts' (2001) study on St John should be repeated and an attempt made to collect more samples of goats and deer. Research relating to goats

and sheep would provide information useful in refining control techniques, population censusing and habitat utilization modeling (Brisbin and Mayer 2001).

Restraint and Handling of Non-native Goats and Sheep

Although goats have the reputation of being able to withstand heavy stresses, in reality they are relatively delicate. Their bones are small and easily broken. Rough handling is avoided and necessary, goats are docile and easily managed; when accustomed to being handled (Fowler 1978).

Goats do not bite, strike or kick, but usually fuss more than sheep. They vocalize and they may stamp their feet in obvious threat, but once they are grabbed they do not strike. They do, however, use their heads for butting. Horns pose the most serious threats to human handlers and may be used as battering rams. The ram (male) is frequently adorned with heavy horns capable of inflicting serious injury.

Goats are considerably more agile than sheep and less prone to accept people placing an arm around the goat's chest. If placed in the set-up position, a goat would lash out with both forefeet and hind feet in a purposeful attack on the face and hands of the handler.

Sheep are one of the easiest of the large domestic animals to handle (Fowler 1978). Sheep do not generally bite, strike or kick a human handler. The only danger of injury they offer is from the use of the head as a battering ram. Fortunately, they grow either horns or antlers.

Sheep are one of the easiest of the large domestic animals to handle (Fowler 1978). Sheep do not generally bite, strike or kick a human handler. The only danger of injury they offer is from the use of the head as a battering ram. Fortunately, they grow neither horns nor antlers. Sheep have strong flocking instincts and normally move in a group. It is difficult to separate one individual from the group. If one animal can be enticed to pass through a gate, the rest usually follow.

U.S. Department of Agriculture (USDA) Wildlife Services Program

The USDA Animal and Plant Health Inspection Service (APHIS) Wildlife Services Division would be conducting the goat and sheep management program under contract and with co-management with the NPS. Virgin Islands National Park is reducing the number of goats and sheep in the park directly by trapping and shooting. Meat would be distributed to local community members or to volunteers participating in the reduction program.

Wildlife Services provides federal leadership and expertise to resolve conflicts between people and wildlife. Wildlife Services works in all 50 states upon request to help balance the needs of both people and wildlife. In the last decade, their mission has expanded beyond agricultural damage management to include minimizing wildlife threats to public health and safety, resolving wildlife conflicts in rural areas, protecting private and industrial property, protecting threatened and endangered species, and preserving natural resources.

Collection by Territorial Department of Agriculture (VIDA)

A Memorandum of Understanding (MOU) between the NPS and the Territorial Government of the U.S. Virgin Islands Department of Agriculture (VIDA) was developed and implemented last year (Appendix D). This MOU authorizes VIDA personnel to humanely trap goats and sheep within NPS lands. Biological data would be collected by the NPS from each animal prior to final deposition. Depending on the location, collected animals would be either turned only to ranchers who participants with the VIDA Animal Registration and Impoundment Program or slaughtered for consumption. Where neither options are feasible, NPS-USDA personnel would humanely euthanize collected animals for final disposition by

liming or sea burial Consult the Final Deposition section for additional details on Page 24, and Appendix D, Memorandum of Understanding between NPS and Department of Agriculture.

II.A.2. Alternatives Considered but Eliminated from Detailed Analysis

Sequential Park-wide Reduction by Fenced Zone Hunting (Install Ungulate-proof Fences on Parklands and Reduce Goats and Sheep within the Fenced Areas). One method used to prevent re-colonization of Parklands by goats and sheep is to construct permanent barriers to their dispersal. This method is practiced where eradication is the objective. The method requires fencing small areas and eliminating animals from within the fenced exclosure. Exclosures without goats and sheep are joined to create larger goat-and-sheep-free areas. This measure, although effective, would be impractical and unfeasible to implement on St. John for many reasons. The primary reasons why this method is impractical are cost, boundary surveys, cultural impact mitigation, archaeology inventories and data recovery, resident and visitor access, exorbitant installation and maintenance costs, and lack of funds to complete this alternative within the foreseeable future (3 to 4 years). Finally, the method would take over ten years to implement and could be entirely compromised by the introduction of a single pregnant goat or sheep. The method would be most effective in areas with few inholdings, an uncontested boundary, limited access and substantial financial and maintenance resources.

Initially, the Park would be required to request funds from line item construction and compete nationally for these funds, which is a ten-year cycle. Next, several hundred thousand dollars would be required for an updated boundary survey, because 1986 is the most recent surveys. Then, extensive archaeological surveys and data collection must be conducted. The terrain on St. John is very rugged, which greatly increases the expense and difficulty associated with construction and maintenance of fences. Several hundred inholdings, about 25% of the land are within the authorized boundary. These would substantially increase the amount of fencing and gates required to guard against private livestock escaping into Park lands from within or adjacent areas. The aquatic boundary alone is approximately 75 miles. Maintenance and financial costs and access considerations negate this option from consideration.

Boundary fencing has been an important management tool for controlling goats and sheep at Hawaii Volcanoes National Park (Barrett 1984). Over 100 miles of boundary and interior fences, which cost over $2 million to construct, are the key asset in the ungulate control program of this national park. Seventy miles of goat and sheep-proof fences are inspected monthly and 30 miles of goat and sheep-proof fences are inspected every two to six months. Minor repair work is need on small sections of fence following inspections, particularly after tree falls and washouts. Fences need to be replaced every 5 to 35 years depending on their location and exposure. Fences in high rain fall areas or directly exposed to volcanic fumes on the east and southwest rift zones or to salt spray near the coast require replacement more frequently than others (Resources Management Plan, Hawaii Volcanoes National Park 1999). A systematic effort is underway to replace the most deteriorated fences in this national park. Essentially all fences built in the 1970s and 1980s need to be replaced. Approximately 19 miles of the most deteriorated fences were replaced in 1995-1999. An additional 28 miles of older fences needs to be replaced in the near future.

A goat and sheep-proof fence has been proposed at the boundary of Great Smoky Mountains National Park, where goats and sheep have historically entered the park. It has been proposed that such a fence would impede goat and sheep immigration into areas where goat and sheep control has been effective.

Fencing the boundary has merit, but is distasteful, particularly if visitors frequently encounter it. Fencing the Park boundary would also be prohibitively expensive. For example, Goatcher (1989) estimated it would cost $2,160,000 to fence 60 miles on Santa Rosa Island, Channel Islands National Park in

California. Fence maintenance, also, would be a major concern since falling trees; vandalism and the corrosive moist ocean salty environment are expected to increase maintenance costs estimated at $100,000 per year. Finally, the fencing effort could be neutralized if people physically reintroduced goats and sheep back into controlled areas. Based on the Channel Islands costs, we conservatively estimate the cost of installation and gate access to be $7.5 million in FY 2003 dollars. Unfortunately, these monies may not ever be available for due to the competition for that funding source – Line Item Construction, while impacts continue to increase. Moreover, the impacts to vegetation, cultural and historical resources, visitor mobility and user experiences, tremendous ongoing maintenance costs and ineffective method to permanently restrict goat and sheep encroachment.

Because goats and sheep aggressively trample and jump, fencing designed to prevent goat and sheep encroachment would be especially expensive to install on St. John, and the buried portion would require frequent replacement. Aside from the high cost to fence, one major drawback is that a single pregnant goat and sheep can soon repopulate a watershed if inadvertently or deliberately reintroduced.

Goat and sheep removal would occur in each of these management units on a sequential basis. Complete reduction would be achieved in each of the units in a coordinated effort lasting approximately three years using trained, professional direct reduction experts and volunteers. Areas experiencing reductions would be closed to the public temporarily for an estimated 90 days. It is the goal of this program to considerably reduce the goat and sheep populations in a timely, humane fashion, and their detrimental impacts to the island. The establishment of fenced zones would allow greater flexibility in the duration of the overall program; however the risk of failure is increased substantially when the program is projected over many years. This alternative is entirely unfeasible and impractical regardless of the exorbitant costs.

Fences would be constructed of either triple-galvanized steel or special alloy metals to resist corrosion in the warm moist saline environment of St. John. This fence type has been demonstrated to be effective in Channel Islands National Park and Hawaii Volcanoes National Park's for several years.

Live Capture of Non-native Goats and Sheep and Relocation to Another Island. Non-native goats and sheep are susceptible to a wide range of infectious and parasitic diseases. While some of these diseases are specific only to goats and sheep, others are shared with other animals, including some that are shared with humans. Millions of dollars have been spent in an effort to rid the United States of these wildlife and human plaguing diseases. Therefore, agencies considering actions that could increase the potential for transmission of these diseases are highly discouraged from doing so. Also, the costs associated of capturing, holding and shipping goats and sheep to another island are extremely high. Therefore, this alternative has been rejected on a large scale. However, some animals may be relocated to other islands within the USVI as per USDA/VIDA and NPS approval, and within veterinarian authorization.

Use of Poison. There are a number of toxicants which can be effective as part of a reduction program. However, each of the potential poisons could negatively affect non-target species. It would be very difficult to protect non-targets from incidental poisoning. Additionally, there are rare, threatened and endangered species which would be threatened by increased mortality from poisons. For these reasons, poisons would not be used as a tool in the reduction of non-native goats and sheep.
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Use of Contraceptives or Sterilization. Contraception or sterilization could be a relatively benign way to reduce some goats and sheep from an area; however, many would remain in the area unless other aggressive reduction techniques were simultaneously employed. Unfortunately, birth control technology is presently inadequate to achieve a substantial, immediate and cost-effective reduction of goat and sheep populations throughout the Park. This is especially true when goat and sheep herds are essentially

thriving throughout the Park is entirely covered with vegetation and with a year-round growing season. Contraceptives are expensive and require annual reapplication.

Public Hunting on NPS Property. Authorize goat and sheep hunting by the public within the Park. The primary reason this method is inapplicable for the reduction program because the Superintendent lacks the legal authority to authorize public hunting in Virgin Islands National Park (36 CFR 2.2). In addition, public hunting, guided or unguided, is insufficient to substantially reduce the population and maintain a near-zero goat and sheep population throughout the Park.

Recreational hunting can achieve control or reduction of animals that have a relatively low reproductive potential. However, animals with high reproductive potentials, such as goats, sheep, hogs and rabbits, are considerably more difficult to control. This is especially true when a reduction program is initiated after a species population has gone unchecked over several decades, as with goats, sheep, hogs, burros and others in VINP.

II.A.3. Alternative 1. No Action, Continue Current Level of Management

Under this alternative, no reduction efforts would be used on the non-native goats and sheep within Virgin Islands National Park. Their population numbers would continue to rise with the availability of food resources and the documented trend to move into new areas would continue within VINP. Goats and sheep would continue to impact island vegetation including endemic and Federally listed plant species. Impacts to native plants and native plant communities from goats and sheep have been well documented in the literature (Baker and Reeser 1972: Coblentz 1978 and 1980; DieterSpatz *et. al.* 1973; Katahira and Stone 1982; Mueller-Dombois *et. al.* 1975; Scowcroft and Hobdy 1987; Stone *et. al.* 1992; Stuht 2001; Taylor and Katahira 1988; and Yocum 1967).

If left unchecked, goat and sheep populations would be expected to increase throughout the Virgin Islands National Park. Goats and sheep have established non-native breeding populations in many areas and all habitat types of the Park. Many people keep goats and sheep in herd sizes ranging from a few animals to several dozen. Small herds of sheep sometimes mix with goatherds, but sheep are considerably less common than goats. The Park has experienced goat and sheep grazing since it was established in 1956. The original areas of goat and sheep encroachment included: portions of Leinster Bay near the Johnny Horn Trail; Bordeaux Mountain area above and including much of the Lameshur watershed; the East End near the NPS Firing Range; the upper-eastern portion of Hawksnest Bay; and the Ram Head area. By the early 1990's, free-ranging goatherds were established in Brown Bay and Ram Head. In 1999, 5 goats were abandoned at the former seaplane ramp at Lind Point. Finally, in the summer of 2000, approximately 12 goats were abandoned on the North Shore Road immediately inside the Park boundary above Cruz Bay.

A conservative domestic goat estimate within the Park is from 600 to 1000 animals, and the present area of impact is 85% of the island, some of which is among the most sensitive and rare forest habitat types found in the Caribbean region. A conservative domestic sheep estimate within the Park is less than 50 animals. These estimates include animals living in the Park and omits animals those grazing the Park routinely, but living outside the Park; a situation occurring at Bordeaux Mountain, the East End and Susanaberg, and others. Moreover, because of the dramatically increased herd size at Ram Head/Lameshur, and Brown Bay/Leinster, natural resource degradation would continue at a much faster pace. In addition, perhaps the worst aspect is the new introductions at Lind Point and along the North Shore area, because goats could be impacting 100% of the Park, within a few years. From these new locations, goats and sheep would readily move into adjacent watersheds, causing irreparable damage to

sensitive natural and cultural resources. Goats and sheep also pose threats to public health and safety and pose severe environmental damage to cultural and natural resources.

Under the No Action Alternative, NPS would continue to animal-proof trash receptacles, dumpsters and buildings at campgrounds, day use sites, concession areas, Park overlooks, and employee housing areas and collect trash on a regular basis. FY 2000, Virgin Islands NP installed about 100 animal-proof trash containers (at a cost of about $75,000) at all Park sites except the major concession operations at Trunk Bay and Cinnamon Bay to collect both refuse and recyclables. In fiscal year 2002, the NPS requested $30,000 in funding to purchase and install an additional 20 animal-proof trash containers at major concession locations (eight at Trunk Bay and twelve at Cinnamon Bay) to collect both refuse and recyclables. Also in 2002, NPS has contracted for the construction of a one-mile long burro exclusion fence with four barbed-wire strands around the perimeter of the Cinnamon Bay Campground at an estimated cost of $67,000 that is not designed to also exclude goats and sheep. A design necessary to exclude goats and sheep would have been prohibitively expensive and the non-native animal causing the greatest problems during the planning stage and previously was the burro.

II.A.4. Alternative 2. Reduce Goats and Sheep within VINP and Sustain a Near-zero Population, Environmentally Preferred Alternative

The program goals for the Environmentally Preferred Alternative include:

1) Substantially decrease the goat and sheep populations throughout the Park to near-zero levels;
2) Monitor and remove goats and sheep periodically, and install and maintain fences indefinitely,
3) Prevent or minimize future encroachment through education and community outreach.

Under this alternative non-native goats and sheep would be controlled from within Virgin Islands National Park lands on St. John, Hassel Island, and St. Thomas, (should goats or sheep move into NPS property on St. Thomas). The goal would be to humanely and substantially reduce their population throughout the Park, and sustain the reduction to zero or near-zero through monitoring, periodic removals, selective fence installation and maintenance, and ongoing information dissemination through partnerships with governmental and non-governmental organizations.

The National Park Service and the USDA APHIS Wildlife Services (WS) Division as lead cooperating agencies would conduct the initial reduction of non-native goats and sheep. Each agency would have a Program Coordinator and this team would manage and supervise the program. The Virgin Islands Department of Planning and Natural Resources, Division of Fish and Wildlife (VIDPNR); and VIDA; would play an advisory role to plan and implement the reduction, mitigation and monitoring components of the program. All personnel involved with this program would follow the measures described in this document for the protection of resources.

Prior to implementing a Park-wide goat and sheep reduction program, goat and sheep ranchers would be requested by letters and press releases to remove their livestock from within Virgin Islands NP. Ranchers would be required to remove their animals within the 60 days before implementing the direct reduction program. Following this sixty-day amnesty period, goats or sheep residing within the Park would be considered abandoned, and subject to collection to protect the Park's vegetation, wetland and cultural resources from the negative effects of free-ranging livestock (Code of Federal Regulations, Title 36, Part 2.15(5)(c): pets or feral animals). The Virgin Islands Code, Title 19, Section 2616 (a): "any animal found running at large, or tied on public property or on private property without the consent of the owner of said

property, shall be taken up by animal wardens and impounded in an animal shelter, and there confined for disposition in accordance with the provisions of this subchapter."

The primary tools for goat and sheep collection would be live traps, shooting and snares. During the peak period of the goat and sheep reduction program, there would be an increase in personnel on St. John Island of 2 – 4 people. However, they would be the same individuals contracted by the NPS to implement the sustained reduction of non-native hogs from VINP. They would be housed generally in government housing on NPS owned property. A standard-sized pickup truck would be the primary mode of transportation. All-terrain vehicles may be used incidentally for transportation, one or two horses may be considered for limited field operations at some point. Temporary tent camps may be established to facilitate operations in remote areas.

The techniques and tools for achieving the reduction goal would be similar to those described under Alternative 2, and are consistent with goat and sheep reduction models on Santa Rosa Island and Santa Cruz Island (NPS 2001) in Channel Islands National Park and Hawaii Volcanoes National Park (1999).

Steps Required for Park-wide Goat and Sheep Sustained Reduction

Under this Alternative, the reduction program would occur in three phases:

1) Administration, infrastructure acquisition and selective fencing;
2) Collection using baits, traps and contract hunters; and
3) Monitoring and periodic removal of remnant goats, resource education, community outreach, information dissemination, record keeping, fence maintenance and partnership renewal.

Phase I – Administration, Infrastructure Acquisition and Selective Fencing (Approximately 1 to 2 years)

This phase would require approximately one year to complete once environmental compliance is met. This year would be used to hire or contract with personnel, purchase supplies, construct traps, establish communications, and fence especially vulnerable long-term monitoring plots. NPS may also begin selective fencing near limited areas of the boundary where goats and sheep can easily reenter the Park. Funds would possibly be made available for island livestock ranchers to install or repair their fences.

Consensus building would be established before and during the NEPA process, continued into Phase I and sustained indefinitely. A strong bridge would be established and strengthened between the NPS, USDA-Wildlife Services and VI Department of Agriculture (VIDA). Key groups or officials may facilitate this crucial bridge, including Friends of VINP, the St. John Community Foundation, VI Department of Planning and Natural Resources, the University of the Virgin Islands Cooperative Extension Service, The Environmental Association of St. Thomas and St. John, the St. John Rotary Club, and the Island Administrator.

Fences would be constructed to exclude non-native animals from specific long-term vegetation monitoring plots and limited selective areas of the boundary where goats and sheep easily reenter the Park from nearby private livestock ranches. For example Herman Farm, L' Esperance, Catherineberg, Bordeaux Mountain, Hawksnest, Cinnamon, Ram Head and Lameshur may be considered if wildlife trails are present.

Non-governmental organizations (NGO's) with guidance and assistance from the NPS and USDA would develop a comprehensive community outreach strategy. This outreach serves to inform, advise and

educate the St. John community and island visitors about goats and sheep and the ecological damage a small group of goats and sheep can inflict on a small, remote subtropical island. VIDA and the UVI Cooperative Extension Service would play a key role with the NPS to prepare and disseminate information in an ongoing basis. One focal point of this informational campaign would be the VIDA Animal Registration and Impoundment Program. The community would be advised of the global problems germane to introduced goats and sheep as well as the potential economic loss to the U. S. Virgin Islands if no action is taken to reduce their populations.

The necessity of a long-term monitoring plan that includes periodic goat and sheep removal from the Park would be emphasized. The importance of preventing or minimizing new feral animal introductions, cessation of feeding activity for dry soils within the Park and other general conservation measures would be emphasized. Once the NPS/USDA team develops this program with key NGO's (such as Friends of VINP, St. John Community Foundation, and the Environmental Association of St Thomas and St. John), it is envisioned these partnership would share in the ongoing development and determination of information. Of paramount importance is the prevention of future non-native wildlife encroachment in VINP.

Phase II – Collection Using Baits, Traps and Contract Hunters (3 to 4 years)

Initial scoping and observation conducted in Phase I and before would allow Program Coordinators to determine where to concentrate their resources. Several methods or techniques may occur simultaneously, but different methods would be used later in Phase II, as goats and sheep become trap-shy. Then radio-telemetry and baying dogs may be employed to collect additional goats and sheep. Because goats are highly social animals, a goat equipped with a radio transmitter can lead field personnel to remote locations where animals congregate. As goats become trap shy and less common, contract shooters (USDA APHIS/NPS) may use bait stations to eliminate these individuals. Once collected a goat would be donated through VIDA processed for consumption, treated with lime for decomposition, or (in rare instances, possibly) buried at sea. Please see Final Disposition and Use of By-products on page 23. Fence installation may be completed in areas designated for selective fencing while minimizing damage to cultural sites and structures.

A relatively fast initial goat and sheep population reduction campaign is envisioned. Phase II would possibly take approximately 3 to 4 years. Baiting in conjunction with snares, single-capture and corral traps would be employed throughout each targeted watershed. Areas of high goat (and to a much smaller degree sheep) concentrations such as Cinnamon, Lameshur and Reef bays would be selected and removed initially. Goat and sheep movements would determine where the collection efforts must then be focused. Biological and ecological data would be recorded from each collected animal. These data, field observation records and scat and track analysis would help determine relative abundance, for workers to establish a baseline from which to estimate and measure group population dynamics.

Phase III – Monitoring and Periodic Removal of Remnant Goats and Sheep, Resource Education, Community Outreach, Information Dissemination, Record Keeping, Fence Maintenance and Partnership Renewal (Ongoing, Indefinitely)

This phase would be an indefinite period of scheduled and systematic monitoring throughout NPS land for goat and sheep sign. Monitoring efforts for the presence or absence of goats and sheep is crucial to routinely locate and remove animals from the Park, and protect the sensitive natural and cultural resources. Water sources, which are preferred habitat for goats and sheep, historical locations of high population densities and NPS lands near private livestock ranches, would serve as key monitoring areas.

If goats, sheep or their foraging and trampling sign become evident in an area, NPS Law Enforcement or Resource Management personnel would be authorized to trap or humanely dispatch the animals as described in Phase II. VIDA would be sought for their assistance Long-term ecological monitoring to assess ecosystem change due to goat and sheep reduction would continue indefinitely.

NPS law enforcement and interpretation rangers, maintenance and resources management personnel performing routine fieldwork would be provided with general "Introduced Species Observation Sheets." These personnel would be instructed on the animals of particular concern and importance of reporting any suspected sightings, sign or activity, and be routinely notified by resource management personnel to submit any documented sighting as soon as possible.

Two possible fence uses are described in this alternative: selective fencing critical areas of the boundary near existing livestock ranches, and fencing some existing long-term vegetation plots. VINP personnel would monitor the selective boundary fence and long-term vegetation exclosure fences every 6 and 12 months, respectively. These workers would also monitor the four watersheds annually using transects for goat and sheep sign. Monitoring for encroachment would be intensive where goat and sheep concentrations were historically high, and in areas near private livestock ranches. Detailed records would be documented from these areas and monitored in a comprehensive mammal database.

The partnerships and community outreach established before and during the NEPA process in Phase I would be supported, maintained and strengthened as key personnel change. Consistent, ongoing education and cooperation would be central outreach themes, with emphases on the efforts to routinely provide this information to the resident and visiting public. Dissemination would occur through the development of printed and electronic media. In concert with VIDA, the Cooperative Extension Service and other partners, the NPS would continually work with goat and sheep ranchers to keep goats and sheep on private property; and emphasize the importance of the Animal Registration and Impoundment Program. Other governmental (e.g. PNR) and NGO (e.g. Friends of VINP, the St. John Community Foundation, *et al*), partners would be used to systematically disseminate the information previously developed to continually educate the public about non-native animals and their impacts to natural and cultural resources. This campaign dovetails well with similar partnerships and information regarding sustained reductions of rats, cats, mongooses and hogs from within NPS lands.

II.B. Environmentally Preferable Alternative

In accordance with Council on Environmental Quality (CEQ) regulations, Alternative 2 is identified as the Environmentally Preferred Alternative. The Environmentally Preferable Alternative is defined by CEQ as the alternative "that will promote the national environmental policy as expressed in NEPA's Section 101. Generally, this means the alternative that causes the least damage to the biological and physical environment and best protects, preserves and enhances historic, cultural and natural resources" (*46 CFR 18027, Forty Most Asked Questions Concerning CEQ's NEPA Regulations*).

Section 101(a) of NEPA recognizes the importance of environmental quality to the overall welfare of man, and declares a continuing policy to promote conditions under which man and nature can exist in productive harmony. Section 101(b) establishes a continuing responsibility for the Federal government to improve and coordinate Federal plans, functions, programs and resources to the end that the Nation may:

1. fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
2. ensure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings;

3. attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences;
4. preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice;
5. achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities; and
6. enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

According to NPS policy (Director's Order 12, 2001), the Environmentally Preferable Alternative is the alternative that will promote the national environmental policy expressed in NEPA Section 101(b), which includes alternatives that accomplish the goals from this section (listed above).

Because, in comparison to Alternative 1, Alternative 2 better restores the natural conditions throughout the Park, it is considered the Environmentally Preferable Alternative. Alternative 2 best responds to NPS mandate to preserve and protect unimpaired the significant resources for which VINP was established and allows for appropriate use and enjoyment by the public. Potential adverse effects on natural and cultural resources would be reduced over those in the No Action Alternative. By reducing the population of non-native goats and sheep inside the Park, adverse impacts on visitors, residents and natural and cultural resources would decrease. The proposed reduction programs would produce minimal or no damage to Park resources or threats to visitor and employee safety. Collectively, goat and sheep populations pose a very large threat to the native natural resources, long-term resource management programs of the Park, NPS mandates, and the health and safety of Park visitors.

The Environmentally Preferable Alternative would cause the least damage to the biological and physical environment and best protect, preserve and enhance the Park's historic, cultural, natural and wetland resources. However, Alternative 2 would best fulfill NPS's statutory mission and responsibilities; best meet the purpose and need for a Sustained Reduction Plan for Non-native Goats and Sheep; best respond to the very great issues identified through public and agency scoping; and achieve the best balance of environmental protection, visitor experience, public safety, economic well-being and other factors.

III. CHAPTER III. AFFECTED ENVIRONMENT

III.A. NATURAL RESOURCES

This chapter of the Environmental Assessment describes the current status of baseline information from inventories, monitoring and research projects. NPS-77, "Standards for Natural Resource Inventory and Monitoring", and the *1997 Inventory and Monitoring Implementation Plan* by the Biological Resources Division, USGS were also used as sources of information. The description of the affected environment is not meant to be a complete description of the program area. Rather, it is intended to portray the significant conditions and trends of the resources that may be affected by the proposed program or its alternatives.

Wetlands and Floodplains

Several guts or gullies have been known to have permanent pools of freshwater, some of which still contain small populations of several species of shrimp and fish that were once a delicacy among local residents. Guinea and Fish Bay guts still have populations of freshwater shrimp (*Macrobrachyum* sp., *Atya* sp. and *Xiphocaris* sp.). In addition, one or two species of gobies and Mountain Mullet (*Agonostomus monticola*). Little is known about these special species, including their population size, ecological role, origin or distribution. Their populations are perhaps greatly reduced due to upstream discharges from commercial activities in the Susannaberg area (e.g. Moses' Laundromat, Majestic Construction, etc.).

The pattern of rainfall and soil type is critical to recharge streams or aquifers. Brief showers do not significantly add to recharge. To create streamflow, 13 to 25 millimeters (2 to 4 inches) in a single rainfall are necessary with a resultant 20-75% surface runoff flow.

Two intermittent streams, Guinea Gut and Fish Bay/Battery Gut, are both outside the park on the south shore. Other smaller intermittent streams and many watercourses carry storm runoff for a short time after heavy rainstorms transporting sediment to the sea. In most cases, the streambed and adjacent floodplain restabilize over the years. If changes are made to the cross section, grade, plane or profile of the stream or adjacent flood plain, sediment loss occurs and restabilization must take place. In most cases, construction and changes in land use can be a major disruptive event increasing erosion and sediment transport.

Normally evapo-transpiration utilizes 90 to 95 percent of the rainfall falling on St. John. The remaining 5 to 10 percent of the rainfall produce minimal surface runoff, except in the storm conditions of heavy rains. A combination of factors (high evapo-transpiration rate; persistent trade winds; high temperatures; and long hours of direct sun) aggravates dry conditions on St. John, where water tends to be in short supply (Nellis, *et. al.* 1985).

Mangrove habitats are the equivalent of salt marshes in North America. They occur as a coastal fringe of red mangroves immediately seaward of terrestrial uplands, but can also be found as basin forests at the base of large watersheds. Mangrove shorelines make up approximately 2% of the shoreline and are found in protected bays: Cruz Bay, Mary's Creek, Haulover Bay, Newfound Bay, Hurricane Hole, Coral Harbor and Fish Bay. Hurricane Hole may be the most pristine of the remnant mangrove habitats remaining in the USVI because over 50 percent of all mangroves in the USVI have been destroyed during the past 50 years. Mangroves provide an extremely important interface between terrestrial processes and marine habitats. They filter sediment from upland runoff, thus maintaining water quality. They produce and

export nutrients used by other marine ecosystems. They provide a vitally important nursery habitat in their submerged prop roots for many species of coral reef fish, juvenile shellfish and numerous marine creatures. Many species of birds' nest, rest, roost or forage in mangroves, where they are safe from predators. The mudflats that form behind mangroves support populations of the large gray land crab (*Cardisoma guanhumii).*

Salt ponds are shallow, saline ponds at the base of valley drainage systems. They form as reefs grow from two rocky points of a bay, eventually meeting in the middle and forming a berm created by storm surge movement of coral rubble. This berm isolates the pond from the sea and usually becomes colonized by mangroves and other salt tolerant species. Salt ponds are effective upland sediment traps, thus maintaining water quality in adjacent marine waters. Ponds are important habitat for many species of shorebirds, bats and waterfowl where they feed on insects and invertebrates living in the pond and nest in the fringing mangrove vegetation. Drastic fluctuations in salinity, temperature turbidity and levels of oxygen and hydrogen sulfide make life in a salt pond a challenge for all but a few adaptable species. Salt ponds also have many traditional uses including, medicinal soaking and salt collection for cooking. Salt deposits as the pond dries up during the dry season. The animal and plant life associated with this ecosystem has not been well studied, and salt pond ecology is complex and only partially understood. There are five salt ponds larger than 2 acres in size on St. John. The largest is on the south shore behind Salt Pond Bay, and about 3 acres.

Trampling and grazing by non-native goats and sheep adjacent to small streams and springs may result in high rates of soil erosion, which severely impacts aquatic habitats. Trampling and grazing by goats and sheep detrimentally affect the aesthetic and wilderness values of the Park. In searching for food and shelter, goats and sheep create winding trails through all plant communities. These paths compact the soil and contribute to increased water run-off and erosion. These paths can also serve as routes for the spread of invasive, non-native plant species.

Mangroves are a fragile ecosystem in need of special protection. Goats and sheep forage on seedlings of the three mangrove species protected under V.I. law. Their trampling and grazing disturbs soil surface layers and contribute to erosion and sedimentation in mangrove habitats found in Cruz Bay, Mary's Creek, Haulover Bay, Newfound Bay, Hurricane Hole, Coral Harbor and Fish Bay.

Terrestrial Vegetation

The destruction of the natural vegetation on St. John has been extensive, and includes about 90 percent of the island. Large portions of the original forests were cleared for plantations during the late 1700s and early 1800s. A majority of the tropical hardwood trees found here were harvested and sent to Europe for furniture, boat and mast construction. This intensive modification of the forest distribution and structure changed the hydrologic regime that was present on St. John. The island became drier as vegetative cover was removed or modified. Evidence from relict streambeds indicates that St. John may have had perennial streams that are no longer in existence. Ultimately, forest destruction has affected over 90% of the island. As a result, some of the native and federally or territorially protected plant species have become extinct, or nearly extinct, with their populations reduced to a few individuals (Woodbury and Weaver1985, Acevedo-Rodriquez 1996).

The present vegetation exhibits differing degrees of revegetation, ranging from recently disturbed to late-secondary successional forests, which may be up to 100 years old. Eleven vegetation types have been mapped and described, including: mangroves, salt flats, pasture, upland moist forest, gallery moist forest, basin moist forest, dry evergreen forest, dry thicket and scrub, thorn and cactus, disturbed vegetation, and rock and coastal hedge. About 63% of the island is in the dry evergreen forest category and 17% in the combined moist forest category. The upland moist forest contains some virgin stands with minimal

exotic floral species. The tallest trees on the island grow along the banks of the intermittent streams within the valleys of large watershed areas.

The greatest current threats to forest regeneration are human development and growing populations of non-native goats, sheep, hogs and donkeys. Goats, sheep and donkeys alter forest composition by selectively feeding on palatable species and distributing the seeds of exotic species through their feces. Hogs destroy vegetation through rooting up of plants. Despite disturbance by non-native animals and construction, Parklands continue to be a valuable refuge for native plant species. To date, 747 species of vascular plants have been identified from St. John, of which 642 (86%) are native to the island. The species are found in 117 families, of which 12 are introduced. Almost all species (99.7%) on St. John are found on other islands within the Virgin Islands. Two species are endemic to St. John (*Eugenia earhartii* and *Machaonia woodburyana*) and six others are endemic to the Virgin Islands. Another 25 species are endemic to the Puerto Rico platform. Many voucher specimens and representatives of common plants have been collected by premier botanists and placed in the Park herbarium collection, creating an extensive collection of a majority of island plant species. As they conduct monitoring and inventories, botanists continue to identify new species. Pedro Acevedo-Rodriguez of the Smithsonian Institute discovered three species new to St. John in 1992.

A network of long-term monitoring plots, representing a range of stand ages and land-use histories, has now been established in each of the following forest types on the island: upland moist, gallery moist, dry evergreen woodland and dry evergreen scrubland. Peter Weaver (1999) has established 16 plots in the dry evergreen and moist forest of the Cinnamon Bay watershed; the New York Botanical Garden has three plots covering upland moist, gallery moist and dry evergreen woodland; and the Smithsonian has two plots covering dry evergreen woodland and dry evergreen scrubland. In addition, the USDA-NRCS has five long-term plots in the Lameshur and Cinnamon Bay watersheds to measure soil temperature and moisture. Information on forest regeneration, tree seedling growth, changes of species composition and forest structure are gathered by researchers through Memorandums of Understanding, Cooperative Agreements and direct National Park Service funding.

Documented direct effects on plant communities by alien herbivores including non-native goats and sheep are reduction in native species cover, density and biomass. Alien herbivores such as goats and sheep have also caused the elimination of the soil litter layer and loss of seed banks, increased soil disturbance, and soil compaction, and lowered or altered rates and patterns of nutrient cycling. Hoofed herbivores impact native vegetation communities through their grazing and browsing activities, which changes plant species composition and distribution. These changes typically result from the selection and avoidance by herbivores of certain plant species, thereby modifying plant succession processes in that area, eventually leading to a different plant community than existed before. For example, the most palatable and nutritious plants will be preferentially eaten, leaving the thornier, less desirable species (from the herbivores' perspective). If this continues at a high enough level over a period of time, the plant community will be changed towards one containing more thorny species with less total plant cover.

Disturbances caused by non-native goat and sheep grazing and movement through island vegetation may facilitate the spread of non-native, invasive plant species. Once established, these species have demonstrated the ability to expand at the expense of native plant species. Additionally, many of the naturalized exotic plant species found on St. John have not co-evolved with the grazing pressures exerted by large herbivores. They have adaptive mechanisms, which allow them to avoid being grazed or to better survive the impacts of grazing. These exotic plant species have expanded in the presence of goats, sheep, hogs and donkeys on St. John at the expense of the islands' native flora. The presence of non-native goats and sheep would only likely benefit these undesirable species because exotic plants are widely dispersed through their feces.

Documented indirect effects of alien herbivores such as non-native goats and sheep to plant communities include the increase of cover, frequency, and biomass of non-native plant species, increased water run-off and soil erosion, and degradation of soil structure. Goats and sheep have also contributed to changes in soil micro-flora and micro-fauna, and the potential loss of fire-induced successional communities due to inadequate fuels and lack of seed banks.

Non-native goats and sheep are selective browsers: which means they select for their favorite foods; then only browse them. Goats and sheep tend to graze small shrubs and grasses very close to the ground, and often tear the roots from the substrate; preventing regeneration and accelerating topsoil loss and erosion. The most fragile forest community on the island is the dry forest, which predominates, in the southeastern portion of the island. These communities may have the smallest possibility for recovery, and both their species composition and total individual numbers are low. In addition, steep semi-barren cliffs dominate this area, making a perfect habitat for the sure-footed goat. Precious topsoil is lost and will degrade the coral reefs below the cliffs. Some individuals from the main Ram Head herd frequent the Lameshur Bay watershed, perhaps in search of water in the moist forest found there. This frequently occurs on an almost daily basis and has continued unabated for the past several years. This is especially devastating because the Lameshur watershed forms a very large portion of the core area of the Virgin Islands National Park Biosphere Reserve.

Native Animals

The only mammal native to St. John are bats. Three of the six native bat species are protected under the V.I. Endangered and Indigenous Species Act of 1990 (Act No. 5665). Some bat species are primary pollinators of many native floral species and important seed dispersal agents for many species of fruit bearing trees and shrubs. Other bats consume vast quantities of insects, including mosquitoes. Fish-eating bats are also present; these are the second largest bats found in North America. Bat abundance at night on St. John may exceed bird abundance during the day. Except for a short study using ultrasonic surveys to detect bats, little is known of bat abundance on St. John, ecology of roosting maternity colonies or threats. The Park is mandated to identify, monitor and protect native fauna and their habitat.

Recent museum analysis of materials excavated from the Cinnamon Bay archeological dig during 1998 has yielded some startling discoveries. The remains of at least four extinct animals have been identified, including the Caribbean Monk Seal (*Monachus tropicalis*), Puerto Rican Shrew (*Nesophontes*, sp.), a flightless rail and others. At least six other species have been identified which have been extirpated from the Virgin Islands. This dig is revealing considerable information about faunal assemblages on St. John before European colonization, and demonstrating the Prehistoric Indians lived in a substantially different natural world from what we find today. These Indians may have brought some species such as the Green Iguana (*Iguana iguana*) and the Red-Foot Tortoise (*Geochelone carbonaria*) to the Virgin Islands from South America as food sources. These animals were apparently important food sources for these Native American Indians.

Avifaunas are abundant and varied. The latest National Park Checklist of Birds on St. John includes 170 species in 17 families. St. John is an overwintering area for migratory warblers using the eastern flyway. Fragmentation of habitat has been suggested for reducing populations of over-wintering warblers. More recent research from 62 permanently marked survey points in moist forest and dry woodland on St. John suggests that the reduction in numbers of overwintering warblers is due primarily to reduced numbers of one species (Northern Parula) and possible reductions in breeding populations along the southeastern United States from North Carolina to northern Florida. Birds are probably the best-studied group of terrestrial animals in the Park. Continued surveys are necessary to determine trends in populations of resident and migratory species. An intact native forest ecosystem is necessary for avifauna to rest, mate, nest, and feed or migrate within the Park and territory.

Terrestrial reptiles and amphibians on St. John are varied. Three native of tree frogs species (*Eleutherodactylus lentus, E. antillensis and E. cochranae*) and one introduced species, the Cuban Tree Frog (*Osteopilus septrionalis*), occur and one introduced Marine Toad (*Bufo marinus*), two geckos (*Hemidactylus mabouia* and *Sphaerodactylus macrolepis*), three species of Anolis Lizards (*Anolis stratulus, A. cristatellus* and *A. pulchellus*), the Red-foot Tortoise (introduced), Green Iguana (introduced), Ground Lizard (*Ameiva exsul*), Legless Lizard (*Amphisbaena fenestrata*), Worm or Blind Snake (*Typhlops richardii*), a type of Garter Snake (*Arrhyton exiguus*) (introduced), the Puerto Rican Racer (*Alsophis portoricensis*) and the Slipperyback Skink (*Mabuya mabouya*). Herpetological populations on St. John have not been adequately inventoried, monitored or protected. Species that occur on nearby islands may also occur here but have not been observed and documented.

Catherine Curry prepared an insect species checklist from the Park museum collection in 1970, when ten families were represented and 52 species identified (Curry 1970). William Muchmore (1987) studied terrestrial invertebrates in 1987 and made a collection of common representative insects for the Park. Two hundred and thirty-two species representing 124 families were identified. Arachnida (scorpions, pseudoscorpions, harvestmen, and spiders) made up the largest order. Jeremiah Trimble has identified thirteen species of dragonflies and damselflies (Order Odonata) in VIIS (Trimble J., IAR, 1997). Michael Ivie (1983 and 1984) has been studying beetles (Coleoptera) in the Virgin Islands for several years. Before his research, approximately 75 species of beetles had been described for the VI. Ivie has now documented over 1500 species (several new species) and expects to find over 2000. Most of these species may be found in VINP, but will only be documented through further studies. Additional inventories covering a greater number of families are needed to more fully document the species and distributions of insects within VINP.

Non-native hogs continue to have large and adverse effects on island wildlife and fauna. Because herptofauna and invertebrates are small, often slow and readily available, they are particularly susceptible to local extirpation from hog depredation. Of particular concern are the varied native reptile and amphibian populations in the Park and their associated links in the food and ecological web of the island. Wild hogs prey upon three species of tree frogs, two species of sea turtles, two geckos, and three Anolis lizards, the Ground Lizard, Legless Lizard, Blind Snake, the Puerto Rican Racer, and the Slipperyback Skink. The Park has listed over 232 common insect species, including 13 species of dragonflies and damselflies and over 1500 beetle species, many of which are consumed by non-native hogs. Many invertebrate species may be lost before researchers have catalogued them. NPS is mandated to identify and protect native flora and fauna and their habitats for the enjoyment of future generations.

The cessation of goat and sheep grazing and trampling in specific locales would also improve habitat for native lizard, snake, salamander and insect populations which are dependent on the consumption of leaves, fruits and berries for their survival. Goat and sheep removal from riparian areas would improve riparian habitat for frogs and aquatic invertebrates that in turn depend on the consumption of plants for their survival. Goat and sheep removal would provide fruits and berries in years of large food production and would improve habitat for those species which depend on these food sources, such as many bird species (pigeons and doves) bats, herpeto-fauna and insects.

Endangered and Threatened Animal Species

The Endangered Species Act (PL 93-205) requires Federal agencies to protect all listed species and habitats. Twelve Federally listed endangered and threatened species have been observed in the Park (see Appendix A, List of Endangered Plants and Animals of the U. S. Virgin Islands). Five whale and several dolphin species migrate through the Park. The endangered West Indian Manatee is extremely rare around St. John, although it has been recently recorded (ca. 1990) from West End, Tortola in the British Virgin

Islands. These listed species, include six marine mammals, five birds, three reptiles (sea turtles) and two plants.

Five Federally listed threatened or endangered bird species have been identified. The Federally Endangered Brown Pelican nests, feeds and roosts both adjacent to and within National Park boundaries. The U.S. Fish and Wildlife Service is evaluating nesting success in considering this species for delisting. The Federally Endangered Peregrine Falcon is a rare winter migrant. The Federally Threatened Roseate Tern and Endangered Least Tern are summer residents that have both been observed nesting within the Park in recent years (1997 and 1999, respectively). Piping Plover are a rare summer migrant.

Two of the Federally listed sea turtles are commonly found in Park waters. The Hawksbill Sea Turtle requires coral reefs for food and refuge. Peak nesting season on Park beaches is from July through November, although nesting activity may take place any month of the year. While Green Sea Turtles feed in seagrass beds in Park waters, they are infrequent nesters on St. John beaches. Sea turtles are infrequently struck and killed by boats speeding through Park waters. Nesting frequencies have decreased on many beaches due to adjacent upland development that results in people, lights and dogs, all of which deter turtles from using particular beaches. Direct impacts on Federal endangered species by exotic species include the predation of sea turtle nests and eggs by the small Indian mongoose (*Herpestes auropunctatus*) and non-native wild hogs. While considerable information exists on seasonality of nesting for sea turtles using VINP beaches, no rigorous studies of nesting numbers and frequencies on all VINP beaches has been carried out since the early 1980's.

The Federally Endangered Virgin Islands Tree Boa (*Epicrates monensis granti*) has never been observed on St. John although it occurs on the East End of St. Thomas and on Tortola, BVI. This species could conceivably exist on St. John.

Non-native goats, sheep, hogs and donkeys negatively affect the fauna of the Park through predation, habitat alteration or competition for food. One territorially endangered and threatened animal species, the Slipperyback Skink (*Mabuya mabouia*), is endemic to the Park. Other Territorial Endangered species include ground-nesting species such as Bridled Quail Dove, Bahama Pintail Duck and West Indian Nighthawk, all of which suffer egg and chick depredation or habitat loss due to hogs. Areas uprooted by hogs undergo notable declines in small mammal populations (Singer *et. al.* 1982). Goats, sheep and wild hogs are in direct competition with small animals for insects, earthworms and other invertebrates and also compete with native species for other available food resources, especially hard mast.

Threatened and Endangered Plant Species

As of March 31, 2001, 736 native plant species were listed as endangered or threatened under the Endangered Species Act. According to the Center for Plant Conservation, over 4,000 species of U.S. plants, roughly 25 percent of our country's entire known native plant species are at some degree of risk. Of these, many hundreds could vanish in the next few decades. Faced with the expanding development of natural areas, competition from invasive non-native species, loss of pollinators, and over-collection for ornamental and other uses, many of our native plants face an uncertain future. Hawaii, California, Texas, Florida and the Puerto Rican platform have the greatest number of rare, imperiled and federally listed plant species (Harrelson 2001).

Two plant species Federally listed as endangered occur on St. John and non-native goats and sheep consume: Prickly Ash (*Zanthoxyllum thomasianum*) and the St. Thomas Lidflower (*Calyptranthes thomasiana*). Marron Bacora (*Solanum conocarpum*) is also consumed and has been proposed for listing (USFWS 1988; see Appendix A, List of Endangered Plants and Animals of the U.S. Virgin Islands). Twenty-five plant species Territorially listed as threatened or endangered exist on St. John that goats and

sheep consume: *Cyposelia humifusa*, Urban's Holly (*Ilex urbanii*), Central American Oak (*Ilex sideroxyloides*), Pinion (*Tillandsia lineatispica*), Wooly Nipple (*Mammilaria nivosa*), *Croton fishlockii*, Egger's Cockspur (*Erythrina eggersii*), Egger's Galactia (*Galacteria eggersii*), Cowage Cherry (*Malpighia woodburyana*), *Malpighia linearis*, *Byrsonima sp.*, *Psidium sp.*, *Eugenia sp.*, *Schoepfia schreberi*, Christmas Orchid (*Encyclia ciliare*), Yellow Dancing Lady (*Tolumnia prionochila*), White Dancing Lady (*Tolumnia variegatum*), *Ponthieva racemosa*, *Prescottia oligantha*, *Prescottia stachyoides*, *Tetramicra canaliculata*, Myrtle-leaved Peperomia (*Peperomia myrtifolia*), *Machaonia woodburyana*, Bulletwood (*Manilkara bidentata*), and *Solanum mucronatum*. The non-native hogs, goats, sheep and donkeys on the island variously threaten each of these. The Federal listing proposal for these species identified non-native goats, sheep, hogs and donkeys as the major cause of decline` for each of these plant species. The primary causes of impact to these rare species by non-native goats, sheep, hogs and donkeys are trampling, direct feeding and soil erosion.

Non-native goats, sheep, wild hogs and European boar are seriously threatening the sole, small remaining populations of the endangered St. Thomas Lidflower (*Calyptranthes thomasianum*), Prickly Ash (*Zanthroxyllum thomasianum*) and Marron Bacora (*Solanum conocarpum*), which has been proposed for listing. Resource managers are particularly concerned about protecting the St. Thomas Lidflower, because the largest population of 216 individuals lives, near the top of Bordeaux Mountain. Goat and sheep herds are capable of denuding large areas of land of all vegetation, including trees (through bark stripping) and cactus. The VINP represents possibly the largest and best example of dry sub-tropical forest remaining in the Caribbean and many of these exotic species are having a serious impact on its health and sustainability.

Direct impacts to twenty-five listed plant species would include herbivory of Threatened and Endangered plant species by non-native goats and sheep and the trampling, crushing and uprooting of listed plant species should goats and sheep walk, root or bed down within listed plant occurrences. Depending on the number of individual goats and sheep within an area, one too many T&E plants may be grazed, trampled or uprooted. Those occurrences that are found in areas of high goat and sheep use would likely incur the most damage. Because the rarity of these listed plant species is defined by their limited numbers; even relatively small impacts can have a large detrimental effect. Individual plants lost through predation, trampling or uprooting cannot contribute offspring to the succeeding generation. This results in a loss to the next generation of both absolute numbers and potential genetic diversity. A decrease in genetic diversity can lead to an overall decrease in evolutionary fitness for a species. Decreased population numbers, lead to increased potential for extirpation from continued predation or from large random disturbance events such as fire, hurricanes or drought.

Indirect effects to listed Threatened and Endangered plant species by non-native goats and sheep include alterations in listed plant micro-habitats, soil erosion, and facilitation of the spreading of invasive, non-native plants into the habitats of listed plant species. Disturbances caused by goats and sheep in and around listed plant occurrences can lead to increase erosion without those occurrences. This increased erosion can expose the roots of listed plant species inhibiting water and nutrient uptake or in severe cases completely up-root individual plants. Disturbances caused by goat and sheep foraging and grazing can also facilitate the spread of invasive, non-native plant species within listed plant occurrences. Invasive, non-native plant species can out-compete native plant species, including listed plants, for available nutrients and water. This can lead to the local extirpation of listed plant occurrences.

Goats and sheep excrete excess nutrients and waste in the form of urine and feces. Nitrogenous organic compounds in urine can chemically burn (over-fertilize) individual Threatened and Endangered listed plants and alters the microhabitat around the point of urination. Goat and sheep feces can cover individual listed plants blocking their access to sunlight, reducing the plant's vigor and health. Adjacent

plants may benefit from the extra nutrients available in urine and feces similar to the effects within the application of normal fertilizer. Increased nutrient availability may still be evident three years after deposition of dung.

Each Federally and Territorially listed species require the NPS to provide some level of protection and monitoring. Direct impacts on Federal endangered species by exotic species include the grazing of *Z. thomasianum, C. thomasiana* and *S. conocarpum* by non-native goats, sheep, hogs and donkeys. Non-native goats, sheep, hogs, deer and donkeys may be having an impact on many Territorial endangered species of plants. While the distribution of endangered plants is relatively well known, the extent of threats to each species is imprecise.

Introduced Animals and Plants

With the exception of bats, the Virgin Islands National Park is presently inhabited by numerous species of non-native mammals that have produced severe impacts on many indigenous species of plants and animals and threats to visitor safety (Appendix B, List of List of Introduced Animals to St. John Island). Feral or wild mammals include the white-tail deer, donkey, wild hog, goat, cow, sheep, European boar, West Indian mongoose, tree rat, Norway rat and cat, dog and house mouse. Some of these species also threaten visitor experience and safety. With the possible exception of deer, increasing populations of these species are seriously affecting native species of plants and animals. Additionally, introduced species of birds, amphibians, reptiles, insects and plants are impacting the fragile environment (see Appendix B).

For a more thorough description of the effects of these introduced animals, see Sustained Reduction of Non-native Rats, Cats and Mongooses from Virgin Islands Environmental Assessment (NPS 2002). Norway Rats or Brown Rats (*Rattus norvegicus)* existed on St. John from the 1700's and were introduced by European explorers. Black or Tree Rats (*Rattus rattus)* existed on St. John from the earliest records and were also introduced by Europeans. Both species occur in Virgin Islands National Park and range throughout St. John, but the tree rat is considerably more common. Most problems arise from the nocturnal black rats, which reside in trees and generally forage at night. Tree rats are associated largely with people and human establishments and are known as commensal rodents.

As commensal rodents, Norway and tree rats are habituated to living near humans and except for an occasional predation by red-tailed hawks, they have no biological predators. Rats are omnivorous; they eat nearly every kind of grain, fruit, fish, fowl, carrion, milk products, and vegetables. Several rodents can destroy hundreds of chicks in just one night. They are behaviorally plastic, have high reproduction rates, and survive in a variety of habitats. These traits make them ideally suited to survive on a variety of predator free islands. Even if extinctions do not occur, rats can have ecosystem wide effects on the distribution and abundance of native species through direct and indirect effects. For example, comparisons of rat-infested and rat-free islands, or pre and post rat eradication experiments, have shown that rats depressed the population size and recruitment of birds, reptiles, plants and terrestrial invertebrates. Rats have also been shown to affect the abundance and age structure of intertidal invertebrates. The introduction of new *Rattus* species should be avoided, even to islands that already have introduced rats.

Cats originated from an ancestral wild species, the European and African Wild Cat (*Felis silvestris*). The cat (*Felis catus*) is now considered a separate species. The estimated numbers of pet cats in urban and rural regions of the United States have grown from 30 million in 1970 to nearly 65 million in 2000. Reliable estimates of the present total cat population are not available. Nationwide, approximately 30% of households have cats. In rural areas, approximately 60% of households have cats. Populations of birds on oceanic islands have evolved in circumstances in which predation from mammalian predators was

negligible and they, and any other island vertebrates and invertebrates, are therefore particularly vulnerable to predation when non-native cats have been introduced.

The impacts of cats on wildlife are difficult to quantify. However, a growing body of literature strongly suggests that cats are a very large factor in the mortality of small mammals, birds, reptiles and amphibians. Because free-ranging cats often receive food from humans, they can reach population levels that may create areas of abnormally high predation rates on wildlife. When the wildlife prey is a threatened or endangered species, the results may be extirpation or extinction. Effects of cat predation are most pronounced in island settings (both actual and islands of habitat), where prey populations are already low or stressed by other factors, or in natural areas where cat colonies are established.

Domestic cats have and continue to threaten populations of reptiles and ground and shrub nesting birds as well as providing vectors for transmission of parasites and diseases to humans. Cats carry many diseases, some which may be passed to humans (cat scratch fever, various bacterial skin diseases) and others that are transmissible to cats. Certainly, their feet and fur carry germs, which they invariably disperse in their wanderings. Cats also apparently like to defecate in the bathrooms and showers at Trunk Bay, producing very unsanitary conditions and additional work for Park employees. Several visitors have contracted "creeping eruption" (also known as hookworm), a nematode infection, and while on the beach at Trunk Bay. This is transmitted via cat feces, probably deposited on the beach where conditions are favorable for parasitic survival.

Cats hunt for both fun and food. Unlike wild predators, cats hunt whether they are hungry or not. These cats are called "subsidized predators" because they sometimes receive a steady supply of food at home. Pet cats can hunt longer and are less susceptible to disease than many wild predators. Because non-native cats routinely kill insects and other small animals for "sport" to practice their hunting skills, in addition to using them as a food source, great numbers of wildlife are lost each year to a small non-native cat population. A recent university study in Wisconsin (Fish and Wildlife Today 1998) estimated that "1 to 2 million free ranging rural cats in Wisconsin kill roughly as many as 217 million birds each year." Researchers noted that birds make up only 20 percent of the cats' diet. Seventy percent of the diet was small mammals and 10 percent reptiles and amphibians (Patronek 1997; Coleman and Temple 1995). Thus, great numbers of wildlife can be lost each year to a small non-native cat population.

In the 1880's, European planters introduced the West Indian Mongoose (*Herpestes auropunctatus)* to the Caribbean and to St. John as a biological control to suppress the tree rat populations that decimated sugar cane fields (Nellis and Everard 1983). It was thought to be the salvation for the large sugar cane plantations on the islands that were being ravaged by tree rats. At first, the statistics indicated that a very large decline in the rat population had occurred and the decline was attributed to mongoose predation. As a result, in the next 30 years (1872 to 1900), even more mongooses were brought to the islands and distributed throughout the Caribbean as a biological control.

Soon it was discovered that rats hunt at night and did not cross paths with the daytime foraging mongooses. Rats are nocturnal and sleep in trees during the day. They were therefore able to eat as much sugar as they wanted by night, while the mongooses were sleeping. The rats were safe, during the day, from the mongooses, which cannot climb trees. They coexist well and we now have both non-native species to contend with. Mongoose populations are scattered throughout St. John, with the highest concentrations near human populations, due to increased food availability. Mongooses have no biological predators and populations rise sharply when sufficient food quantities become available (Nellis and Small 1983).

Problems compounded as the rats continued to enjoy sugar cane and mongooses feasted instead on bird

and sea turtle eggs, as well as, insects, papaya and guava. Public health concerns increased when the mongoose was discovered to be a carrier of rabies. Since mongooses have no natural predators here, the checks and balances of natural population control are missing. Non-native mongooses have devastated reptile populations, some bird populations and continue to depredate the nests of the endangered Hawksbill Sea Turtle (Coblentz, 1983).

Because reptiles, amphibians and invertebrates, such as insects, are small, often slow and readily available on St. John, they are particularly susceptible to local extinction from non-native rat, cat and mongoose depredation. Of particular concern are the varied native reptile and amphibian populations in the Virgin Islands National Park and their links to the ecological web of the island. Non-native rats, cats and mongooses prey upon three species of tree frogs, two geckos, three Anolis lizards, the Ground Lizard, Legless Lizard, Blind Snake, the Puerto Rican Racer, and the Slipperyback Skink. The Park has listed over 232 common insect species, including 13 species of dragonflies and damselflies and over 1,500 beetle species; all of which may be eaten by rats, cats and mongooses.

Great numbers of wildlife, therefore, are lost each year to relatively small non-native rat, cat and mongoose populations. The cumulative impacts associated with these increasing wildlife loses are very large. Small islands typically have both smaller resident wildlife populations and lower species diversity. This is particularly true on very small and highly fragmented islands such as St. John, because most negative impacts are concentrated and accelerated when compared with similar impacts to a larger landmass.

Non-native rats, cats and mongoose prey upon endangered Hawksbill and Leatherback sea turtles, which nest on St. John. Norway and roof rats, cats and mongoose kill emergent hatchlings as they crawl from the nest to the ocean at night, when the rats are most active. Non-native rats, cats and mongoose will also prey upon sea turtle nests soon after being laid when the odor is still present, eating many eggs and spoiling the remaining ones. The Sea Turtle Recovery Plans stipulate that predators should be removed from turtle nesting beaches in order to protect species listed under the authority of the Endangered Species Act.

Non-native rats, cats and mongooses prey upon chicks, juveniles and adults of most bird species that nest on St. John. Of particular concern are endangered Brown Pelicans, Least Terns and threatened Roseate Terns. Territorial endangered species preyed upon by non-native rats, cats and mongoose include ground and tree nesting species such as Bridled Quail Dove, Bahama Pintail Duck, and the Antillean Mango Hummingbird, all of which suffer egg and chick death due to rats. Non-native rats, cats and mongoose also prey upon four (of the five) native bat species, three of which are territorially endangered, and the only indigenous mammals on the island.

Donkeys destabilize steep slopes through maintenance of trails and these results in erosion and impact to coral reefs and seagrass beds. They also affect plant community composition, distribution and succession through selective feeding and dispersal of exotic plant species. Donkeys continue to enter campsites and destroy tents and camping equipment in their efforts to locate food items. Visitors have been bitten and threatened by some donkeys. Traffic safety becomes an issue when visitors stop to look at or photograph donkeys on the road, thus impeding traffic and causing accidents.

Goats, sheep, wild hogs and deer are seriously threatening the sole, small remaining populations of the endangered St. Thomas Lidflower (*Calyptranthes thomasianum*), Prickly Ash (*Zanthroxyllum thomasianum*) and Marron Bacora (*Solanum conocarpum*), which has been proposed for listing. Resource managers are particularly worried about the protection of the St. Thomas Lidflower, because the largest population of 216 individuals lives near the top of Bordeaux Mountain. Goat and sheep herds are

capable of denuding large areas of land of all vegetation, including trees (through bark stripping) and cactus. The VINP represents possibly the largest and best example of dry tropical forest remaining in the Caribbean and many of these exotic species are having a serious impact on its health and sustainability.

III.B. NATURAL RESOURCE THREATS

This chapter of the Environmental Assessment summarizes the condition of the natural resources. It addresses the nature and severity of major threats to the natural resources and impacts that have the potential to affect those resources.

Land Use and Boundary Issues

Approximately 52.0% of the island is Federal land. The Park owns 2,816 hectares (7,444 acres) of the 3840 hectares (9,485 acres) authorized by the enabling legislation. Within the Park boundary, 26.5% (901 hectares or 2,226 acres) of the land is owned by either private interests or the Virgin Islands government. These separate parcels of non-federal land or "inholdings" are dispersed throughout the federal land within the authorized boundaries. The trend has been to further sub-divide the parcels and develop them. There were 261 parcels of non-federal land in 1991 and approximately 322 in 1992.

The NPS is unable to restrict development on private adjacent lands, as our Enabling legislation lacks eminent domain authority. Local zoning or Coastal Zone Management Act (CZM) protection is often inadequate due to relaxed or inconsistent enforcement. Virgin Islands National Park participates in CZM or any permit review for construction or modification of land within or adjacent to Park boundaries and offers comments. The Resource Management Division has established mechanisms for the Park to be contacted on adjacent development issues and to participate in the review/permitting process. There is also a need to upgrade the Park's land status maps (1986) to show changes in ownership and anticipate potential development. Due to lack of eminent domain authority, the Park has to compete for NPS acquisition funds and must work closely with groups like the Friends of Virgin Islands National Park and Trust for Public Lands. These non-profit NGO's can either purchase or hold land until Park funds are available or purchase and donate land to the Park.

Development of private inholdings within and adjacent to the Park boundary, and pressure to re-open or pave old Danish cart roads within the Park, represents serious threats to marine and terrestrial ecosystems in the Park. Clearing of St. John's steep hillsides on slopes approaching and exceeding 30 degrees, has resulted in elimination of native species, spread of exotic plants, increased soil erosion, loss of sparse topsoil, and fragmentation of the forest and "viewsheds". These impacts need to be minimized or at least mitigated. Because development cannot be prevented, eco-sensitive development must be encouraged to require use of recycled and low energy products as well as forested scenic easements. Agreements with landowners could be developed to achieve energy savings, and to minimize loss of biological diversity, introduction of exotic species, degradation of Park resources and scenic values.

Intact forests are important habitat for migratory birds. Development of private lands within the Park and construction of roads through watersheds which are now largely undisturbed could have drastic consequences for the birds which winter in the Virgin Islands.

Visitation Issues

Visitation to the Park is usually of a short-term nature. The annual number of visitors has increased from around 120,000 in the early 1970's to 1.2 million in 2001. Heaviest visitor use occurs between November and May, reflecting increased cruise ship arrivals. Most visitors spend their time on, in or near the water. Beach use and boating are the most popular activities. The beaches along the northwest shore between

Cruz Bay and Cinnamon Bay receive the highest concentration of use. Many tours also visit the premier cultural site of VINP, Annaberg Sugar Plantation.

It is desirable to provide a variety of appropriate opportunities and experiences for visitors, from concession operated/heavy use to primitive surroundings/light use. Human carrying capacities were established in the 1983 GMP for Park facilities, anchorages, recreational beaches and Biosphere Reserve core areas. These carrying capacities will be reevaluated in light of the trends in visitation since 1983, as well as the 2004 GMP update. Congestion and potential crowding threaten to impact or possibly impair not only the quality of the visitor experience but also the integrity of scenic, natural and cultural resources. The Final Commercial Services Plan/EA (2001) identifies desired future conditions that represent only commercial use capacities which best balances resource protection with a quality visitor experience. Total capacity has yet to be addressed. Trails, roads and facilities must be maintained and upgraded, but not at the expense of the environment.

Starting in 1998, the Fee Demo Program instituted a fee collection program for Trunk Bay and Annaberg Sugar Plantation. Visitors now pay $4.00 per person to visit both sites, whether by land or water. Of fees collected, the Park retains 80%, less cost to operate collections and can submit proposals to compete for the remaining 20%. In the four years of this program, substantial funds have been collected for use in upgrading visitor facilities and providing enhanced services, such as animal-proofing many trash receptacles and dumpsters, improving trails and boardwalks, and new comfort stations and sewage treatment facilities. During the four years of operation, the annual net fee revenue averages $284,000 per year.

Threats to Endangered and Threatened Species

Protection of threatened and endangered species and their habitat is imperative, as is reduction or control of exotic and non-native species. Threatened and endangered species of plants are threatened by development of inholdings and damage caused by non-native animals. Rooting activities of hogs is damaging the *Calyptranthes* population on Bordeaux Mountain. Non-native goats, sheep and donkeys graze on seedlings and saplings of rare plants and disperse the seeds of non-native species that compete with the rare species for light, water, space and nutrients.

Law Enforcement rangers strictly enforce the pet leash and restriction laws, especially during turtle nesting season. Dogs must be kept on a leash or physically restrained while in the Park (36 CFR 2.15). Dogs are restricted from all NPS beaches, not only sea turtle nesting beaches. Dogs dig in the sand, sometimes scenting a sea turtle nest, then predating and destroying the entire nest.

The major threat to the reproductive success of threatened and endangered sea turtles is predation of eggs and hatchlings by mongooses and rats. Predation of sea turtle eggs by mongooses is a learned response. Mongooses see a dog or other mongoose digging a nest or find a recently dug nest and discover a high protein source of food. Although sea turtles attempt to disguise the scent by dispersing sand with their flippers, mongooses often detect it and dig to find the eggs. Mongoose predation accounted for up to a 23% loss of sea turtle eggs (Nellis & Small, 1983). Some beaches on St. Thomas experience 100% predation of eggs and nests. Since they are the major predators and threat to nesting success; trapping mongooses each season is necessary adjacent to nesting beaches.

Human poaching of threatened and endangered sea turtles and taking of eggs may be a problem in remote areas of the Park. Sea turtle products, mostly hawksbill shells, are the most commonly confiscated products by the U.S. Customs at United States borders. These confiscations are on the increase. Taking of adult turtles, mostly green, is still allowed in adjacent British waters. Public education, involvement of volunteers with beach patrol programs and encouraging protection of the endangered and threatened sea

turtles in British waters, can raise community awareness about these ancient animals while reducing the incidence of taking and poaching.

Turtle mortality due to boat strikes has greatly increased over the last fifteen years (Boulon, 1997). In some years, over half of all reported turtle strandings involved damage to the carapace from boat propellers or hulls. Increasing populations of juvenile green turtles and increasing numbers of high speed powerboats results in increased numbers of incidental mortalities. The numbers of high speed boats travelling along the north shore of St. John en route to the BVI continues to increase.

While other parts of the world (Southeastern U.S., Hawaii) have been reporting large numbers of green turtles affected with fibropapillomas, the USVI has only had a few reports of individuals having this disease. However, reports of infected turtles are on the increase and sizes of reported tumors are also increasing. This may become a great concern if this disease starts to affect a large segment of our turtle population. Monitoring of in-water sightings and strandings must be maintained.

Endangered and threatened seabirds (Brown Pelican, Roseate and Least Terns) are most commonly affected by predation on eggs and young by rats, cats and mongooses. Humans are also potential poachers of eggs in remote areas. Disturbance by human visitation to offshore cays results in low egg production, death of chicks to sun exposure or even abandonment of the whole nesting colony. Decreases in baitfish populations may limit nesting populations and affect the breeding and fledging success of these birds.

Non-native/Exotic Animal Impacts

Indian mongooses are one of many problem exotic and non-native animals on St. John. Mongoose predation has contributed to the reduction of many reptiles, amphibians, insects, ground nesting birds and sea turtles. Because of its high fecundity and large population, it is unrealistic to try to eliminate this predator from the island. Attempts to eliminate mongoose from much smaller islands than St. John (Buck Island, St. Croix) have been time intensive, costly and have failed. A single pregnant female will reestablish the population in just a few years. The only realistic management measure is to control this species through poison/removal at certain sites during certain times of the year is to reduce its impact on indigenous species (e.g. turtle nesting beaches from June through October).

Non-native cats prey on birds, frogs and lizards, having large effects on their populations. The populations of non-native cats at certain beaches (Trunk Bay, Cinnamon Bay, and Francis Bay) have increased dramatically in recent years. A local vet, in conjunction with the St. John Animal Care Center, has offered to neuter cats brought to her. These cats have then been released in the Park or elsewhere, with the goal of cat population reduction through attrition. However, these cats may live for many more years, continuing to depredate natural populations of birds and reptiles. More recently, cats have been trapped and taken to the Humane Society on St. Thomas for adoption. This has resulted in greatly reduced non-native cat populations in the Park. This effort must be maintained, as the populations will expand again as cats' reproduce and others wander into or are released in the Park.

Donkeys, goats, sheep and hogs graze and browse on vegetation both inside and out of the Park. Impacts to vegetation have been identified and recorded (Coblentz 1983; Nellis *et. al.* 1985, and Ray 1990). Plants on St. John did not evolve with grazers and browsers so have not developed defenses and survival tactics. Forest structure and species composition is changing due to introduction of exotic plants in fecal matter and disappearance of favorite non-native animal foods. Goats and sheep are predominantly concentrated along the east and southeast boundary of the Park, and Reef and Fish bays. They are beginning to utilize Ram Head, Annaberg and Brown Bay quite heavily. Hogs are centered around the Susannaberg landfill and have spread from there to Bordeaux Mountain, Cinnamon Bay and Annaberg. Signs of rutting are now found in Catherineberg, Reef Bay, Cinnamon Bay and Lameshur Bay. Donkeys

wander the entire island. Young black mangrove saplings (a protected species) are one of their favorite foods.

A conservative non-native sheep estimate within the Park is less than 50 animals. Recent introductions include two species of frogs from Puerto Rico and a bird. The Cuban Tree Frog is thought to prey on species of smaller frogs such as our indigenous tree frogs. The "coqui" has been heard around Caneel Bay. The House Sparrow flew across the narrow 3-mile wide channel separating St. Thomas and St. John and now breeds on the island. Audubon Society members are monitoring this species and have attempted some reduction.

Non-native Domestic Goats and Domestic Sheep Impacts

Origin. Non-native Domestic Goats *(Capra hirus) and* Domestic Sheep *(Ovis aries)* are ungulate species introduced (not native) to North or South America; but originate from South West Asia (Gordon Luikart *et. al.* 2001). In Europe, the domestic goats came from South West Asia already domesticated. Christopher Columbus first brought goats and sheep into the West Indies in 1493. The Danes brought goats and sheep to St. John in 1718 when they colonized the island. Goats and sheep have established non-native breeding populations in many areas and all habitat types of the Virgin Islands National Park.

The goat is one of the smallest domesticated ruminants, which has served mankind earlier and longer than cattle and sheep (Gordon Luikart *et. al.* 2001). Domestic goats are still the main economic resource in many developing countries. Their importance hails back to the Neolithic age: indeed, they may have played a crucial role in the spread of agriculture at that time. Goats are more likely to follow humans in their travels than other domestic animals, and they are much less fussy about their food. It is managed for the production of milk, meat and wool, particularly in arid, semitropical or mountainous countries. It is better adapted to dry conditions than cattle or sheep.

Physical Description. During mating season in late summer, the buck releases an oily substance through facial and leg glands. The strong scent attracts females during the rut. Ranchers who breed goats for their fleece will put the goats they wish to breed in a pen called a mating pen. The goat will be kept here until the female or females are pregnant (D.Ohashi and Schemnitz 1987). Following a 5-month gestation period, the kid remains with the mother for several months, unlike the wild breed that abandons their young within two days. They usually live between 8 to 10 years.

Maximum weight for a goat is 225 pounds; most male goats in the Virgin Islands weight about 180 pounds. Adult females weigh considerably less. Goats are 3 ½ to 5 feet long and stand 3 to 4 feet at the shoulder. Both sexes have 30 to 32 teeth. Coat color varies from white, tawny, tan, brown, grey, black and all colors in between. Goats usually have very small horns, if any at all. Their horns are often cut off before they get too long to prevent injury to the shepherd and the other goats in the herd.

Distribution and Abundance. A few residents say all goats and sheep have owners, and many people keep goats and sheep in herd sizes ranging from a few animals to several dozen. Many residents believe the "free-ranging" goatherds in the Park are not owned by people. The Park has experienced goat and sheep grazing since it was established in 1956. The original areas of goat and sheep encroachment included: portions of Leinster Bay near the Johnny Horn Trail; Bordeaux Mountain area above and including much of the Lameshur watershed; the East End near the NPS Firing Range; the upper-eastern portion of Hawksnest Bay; and the Ram Head area. By the early 1990's, free-ranging goat and sheep herds were established in Brown Bay and Ram Head. In 1999, 5 goats were abandoned at the former seaplane ramp at Lind Point. Finally, in the summer of 2000, approximately 12 goats were abandoned on the North Shore Road immediately inside the Park boundary above Cruz Bay.

Non-native goat numbers on St, John are known to oscillate widely between climatic episodes. During drought years, goat numbers have been estimated to be between 300 and 375. Under normal rainfall years, numbers have been estimated to be as high as from 600 to 1000 animals. The island's free-ranging goat population changes within the year. These numbers are not surprising given that goats have a high reproductive potential. Conservatively, with plentiful food, goats can be expected to double their numbers at least once a year.

A conservative goat estimate within Virgin Islands National Park is from 600 to 1000 animals, and the present area of impact is 85% of the island, some of which is among the most sensitive and rare forest habitat types found in the Caribbean region. A conservative non-native sheep estimate within the Park is less than 50 animals. The estimate includes animals that live in the Park and omits animals that graze the Park routinely, but live outside the Park, a situation that occurs at Bordeaux Mountain and the East End. Moreover, because of the dramatically increased herd size at Ram Head/Lameshur, and Brown Bay/Leinster, natural resource degradation will continue at a much faster pace. In addition, perhaps the worst aspect is the new introductions at Lind Point and along the North Shore area, because goats could be impacting as much as 100% of the Park, within a few years.

Also, by the late 1990's, the Brown Bay herd grew to at least approximately 100 individuals. Clearly, the larger breeding populations remain in the wild, with basically unlimited food sources, no hunting or predation pressure, the faster the population will raise and the more extensive control measures will be. The environmental and to a lesser degree cultural impacts as well. Continuing the downward chain of ecological calamity from changing species composition, spreading nonnative vegetation, trail making, increasing erosion, and reducing habitat for birds, herptofauna, insects and others.

The very large concerns are the potential for spreading into new areas, especially now that a population is established on the northern portion of the Park, and the speed and thoroughness with which goats and sheep degrade the sensitive natural and cultural environments. The amount of disturbance caused by goats and sheep would vary by plant community depending upon access, shelter, water sources, and food availability. These plant communities providing adequate water, abundant food sources and shelter would probably incur the most use.

Impacts on Flora. Documented direct effects on plant communities by alien herbivores including non-native goats and sheep are reduction in native species cover, density and biomass (Baker and Reeser 1972; Coblentz 1977). Alien herbivores and goats and sheep have also caused the elimination of the soil litter layer and loss of seed banks, increased soil disturbance, and soil compaction, and lowered or altered rates and patterns of nutrient cycling. Hoofed herbivores impact native vegetation communities through their grazing and browsing activities, which changes plant species composition and distribution. These changes typically result from the selection and avoidance by herbivores of certain plant species, thereby modifying plant succession processes in that area, eventually leading to a different plant community than existed before. For example, the most palatable and nutritious plants will be preferentially eaten, leaving the thornier, less desirable species (from the herbivores' perspective). If this continues at a high enough level over a period of time, the plant community will be changed towards one containing more thorny species with less total plant cover.

In searching for food and shelter, goats and sheep create winding trails through all plant communities (Coblentz 1974, 1977, 1978 and 1980). These paths compact the soil and contribute to increased water run-off, sediment and nutrient loading erosion. These paths can also serve as routes for the spread of invasive, non-native plant species. Where they intersect maintained Park trails, these goat and sheep trails can also lead visitors astray.

Micro-biotic flora or crusts are a critical component of many of the arid and semi-arid rangelands throughout the Northern American West, Midwest and East (Vtorov 1996). These crusts are found throughout the world and are known to occur on St. John. Cyano-bacteria make up the majority of the micro-biotic crusts, but lichens, mosses, green algae, micro-fungi, and bacteria are present as well. These soil crusts significantly modify the surfaces on which they occur and can represent 70-80 percent of the living ground cover. Soil crusts are known to be important in nitrogen fixation, enhancing vascular seedling establishment, and reducing soil erosion.

Several studies have shown that soil crusts are severely impacted by the trampling associated with grazing. Researchers have noted that soil lichen cover is negatively correlated with livestock grazing and that soil mobility and erosion increased with reduced lichen cover. It is likely that non-native goat and sheep grazing would be equally or more damaging. Recovery of soil crusts following the cessation of grazing and trampling has also been noted.

Disturbances caused by goat and sheep grazing and movement through island vegetation may facilitate the spread of non-native, invasive plant species (Yocum 1967). Once established, these species have demonstrated the ability to expand at the expense of native plant species. Additionally, many of the naturalized exotic plant species found on St. John have not co-evolved with the grazing pressures exerted by large herbivores. They have adaptive mechanisms, which allow them to avoid being grazed or to better survive the impacts of grazing. These exotic plant species have expanded in the presence of goats, sheep and hogs on St. John at the expense of the islands' native flora. The presence of non-native goats and sheep would only likely benefit these undesirable species because exotic plants are widely dispersed through their feces.

Documented indirect effects of alien herbivores and non-native goats and sheep to plant communities include the increase of cover, frequency, and biomass of non-native plant species, increased water run-off and soil erosion, and degradation of soil structure. Goats and sheep have also contributed to changes in soil micro-flora and micro-fauna, and the potential loss of fire-induced successional communities due to inadequate fuels and lack of seed banks.

Goats and sheep are selective browsers: which means they select for their favorite foods; then only browse them (Coblentz 1974, 1977, 1978 and 1980). Goats and sheep tend to graze small shrubs and grasses very close to the ground and may even tear the roots from the substrate, preventing regeneration. The most fragile forest community on the island is the dry forest, which predominates, in the southeastern portion of the island. These communities may have the smallest possibility for recovery, and both their species composition and total individual numbers are low. In addition, steep semi-barren cliffs dominate this area, making a perfect habitat for the sure-footed goat. Precious topsoil is lost and will degrade the coral reefs below the cliffs. Some individuals from the main Ram Head herd frequent the Lameshur Bay watershed, perhaps in search of water in the moist forest found there. This frequently occurs on an almost daily basis and has continued unabated for the past several years. This is especially devastating because the Lameshur watershed forms a very large portion of the core area of the Virgin Islands National Park Biosphere Reserve.

The ecological impacts from introductions of non-native herbivores can be both drastic and immediate (Scowcroft and Hobdy 1978). Hoofed herbivores impact native vegetation communities through their grazing and browsing activities, which changes plant species composition and distribution. These changes typically result from the selection and avoidance by herbivores of certain plant species, thereby modifying plant succession processes in that area, eventually leading to a different plant community than existed before. For example, the most palatable and nutritious plants will be preferentially eaten, leaving the thornier, less desirable species (from the herbivores' perspective). If this continues at a high enough

level over a period of time, the plant community will be changed towards one containing more thorny species with less total plant cover. The exact impact to a plant community will depend on the feeding habits and habitat preferences of the herbivores, the herbivore population size, and thew length of time they occupy an area.

Presently, the greatest threats to forest regeneration are development and growing populations of non-native goats, sheep, hogs and donkeys (Coblentz 1974, 1977, 1978 and 1980). Goats, sheep and donkeys alter forest composition by selectively feeding on palatable species and distributing the seeds of exotic species through their feces. Hogs destroy vegetation through rooting up of plants. Despite disturbance by non-native animals and construction, Park lands continue to be a valuable refuge for native plant species. To date, 747 species of vascular plants have been identified from St. John, of which 642 (86%) are native to the island. The species are found in 117 families, of which 12 are introduced. Almost all species (99.7%) on St. John are found on other islands within the Virgin Islands. Two species are endemic to St. John (*Eugenia earhartii* and *Machaonia woodburyana*) and six others are endemic to the Virgin Islands. Another 25 species are endemic to the Puerto Rico platform. Many voucher specimens and representatives of common plants have been collected by premier botanists and placed in the Park herbarium collection, creating an extensive collection of most species on the island. As they conduct monitoring and inventories, botanists continue to identify new species.

A network of long-term monitoring plots, representing a range of stand ages and land-use histories, has now been established in each of the following forest types on the island: upland moist, gallery moist, dry evergreen woodland and dry evergreen scrubland. Peter Weaver (1999) has established 16 plots in the dry evergreen and moist forest of the Cinnamon Bay watershed; the New York Botanical Garden has three plots covering upland moist, gallery moist and dry evergreen woodland; and the Smithsonian has two plots covering dry evergreen woodland and dry evergreen scrubland. In addition, the USDA-NRCS has five long-term plots in the Lameshur and Cinnamon Bay watersheds to measure soil temperature and moisture. Information on forest regeneration, tree seedling growth, changes of species composition and forest structure are gathered by researchers through Memorandums of Understanding, Cooperative Agreements and direct National Park Service funding.

The Virgin Islands National Park has probably the best baseline set of data for dry tropical forest in the Caribbean. The numerous studies and long-term monitoring plots, coupled with the inventories and published works on St. John vegetation, make this the most comprehensively studied habitat type in VINP. All of the Federally and Territorially listed species require some level of protection and monitoring.

Impacts on Threatened and Endangered Plants. Direct impacts to twenty-five listed plant species would include herbivory of T&E plant species by non-native goats and sheep and the trampling, crushing and uprooting of listed plant species should goats and sheep walk, root or bed down within listed plant occurrences (Mueller-Dombois and Spatz 1973). Depending on the number of individual goats and sheep within an area, one to many T&E plants may be grazed, trampled or uprooted. Those occurrences that are found in areas of high goat and sheep use would likely incur the most damage. Because the rarity of these listed plant species is defined by their limited numbers; even relatively small impacts can have a large detrimental effect. Individual plants lost through predation, trampling or uprooting cannot contribute offspring to the succeeding generation. This results in a loss to the next generation of both absolute numbers and potential genetic diversity. A decrease in genetic diversity can lead to an overall decrease in evolutionary fitness for a species. Decreased population numbers lead to increased potential for extirpation from continued predation, or from large random disturbance events such as fire, hurricanes or drought.

Indirect effects to listed T&E plant species by non-native goats and sheep include alterations in listed plant micro-habitats, soil erosion, and facilitation of the spreading of invasive, non-native plants into the habitats of listed plant species (Mueller-Dombois and Spatz 1973). Disturbances caused by goats and sheep in and around listed plant occurrences can lead to increase erosion without those occurrences. This increased erosion can expose the roots of listed plant species inhibiting water and nutrient uptake or in severe cases completely up-root individual plants. Disturbances caused by goat and sheep foraging and grazing can also facilitate the spread of invasive, non-native plant species within listed plant occurrences. Invasive, non-native plant species can out-compete native plant species, including listed plants, for available nutrients and water. This can lead to the local extirpation of listed plant occurrences.

Goats and sheep, like all animals, excrete excess nutrients and waste in the form of urine and feces. Chemicals, primarily nitrogen, in urine can chemically burn individual T&E listed plants and alters the microhabitat around the point of urination. Goat and sheep feces can cover individual listed plants blocking their access to sunlight, reducing the plant's vigor and health. Adjacent plants may benefit from the extra nutrients available in urine and feces similar to the effects within the application of normal fertilizer. Increased nutrient availability may still be evident three years after deposition of dung.

Goat and sheep herds are capable of denuding large areas of land of all vegetation, including trees (through bark stripping) and cactus. The VINP represents possibly the largest and best example of dry tropical forest remaining in the Caribbean and many of these exotic species are having a serious impact on its health and sustainability.

Altered and degraded forest systems are recovering from the clear-cutting done in plantation days. Most species are still present, but composition and forest structure do not yet resemble pre-plantation descriptions of the forests. Ecological succession to dominant communities is being monitored. Grazing and browsing by non-native livestock and development pressures are the greatest threats. The few remaining mangrove forests have been considerably stressed by recent hurricanes: Hugo (1989), Luis (1995), Marilyn (1995), Bertha (1996) and Georges (1998) and development pressures. Fragmentation of small natural areas into even smaller parcels is a threat to natural systems and processes.

There are no permanent streams or lakes on St. John. There are only a few perennial pools in major watersheds that may hold water all year. The water in salt ponds and mangroves are brackish at best. Neither deer nor goats were seen drinking from the ocean. Water is critical to the health of all ruminants. Deer will often travel a long distance for a drink of water. It would be useful to know how the lack of fresh water affects the behavior, movement and general health of the deer on the island. In Arizona, years with poor fawn crops and poor body condition are associated with drought. The goats in the study ranged on VINP land during the morning hours, and regularly returned to a farm outside the Park boundaries in the afternoon where fresh water may have been available (Stuht 2001).

Potential Transmission of Goat and Sheep Disease and Parasites Issues. Fecal samples were collected in June 2000 from white-tailed deer and free-ranging goats in the Virgin Islands National Park (Stuht 2001). Eggs of strongyles, *Moniezia sp.*, *Trichuris* sp. and oocysts of coccidia were found in both deer and goats. The coccidium in deer was identified as *Eimeria mccordocki*. This was the first study of parasites of white-tailed deer on St. John. Strongyles have been reported previously from white-tailed deer on St. Croix. None of the parasites found in this study are highly pathogenic to deer and goats and none are of known public health significance. It is thought that exotic populations host fewer species of parasites than native populations of the same species.

In the areas where deer and goats were watched closely by Stuht (2001) it appears that their food habitats are a little different. Goats seemed to eat more leafy vegetation of all kinds. If they can reach it, they eat

it. Deer seem pickier, and spend more time looking for green herbaceous plants nearer the ground. However, some green plants are ignored by deer. Both deer and goats appeared to like the fruit of the local tamarind (*Tamarindus indica*). They both made regular visits to the base of these trees in search of fruit that had recently dropped.

Great numbers of goats and sheep serve as co-hosts with native wildlife and livestock for infectious and parasitic diseases (New, Barton, Morris and Potgieter 1994). A variety of arthropod, protozoan, and helmith parasites also has been found from the Park, including, ticks, lice, protozoa, kidney worms, esophageal worms, stomach worms, intestinal worms, and lungworms. Goats also carry foot rot. It is very hard to get rid of this disease in sheep if goats are nearby. Goats are also potential carriers of exotic diseases such as foot and mouth disease. These are common parasites for both wildlife, and goats and sheep. Suggested cautions would be to inform people that during butchering activities, gloves should be used and that contact with the reproductive tracts and fetuses of female goats and sheep should be avoided.

Biological Pollution (Exotic Plants)

Harmful exotic plants can have profound environmental consequences ranging from wholesale ecosystem changes and extinction of indigenous or native species, especially on islands, to more subtle ecological changes and increased biological sameness (monospecific forests). Both intentional and accidental introductions of harmful non-indigenous plants occur. Intentional introductions take the form of ornamental plants to enhance perceived beauty or of crops, fruit trees and medicinal plants to generate a new source of food or income. Accidental introductions arrive as contaminants or hitchhikers on bulk commodities, packing material, in ship ballast, seed shipments and soil. Agricultural inspections of plants entering the Virgin Islands through customs are cursory at best. No inspections are done on cargo transported between the Virgin Islands. An inventory of exotic species and determination of their status in the Park are needed. If the species interferes with Park objectives, has the ability to alter ecosystems, can spread to natural communities, can out-compete native species or is allellopathic, management actions need to be evaluated and implemented.

Disturbances caused by goat and sheep trampling, grazing and movement through island vegetation may facilitate the spread of non-native, invasive plant species. Once established, these species have demonstrated the ability to expand at the expense of native plant species. Additionally, many of the naturalized non-native plant species found on St. John Island have not co-evolved with the grazing pressures exerted by large herbivores. They have adaptive mechanisms, which allow them to avoid being grazed or to better survive the impacts of grazing. These non-native plant species have expanded in the presence of goats, sheep and hogs on St. John at the expense of the island's native flora. The presence of goats and sheep would only likely benefit these species due to the fact that exotic plants are currently widely dispersed through their feces.

Forest Recovery and Fragmentation

Altered and degraded forest systems are recovering from the clear-cutting done in plantation days. Most species are still present, but composition and forest structure do not yet resemble pre-plantation descriptions of the forests. Ecological succession to dominant communities is being monitored. Grazing and browsing by non-native livestock (goats, hogs, sheep and burros) and development pressures are the worst threats. The few remaining mangrove forests have been considerably stressed by recent hurricanes: Hugo (1989), Luis (1995), Marilyn (1995), Bertha (1996) and Georges (1998) and development pressures. Fragmentation of small natural areas into even smaller parcels is a threat to natural systems and processes.

Garbage Disposal and Recycling
Until 1994 the St. John solid waste disposal site was an open landfill located at Susannaberg, 2.4 kilometers (1.5 miles) east of Cruz Bay, south of Centerline Road. The Territorial Department of Public Works manages the facility. This landfill served the needs of the entire island, including the Park until it was closed after a large fire erupted and eventually was put out in 1992. The landfill has been capped and closed according to the Environmental Protection Agency's standards; however, leachates carrying contaminants may wash down Guinea Ghut or seep into the groundwater during heavy rainstorms. Garbage generated on St. John is taken to the landfill site, loaded onto trucks, barged to St. Thomas and deposited in the Bovoni Landfill. This landfill has exceeded capacity and resource recovery alternatives are being explored by the VI Government.

Twelve percent of the contents of the landfill are metal, 40% is paper and 5% is glass. If just these materials were recycled, the volume of garbage going to the landfill would be decreased by over 50%. If composting household garbage, grass and leaves were done; another 23% in volume would be reduced. The Park, the VI Anti Litter and Beautification Commission (VIALBC) and a few key local citizens has initiated recycling programs for aluminum. Recycling would decrease the volume of garbage sent to the landfill as well as save energy. Ninety percent of the energy it takes to manufacture aluminum from virgin materials can be saved if aluminum is recycled. Goat and sheep access to human garbage at all NPS visitor and concession facilities and structures are one of the reasons why the Park is animal-proofing all of food containers.

III.C. CULTURAL RESOURCES

This chapter of the Environmental Assessment describes the current status of baseline information from inventories, monitoring and research projects. Major Park planning documents have been completed. Some are in the process of being updated; the Land Use Plan, General Management Plan, and the Resource Management Plan. Virgin Islands National Park needs an update to major inventories and documentation of cultural resources in addition to special studies and an administrative history.

History
Non-native Domestic Goats *(Capra hirus) and* Domestic Sheep *(Ovis aries)* are ungulate species introduced (not native) to North or South America; but originated from South West Asia (Gordon Luikart *et. al.* 2001). In Europe, the domestic goats came from South West Asia already domesticated. Christopher Columbus first brought goats and sheep into the West Indies in 1493. The Danes brought non-native goats and sheep to St. John in 1718 when they colonized the island. During the 17th Century, sailors released goats onto islands and into some areas of St. John Island for emergency food supplies. Goats and sheep have established non-native breeding populations in many areas and all habitat types of the Virgin Islands National Park.

The goat is one of the smallest domesticated ruminants, which has served mankind earlier and longer than cattle and sheep (Gordon Luikart *et. al.* 2001). Domestic goats are still the main economic resource in many developing countries. Their importance hails back to the Neolithic age: indeed, they may have played a crucial role in the spread of agriculture art that time. Goats are more likely to follow humans in their travels than other domestic animals, and they are much less fussy about their food. It is managed for the production of milk, meat and wool, particularly in arid, semitropical or mountainous countries. It is better adapted to dry conditions than cattle or sheep.

A few residents say all goats and sheep have owners, and many people keep goats and sheep in herd sizes ranging from a few animals to several dozen. Many residents believe the "free-ranging" goatherds in the

Park are not owned by people. The Park has experienced goat and sheep grazing since it was established in 1956. The original areas of goat and sheep encroachment included: portions of Leinster Bay near the Johnny Horn Trail; Bordeaux Mountain area above and including much of the Lameshur watershed; the East End near the NPS Firing Range; the upper-eastern portion of Hawksnest Bay; and the Ram Head area. By the early 1990's, free-ranging goat and sheep herds were established in Brown Bay and Ram Head. In 1999, 5 goats were abandoned at the former seaplane ramp at Lind Point. Finally, in the summer of 2000, approximately 12 goats were abandoned on the North Shore Road immediately inside the Park boundary above Cruz Bay.

Three waves of migrations brought Native Americans north from the Orinoco River valley of Venezuela. By the time of European discovery of the New World, two prehistoric Indian groups inhabited or visited the Virgin Islands, the Arawaks or Tainos and the more aggressive Caribs. On November 4, 1493, Christopher Columbus and a fleet of 17 ships made land fall in the Lesser Antilles beginning two centuries of international wars for supremacy of the West Indies, disrupting native customs and deforesting the land. The Columbus expedition did land on St. Croix, probably at Salt River.

Beginning in 1718, St. Thomas and St. John were colonized by the Danish West India and Guinea Company. Landholdings were cleared and cultivated. These "plantages" or "plantations" relied on slave labor and sizable capital investment. On St. John in 1733-4, development was slowed and nearly stopped by an almost successful slave uprising. The Danish West Indies became a crown colony in 1755 and development accelerated. By 1780, the greater part of St. John was under cultivation. Early crops included cotton, tobacco and dye woods such as indigo, but shifted predominantly to sugar. The rugged terrain, the thin rocky soil and labor-intensive economies created problems. As long as sugar prices remained high and African slaves were easily available, agricultural development was financially viable.

Denmark abolished trade in slaves in 1792. By the 1800s, sugar prices dropped. Plantation economy became marginal. By the mid-1800s, competition with areas where mechanical cultivation of both sugar and cotton and the increased production of the European sugar beet was too much and some plantations folded. In 1848 slavery was abolished in the Danish West Indies. The plantation systems succumbed. Only a few plantations lasted into the 20th century. They introduced crops that produced bay and lime oil, mechanically crushed sugar, or they attempted to raise and sell livestock.

The breaking point for most remaining plantations occurred in 1867. Following a major hurricane and earthquake, tracts of cultivated land were abandoned or allowed to shrink. The population declined. Land reverted to natural vegetation that buried the collapsing remains of the once flourishing agricultural buildings. In 1917, the Danish West Indies was ceded to the United States. The territory of the Virgin Islands was created in 1931 and is currently administered by an elected governor and legislature. Oversight authority for the territory rests in the U.S. Department of Interior.

Now the islands are based on a tourist economy. After World War II, with rising wages and improved large-scale commercial air travel, mass tourism became reality. The over one million tourists per year originate predominantly from the United States (64%), Europe (10%) and Canada (7%). Beginning in the 1950s, St. Thomas became a popular destination for Caribbean cruise ships that send passengers to St. John for day trips. The island, which once harbored fewer than 800 people living mostly in two-room wooden cottages without indoor plumbing, electricity or telephones and their only means of transportation a donkey or a horse, has undergone a dramatic transformation. A population of over 4,500 persons is now sustained by wage employment that allows many to live in modern housing and own cars.

The Virgin Islands National Park was welcomed when it was established in 1956 on St. John. It was thought that the Park would provide economic opportunities for local Virgin Islanders. But, the Park has

been developed as a "natural area", following an U.S. concept of nature foreign to St. Johnians. The general policy adopted by the Park dictated that land be "managed 'back' toward pristine condition" that had prevailed "when the area was first visited by the white man" (Administrative Policies 2001). Access to economic resources in the Park has been restricted, severely limiting traditional use of the environment. The tourist industry created only limited economic opportunities for St. Johnians.

After the Park was established, it undertook the task of undoing the effect of almost 250 years of cultivation. If a St. Johnian had a garden plot under cultivation on land acquired by the Park, the plot could continue to be cultivated but no new land could be cleared. Soil was depleted within several years and the traditional extensive swidden agriculture ceased. Cattle grazing on Parklands were forbidden. No longer permitted to turn their cattle loose on a nearby estate during periods of drought, farmers were forced to slaughter them. Even though hunting and trapping had never been a major part of the local economy, the Park set up large signs prohibiting it. There was a fine of $500 or six months in prison for any person violating Park rules.

The Park Service did not prohibit all economic activity in the Park area, believing it is necessary to provide visitors to the Park with modern facilities, such as trails, roads, camping and dinning facilities. Facilities have been established for swimmers at all beaches held by the Park Service. Tourist facilities have been developed by private businesses on inholdings within the Park, such as Caneel Bay Plantation and Maho Bay.

Archeological Resources

The Virgin Islands prehistorically are part of a larger Caribbean Culture Area. This area consists of two distinct chains of islands. The Lesser Antilles are a line of small, mainly volcanic islands sweeping northward from Trinidad near the mouth of the Orinoco River in Venezuela. The Greater Antilles consists of a chain of four large islands: Puerto Rico, Hispaniola (Haiti and the Dominican Republic), Cuba and Jamaica. American Indians prior to discovery inhabited the Virgin Islands by the Spanish explorers. Prehistoric information and surveys are incomplete.

The earliest occupation of the Americas was detected around 10,000 BC. During the last glaciation when a land bridge formed between Asia and North America, small highly mobile bands of hunters and gatherers reached America. They hunted large megafauna such as the mastodon and mammoth. It is not thought that the Antilles were inhabited during this period (13,000 to 7,900 BC). The earliest recorded prehistoric site for the Caribbean Culture Area is the El Jobo Site in Venezuela. This culture was probably an offshoot of the North American big game hunting tradition.

During the next period of time, the hunter/gatherer groups became more organized and spread out. They developed storage pits, began collecting shellfish, developed habitations, prepared their dead for burials, traded with other groups and developed the atlatyl to increase hunting prowess. This period of time is called Archaic on the mainland (8,000 to 1,000 BC) and Meso-Indian in the Caribbean (5,000 BC to AD 0). The only known site representing this period of time in the Virgin Islands is the Krum Bay Site on St. Thomas although there may be a site as old as 700 AD at the west end of Cinnamon Bay beach.

The third broad period of pre-history is called the Neo-Indian in the Caribbean (AD 0 to contact with Europeans). During this period of time, there was an increase in horticulture, ceramic pottery use and there was a shift to a more sedentary lifestyle. Several waves of culture groups left the Orinoco valley in Venezuela and migrated northwards. Just a few hundred years prior to contact with Europeans, the Arawaks had begun to be displaced by this last migrant group. By European contact, the Caribs had occupied all of the Lesser Antilles including the U.S. Virgin Islands.

Twenty-two prehistoric sites have been recorded on St. John, thirteen of which are on National Park Service land. Only two of these sites are currently on the National Register, the Reef Bay petroglyphs and the Cinnamon Bay site. Nine additional sites may be eligible for National Register listing. The largest and best-known site on St. John is at Coral Bay outside the Park boundary.

The subsistence economy of these Archaic people was based on collecting plants, fishing and small game hunting with an emphasis on the exploitation of maritime resources. No large mammals were present on St. John. The Iguana (*Iguana iguana*), Hutia (*Isolobodan*), and several bird species provided land-based meats. The hutia, a small rodent-like animal, and the iguana are thought to have been introduced to St. John by Arawak settlers. Reef fish were the most important and easiest to exploit. The Manatee (*Trichechus manatus*) was known to have been used by aboriginal and historic settlers alike. Shellfish were abundant, with Conch (*Strombus* sp.) and the West Indian Topshell (*Cittarium pica*) being found the most often in the archeological record. Spiny lobster and crabs were also utilized for food. Recent evidence from Cinnamon Bay shows that the Caribbean Monk Seal as well as freshwater turtles, snakes and a number of rails were also consumed.

The prehistoric archeological evidence from Cinnamon Bay Site established for the first time that Classic Taino Culture dominated the Northern Virgin Islands. Besides defining the presence of Taino culture in the region the Cinnamon Bay Site is also proving to be significant in defining the social, political and religious development of this culture, which was present at the time Europeans enter the New World. The Taino culture that met Christopher Columbus in the New World extended throughout the Greater Antilles and Bahamas. Classic Taino culture was a complex culture verging on civilization. These people were skilled farmers, hunters, fishermen and artists. Travel at sea was done in canoes; some could carry up to 150 people. The Taino impacted European culture through their introduction of such items as sweet potato, the hammock, rubber, tobacco, cassava, pineapple, beans, squash, peanuts and guava. Many words we use today are derived or were Taino such as barbecue, tobacco, hurricane, potato, canoe, hammock, savanna and cannibal.

Spanish colonization ended Taino culture within 30 years as many thousands died and the culture was annihilated as a result of disease, suicide, and extermination. By 1503, every chiefdom on Hispaniola was destroyed; by 1511, there were very few left alive on Jamaica. In 1508, Juan Ponce de Leon, in his search for gold, colonized Puerto Rico. The Borinquen, as the Taino of Puerto Rico called themselves soon rebelled and allied with their neighbors in the northern Virgin Islands. From these Islands the Taino staged warfare against the Spanish. The rebellion resulted in the Spanish King to decree that all were subject to extermination and by 1519 they had all but eliminated the Taino culture.

Non-native goats and sheep damage irreplaceable archeological and historical sites and degrade the scientific importance of the sites located at Cinnamon and Reef bays. Damage to archeological sites by goats and sheep would continue essentially unabated. Goat and sheep grazing at archeological sites on the island has resulted in a loss of integrity, and could ultimately result in a loss of the values that make these sites eligible for the National Register of Historic Places.

Historic Structures

The most conspicuous structures, both in volume and size, are the remains of sugar plantations. They are found predominantly along ridges of the north coast and valleys of the south coast of St. John, where drainages were good for growing sugar cane. On drier areas of the island, cotton and livestock were raised.

Consolidation of small landholdings to larger economically feasible ones occurred over time. From 1728 Danish tax records, 91 plantation lots were counted on St. John. Only half of these were under development. Seventy-two years later, in 1800, P.L. Oxholm mapped 68 plantations, 41 of which were

within the current authorized Park boundaries. Currently there are 46 historic plantations within the authorized boundary, 31 of these are on federal land.

There are 236 historic structures on the 1989 List of Classified Structures for St. John. Seventeen of these are still roofed or with vestiges of roofing. Nine structures are in use. Sixteen historic districts are recorded on the National Register, all of which are on federal land. These contain 180 individual structures. Seven individual structures are recorded on the National Register, four of which are on federal land. Structures range in function from Danish plantation great house, cook house, slave village and sugar processing factory to colonial fort and battery, to a school and even a guard custom house. They date from 1718. Many of the structures have fallen to ruinous piles of rock not considered salvageable and should be removed from the List of Classified Structures (LCS) and added to the Cultural Sites Inventory (CSI) as historic archeological sites. Basic inventories are not complete. Portions of structures and new historic archeological sites hidden by years of vegetative growth are still being discovered. Historic structure reports have not been completed for most structures undergoing stabilization.

No National Landmarks are yet listed for the island of St. John, although there are six worthy of nomination (M. Barnes, 1990). Two sites were nominated in 1994: Fortsberg and the Reef Bay Great House Plantation manager or owner residences were usually with the area of production or on higher ground overlooking the factory. Slave quarters or "villages" were placed on the periphery of the production center. Most plantations included an orchard and plot for raising vegetables. Terrain dictated the pattern, either grid or terracing with walls. Existing roads and trails generally follow original cart roads that should also be considered part of the cultural resource.

Architecture was rural in character and utilitarian of purpose. The most common construction was rubble masonry using locally available fieldstone set in lime mortar with liberal use of imported brick for framing doors, window openings, arches and quoining of corners. Much rubble and brick masonry has traces of a parged or plaster finish. Stucco inlays of colored plaster ornamentation were frequent in principal buildings. The Reef Bay Great House and Hammer Farm are excellent examples of the use of ornamentation. Characteristic, but not common, was the use of blocks of cut and fitted brain coral that was usually left exposed. Annaberg Sugar Plantation is an excellent example of this architectural style. Clay wing tile, both glazed and unglazed, was not an unusual roofing material. Flooring made of brick, clay tile or Gotland limestone flagging was widely used. The few remaining well-preserved structures indicate that workmanship was excellent.

The most significant and complete historic structures on St. John under Park jurisdiction have been cleared of vegetation and stabilized to provide a degree of protection against further deterioration. The work has been predominantly limited to masonry repair of standing walls. The Reef Bay Sugar Factory has been re-roofed with a lightweight modern galvanized-type roofing to protect the machinery and other features of the interior. Significant structures that have been stabilized include the Reef Bay Sugar Factory which is the best preserved example of technology used in mid-19th century sugar making, the Cinnamon Bay sugar plantation which was one of the first established on the island and site of significant events during the 1733 slave rebellion, the Annaberg Sugar Plantation illustrating an excellent example of a complete factory complex, and the Hammer Farm (also called Catherineburg) windmill tower with unique ramp and vaulted storage.

The Reef Bay Great House is considered one of the most important historic structures in the Park and illustrates West Indian formal architecture. It is on the National Register (H-15) and has been nominated for National Historic Landmark status. Fish plates and tie rods were installed in some walls of the Reef Bay Great House to increase structural strength, but have now been removed. Reconstruction of the walls of southwest corner was needed to stabilize it and keep it from imminent collapse. This was completed in

1993. The structure has also been re-roofed with sheets of galvanized aluminum. Plastering of the exterior is still needed.

Fourteen known historic districts and one individual building exist on inholdings within the authorized NPS boundary on St. John. Nine districts qualify for nomination to the National Register for their historical associations and their integrity. They include: Caneel Bay Plantation (H6); Susannaberg Plantation (H7); Adrian Plantation (H8); Oynes Point Custom Guard House (H9); Leinster Bay Plantation (H29); More Hill (H38); Frederiksdal and Mount Pleasant (H41). The State Historic Preservation Office has nominated two sites for the National Register: Frederiksvaern, Fortsberg, Coral Bay (H44); and Whistling Cay Customs Guard House (H47).

The major environmental impact to the historic structures is growth of vegetation. Plant roots penetrate soft mortar and plaster surfaces working themselves deeper into the structure forming cracks through pressure against surfaces as they grow, and providing avenues for moisture, rainfall and leaf litter to enter and accumulate. Consistent and ongoing vegetation removal is the major effort to stabilize historic structures within VINP.

Non-native goats and sheep destroy irreplaceable historic sites and degrade the scientific importance of the sites located at Cinnamon, Reef, Leinster and Brown bay watersheds, as well as Lind Point areas and Hassel Island. Damage to historic sites by goats and sheep continues unabated; and increases each year as the population grows and the impacted areas expand. Goat and sheep grazing at historic sites on the island has resulted in a loss of integrity, and would automatically or concurrently result in a loss of the values that make them eligible for the National Register of Historic Places.

Ethnographic Resources

The culture of island residents is important to understand and maintain. Only limited ethnographic program has been developed. Oral histories are needed before elderly island residents containing a wealth of information forget or pass away. Crafts such as basketmaking were conducted for additional income or trade, but also as avenues to carry on community traditions and lifestyles. An expansion of craft demonstrations, displays and an outlet for their sale may be desirable.

The goat is one of the smallest domesticated ruminants, which has served mankind earlier and longer than cattle or sheep (Gordon Luikart *et. al.* 2001). Domestic goats are still the main economic resource in many developing countries. Their importance hails back to the Neolithic age; indeed, they may have played a crucial role in the spread of agriculture at the time. Goats are more likely to follow humans in their travels than other domestic animals and they are less fussy about their food. They are managed for the production of milk, meat and wool, particularly in arid, semitropical or mountainous countries, and goats adapted better to dry conditions than cattle or sheep.

During mating season between late summer and early winter the buck releases an oily substance to attract does. Ranchers who breed goats for fleece put the goats they wish to breed in a pen called a mating pen. Usually there is one buck with several does. The goats remain together until the females become pregnant. Does usually carry the kid for 5 months, before giving birth. The kid will stay with its mother for several months, unlike the wild breed that will only stay with their mother for one or two days. They usually live between 8 to 10 years.

A few residents say all goats and sheep have owners, and many people keep goats and sheep in herd sizes ranging from a few animals to several dozen. Many residents believe the "free-ranging" goatherds in the Park are not owned by people. The Park has experienced goat and sheep grazing since it was established in 1956. The original areas of goat and sheep encroachment included: portions of Leinster Bay near the

Johnny Horn Trail; Bordeaux Mountain area above and including much of the Lameshur watershed; the East End near the NPS Firing Range; and the upper-eastern portion of Hawksnest Bay. The Brown and Leinster bay watersheds include perhaps a few dozen sheep. Fortunately, sheep are not impacting any additional Park lands. By the early 1990's, free-ranging goatherds were established in Brown Bay and Ram Head. In 1999, 5 goats were abandoned at the former seaplane ramp at Lind Point. Finally, in the summer of 2000, approximately 12 goats were abandoned on the North Shore Road immediately inside the Park boundary above Cruz Bay.

For example, goats and sheep may have played an important role in the colonists and enslaved Africans culture for two hundred years (Olwig 1985). For these residents, goats and sheep were a source of food and clothing. The horns were used as chipping tools, ornaments, headdresses, bow strings and for making fishing lines. Goats and sheep were also an important part of the folklore and the religion of island residents.

Ranchers have a legal right to maintain livestock on their property, and many keep the traditions fresh through the generations. VIDA implemented the Animal Registration and Impoundment Program in 2001, in part to facilitate these practices while protecting public and private lands from devastation by livestock. VINP Interpretative Rangers and others have begun to record oral histories and cultural traditions in the late 1980's and early 1990's. The NPS intends to protect and preserve the rich and varied tradition of both African and European peoples on St. John. However, by removing the goats and sheep from grazing within VINP, any and all related traditions would continue and may be enhanced.

There has been a local goat and sheep-hunting tradition on St. John for centuries (Olwig 1985). Such a cultural tradition reflects the long history of goats and sheep on the island and what is known archaeologically about enslaved African Americans, and others, supplementing their diets (at least in some areas of the Americas) through hunting, fishing, and trapping. Unofficial goat and sheep hunting was allowed in the Park through the mid-1990's, then it was determined the Park's enabling legislation prohibits the Superintendent from authorizing hunting.

If the Environmentally Preferable Alternative were implemented, goat and sheep ranchers would no longer be permitted to graze their livestock on Park lands for the production of milk, meat and wool. They would continue to graze their livestock on non-Park land (approximately 48 percent of the island of St. John). NPS would contact local St. Johnian residents who have requested a hunting permit. They would be asked to participate as Volunteers-In Parks (VIP's) program in implementing this goat and sheep reduction program. We will be able to contact these individuals, as we have their previous hunting permits on record (also see page 21, Use of Local Field Volunteers; as well as page 23, Use of By-products).

IV. CHAPTER IV. ENVIRONMENTAL CONSEQUENCES

Chapter IV discloses the environmental consequences of implementing each of the two alternatives described in Chapter II. This analysis of environmental consequences is largely a qualitative assessment of the direct, indirect and cumulative effects of the alternatives on twelve natural and cultural resources categories. A summary of this analysis can be found in Table 1. In addition this chapter will analyze whether the actions proposed in this analysis will impair park resources. Discussion on "Impairment of Park Resources or Values", as required by National Park Service Management Policies (NPS 2000) and Director's Order 12 (Conservation Planning, Environmental Impact Analysis and Decision –making), is provided as a separate section at the end of each of the twelve resources categories.

Direct effects, as defined by the Council on Environmental Quality, are those that are caused by the action and occur at the same time and place. Indirect effects are those that are caused by the action and are later in time or farther removed by distance. Cumulative effects result from the incremental impact of the action when combined with other past, present or reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

IV.A. Non-native Goats and Sheep Control

IV.B.1. Alternative 1. No Action, Continue Current Level of Management

Goat and sheep populations have been increasing for the past several years as evidenced by the introduction of goats and sheep in Maho and Cinnamon watersheds in 1998, which were historically free of goats and sheep. Impacts associated with the presence and proliferation of goats and sheep would be expected to increase under this alternative. The increase would be in severity, as well as, detrimental cumulative impacts, as a combination of factors merge to intensify a specific resource.

Air Quality Impacts
No adverse air quality impacts would be expected under this alternative. However, there would be no impairment of air quality as a result of the implementation of Alternative 1.

Cumulative Effects: No air quality impacts would be expected under the implementation of the no action alternative.

Scenic Value Impacts
Scenic values would decline under this alternative as non-native goats and sheep eat, trample, crush and uproot native flora. The aesthetics of the Park would be lessened due to the reduction of native vegetation, reduction of plant cover, and damage to archeological and historical sites. The natural and cultural resource values of the Park would decrease. However, there would be no impairment of scenic values as a result of the implementation of Alternative 1.

Cumulative Effects: If the no action alternative is taken, scenic value impacts would continue to decline due to the decrease of native wildlife, decrease of native plant cover, and decreased protection of archeological and historic sites that have been disturbed by goat and sheep grazing.

Cultural Resource Impacts
Non-native goats and sheep would continue to damage irreplaceable archeological and historical resources and would degrade the scientific importance of the St. John archeological record. Under this alternative, damage to archeological and historic sites by goats and sheep would at Cinnamon, Reef, Leinster, Brown, Francis, Maho, Lameshur bays and the Lind Point area and Hassel Island continue essentially unabated. Continued goat and sheep grazing at archeological sites in the Park would likely result in their loss of integrity, and ultimately loss of the values that makes them eligible for listing on the National Register of Historic Places.

Cultural resource impacts would increase where goat and sheep vegetation grazing and exotic seed dispersal continually impact the context of these resources, thereby compromising their scientific value. However, there would be no impairment of cultural resources as a result of the implementation of Alternative 1.

Cumulative Effects: If the no action alternative is taken, the Saint John Island archeological records are significant for the large number and diversity of pristine sites found in the Park. Sites range from isolated artifacts to huge, stratified sites encompassing habitation areas and specialized activity areas spanning a period of 4,000 years. Continued goat and sheep depredations throughout the Park would result in a truncated archeological database. The number and diversity of sites would be greatly reduced, destroying the values of the district, and resulting in de-listing of the National Register district, possibly leaving a small number of individually eligible sites. The value of remaining archeological sites would be greatly reduced, and future researchers would be unable to take advantage of new research techniques that may be developed in the future.

Socioeconomic/Visitor Use Impacts
Under the no action alternative, existing socioeconomic conditions would continue on St. John Island, with visitation continuing to increase. In many areas of the Park, visitation levels would remain heavy except in remote backcountry areas. Goat and sheep ranchers would continue to use Park lands to graze their livestock for the production of milk, meat and wool. The quality of the visitor experience would be somewhat impacted by the presence of non-native goats and sheep and by their effects, which include evidence of goat and sheep trampling and vegetation grazing, the occasional sightings of goats and sheep, and continued impacts to native vegetation that the public hopes to observe.

Health and sanitation impacts would continue to decline under this action. Increasing goat and sheep populations would continue to serve as co-hosts with native wildlife and livestock for infectious and parasitic diseases as when compared with the goat and sheep reduction alternative. However, there would be no impairment of socio-economic/visitor uses as a result of the implementation of Alternative 1.

Cumulative Effects: If the no action alternative is taken, these effects to visitor experience include seeing scarred landscapes because of goat and sheep grazing, the occasional sighting of goats and sheep, and continued impacts to native wildlife which would continue to be at risk until goats and sheep are removed from the Park. Goat and sheep ranchers would continue to use Park lands to graze their livestock for the production of milk, meat and wool. They would also continue to graze their livestock on non-Park land (approximately 48 percent of the island of St. John).

Soil Impacts
Major soil impacts would remain unchanged under this alternative. This alternative would not implement any reductions in the non-native goat and sheep population. Goat and sheep trampling, grazing and herbivory would continue to reduce plant cover and greatly increase soil erosion and sedimentation of streams and nearshore ocean water where it can affect coral reef and other marine communities.

Slopes whose vegetation and soils have been upturned and tilled as a result of goat and sheep trampling and grazing are susceptible to having rapid runoff during storm events. This rapid runoff would continue to deepen existing gullies, and possibly create new gullies. Rapid runoff causes high sedimentation to occur in low gradient valley bottom reaches. However, there would be no impairment of soils as a result of the implementation of Alternative 1.

Cumulative Effects: If the no action alternative is taken, the goats and sheep create disturbed soil conditions. Goats and sheep would continue trampling and grazing around the Park causing more soil erosion and more potential patches for other invasive species invasions. The result of past activities, mainly domestic and feral livestock grazing, has had a major effect on the soil conditions on Saint John Island. Goat and sheep disturbance continues to degrade soil resources. Without implementing this program continued degradation of soils and watershed values would occur.

Threatened and Endangered Species Impacts

Non-native goats and sheep are a potential threat to each of the twenty-eight Federally or Territorially listed Endangered and Threatened (T&E) plant species found on St. John Island (see Appendix A). Under this alternative, the threats to each of the listed species would remain or increase. Fluctuations in the severity of impacts would occur seasonally and yearly as goat and sheep numbers changed. However, the potential for recovery of rare plant species would still be negligible even during those years when goat and sheep numbers are low. This is because the number of goats and sheep in the Park is tied to food availability.

Direct impacts to listed plant species would include herbivory of twenty-eight T&E plant species by non-native goats and sheep and the trampling, crushing and grazing of listed plant species should goats and sheep walk or bed down within listed plant occurrences. Depending on the number of individual goats and sheep within an area, one to many T&E plants may be grazed, trampled or uprooted. Because the rarity of these listed plant species is defined by their limited numbers; even relatively small impacts can have a large detrimental effect. Individual plants lost through predation, trampling or uprooting cannot contribute offspring to the succeeding generation. This results in a loss to the next generation of both absolute numbers and potential genetic diversity. A decrease in genetic diversity can lead to an overall decrease in evolutionary fitness for a species. Decreased population numbers lead to increased potential for extinction from continued predation, or from large random disturbance events such as fire, hurricanes or drought.

The VINP would be failing to actively remove or destroy species that are known to predate listed species. In St. John, the listed species include the Endangered St. Thomas Lidflower (*Calyptranthes thomasianum*), Prickly Ash (*Zanthroxyllum thomasianum*) and Marron Bacora (*Solanum conocarpum*), which has been proposed for listing. Non-native goats and sheep also potentially impact twenty-five territorially threatened and endangered listed plant species. However, there would be no impairment of threatened and endangered species as a result of the implementation of Alternative 1.

Cumulative Effects: If the no action alternative is taken, the three listed plant species would continue to be threatened due to goat and sheep associated activities. Specifically, Endangered St. Thomas Lidflower (*Calyptranthes thomasianum*), Prickly Ash (*Zanthroxyllum thomasianum*) and Marron Bacora (*Solanum conocarpum*), which has been proposed for listing, would continue to grazed by goats and sheep. Goats and sheep also potentially impact twenty-five territorially threatened and endangered listed plant species. Any grazing that currently occurs on these populations would continue to degrade the endangered species, and may eventually lead, if management actions are not taken, to the extinction of these Park populations.

Cumulative effects are those factors that in the past, present or future have affected T&E plant species. All species, but especially those with small population sizes, face the threat of extinction. Threats to a species survival include competition from other species, disease, predation, habitat loss, long-term environmental trends, and catastrophic events. Species with small populations also face threats to their gene pool from inbreeding, loss of heterozygosity, and for those species arising from colonization and subsequent adaptive radiation, possible Founder effects. There is no clear indication, however, whether a decrease in genetic diversity leads to a decrease in species fitness.

Vegetation Impacts

Goats and sheep are voracious browsers of vegetation and prefer native plants because these plants evolved in isolation from large herbivores and lack defenses against ungulates. Under this alternative, no reduction efforts would be used on non-native goats and sheep on St. John Island. Their population numbers would continue to rise and fall with the seasonal and long-term availability of food resources. Goats and sheep would continue to impact the native island vegetation, including endemic and Federally and territorially listed plant species.

Impacts to native plants and native plant communities by introduced alien herbivores have been well documented in the literature. Similar impacts have been noted with regards to goats and sheep.

Documented indirect effects of alien herbivores and goats and sheep to plant communities include the increase of cover, frequency, and biomass of non-native plant species, increased water run-off and soil erosion, and degradation of soil structure. Goats and sheep have also contributed to changes in soil micro-flora and micro-fauna, and the potential loss of fire-induced successional communities due to inadequate fuels and lack of seed banks. However, there would be no impairment of vegetation as a result of the implementation of Alternative 1.

Cumulative Effects: If the no action alternative is taken, the result of past activities has had a major impact on the current vegetation conditions in the Park. Without implementing this program the current vegetation composition, especially those in a low seral condition - and those communities with a high weedy component, would continue to expand and affect the recovery of native communities. High seral communities would continue to be negatively impacted causing less desirable species to continually be introduced into these communities and thereby reducing their resource value.

Implementing present and future activities as described above would add only negligible impacts to the major negative goat and sheep impacts to native communities as a result of implementing this alternative. Cumulative negative impacts to native communities would result from not reducing goats and sheep control as described under this alternative.

Wildlife Impacts

The non-native goat population, estimated at from 600 to 1000 individual animals, would continue to fluctuate due to annual differences in weather. The non-native sheep population of about 50 animals would similarly continue to fluctuate but be expected to increase. In years with favorable precipitation, greater plant productivity would allow goat populations to expand. Conversely, during periods of drought, goat populations would temporarily decrease.

Native wildlife would continue to be adversely impacted by this action because goats and sheep consume very large numbers of native plants that create important habitats for Park fauna, including several native bird, reptile and amphibian species and numerous insect and spider species. However, there would be no impairment of wildlife as a result of the implementation of Alternative 1.

Cumulative Effects: If the no action alternative is taken, the past activities, such as the initial introduction goats and sheep to Saint John Island, has resulted in the current goat and sheep populations. The goat and sheep populations would continue to reside within the Park. Native wildlife would continue to be adversely impacted by this action because goats and sheep consume very large numbers of native plants that create important habitats for Park fauna, including several native bird, reptile and amphibian species and numerous insect and spider species. Ranchers would also continue to graze their livestock on non-Park land (approximately 45 percent of the island of St. John).

Water Quality Impacts

Major adverse water quality impacts would remain unchanged under this alternative. This alternative would not implement any reduction in the non-native goat and sheep population. Goat and sheep trampling, grazing and herbivory would continue to reduce plant cover and greatly increase soil erosion, sedimentation and nutrient loading of streams and nearshore oceans water where coral reef, seagrass and nursery ecosystems would be impacted.

Slopes whose vegetation and soils have been upturned by goat and sheep trampling and grazing are susceptible to rapid runoff during storm events. This rapid runoff would continue to deepen existing gullies, and possibly create new gullies. Rapid runoff causes high sedimentation to occur in low gradient valley bottom reaches.

High sedimentation rates with low watershed slope stability would be a primary concern for decline in water quality for the Park. However, there would be no impairment of water quality as a result of the implementation of Alternative 1.

Cumulative Effects: If the no action alternative is taken, water quality impacts would continue to decline because of the sediment and nutrient loading from goats and sheep grazing.

Wetland, Saltpond and Floodplain Impacts

Adverse impacts to wetlands would continue under this alternative as the native flora continue to decline under the foraging and trampling pressures of non-native goats and sheep throughout the Park. Goats and sheep would also continue to forage on red, black and white mangrove seeds, propagules and seedlings, a protected species in the Virgin Islands. There would also continue to occur increased sedimentation rates into wetlands at Cruz Bay, Mary's Creek, Haulover Bay, Newfound Bay, Hurricane Hole, Coral Harbor, Fish Bay and Hassel Island, under the no action alternative. However, there would be no impairment of wetlands, saltponds and floodplains as a result of the implementation of Alternative 1.

Cumulative Effects: If the no action alternative is taken, wetland impacts would continue to decline because of the sediment and nutrient loading in wetland habitats from goats and sheep grazing.

Park Operations Impacts

Highest potential for adverse operational affects from non-native goats and sheep on the Park's administrative, resources management, interpretation, law enforcement and maintenance costs would be expected to continue. Under this alternative, NPS would continue to animal-proof trash receptacles, dumpsters and buildings at campgrounds, day use sites, concession areas, park overlooks, and employee housing areas. Also in 2002, NPS has contracted for the construction of a 1-mile donkey-exclusion fence with four barbed-wire strands around the perimeter of the Cinnamon Bay Campground at an estimated cost of $67,000 that is not designed to also exclude goats and sheep. However, there would be no impairment of Park operations as a result of the implementation of Alternative 1.

Cumulative Effects: If the no action alternative is taken, it would not complement other programs in the Park such as a Sustained Reduction Plan for Non-native Rats, Cats and Mongooses (NPS 2002); and a Sustained Reduction Plan for Non-native Wild Hogs (NPS 2003). All of these plans have similar objectives for reducing non-native animal populations within VINP. This proposal would also not mesh well with a Commercial Services Plan (NPS 2001); Vessel Management Plan (NPS 2003); and Installation of Moorings in VICRNM (NPS 2003).

Cumulative Impacts and Conclusions

The cumulative impacts from this alternative would have negative consequences for National Park Service lands, plants and wildlife. Many native terrestrial plant, animal and invertebrate species would be adversely impacted under this alternative. The greatest impact would be changes in plant species composition and the associated changes in native fauna, including birds, reptiles, small mammals and insect species.

Health and sanitation impacts would continue to decline under this action. Under the no action alternative, greater numbers of goats and sheep would continue to serve as co-hosts with native wildlife and livestock for infectious and parasitic diseases as when compared with all goat and sheep reduction alternatives. Goat cholera, goat brucellosis, trichinosis, foot and mouth disease, African goat fever, and pseudo-rabies are all diseases that would continue to be transmitted from goats to other livestock more frequently than when compared to all goat and sheep reduction alternatives. A variety of arthropod, protozoan, and helmith parasites were found in the Park, including, ticks, lice, protozoa, kidney worms, esophageal worms, stomach worms, intestinal worms, and lungworms. These are common parasites for goats and sheep.

This alternative is inconsistent with the National Park Service Organic Act (16 U.S.C.), the Virgin Islands National Park General Management Plan (NPS 1983), and the Resources Management Plan (1999): non-native and exotic pests such as goats and sheep are threats to native fauna and flora and should be controlled.

This alternative is not consistent with the approved Coastal Zone Management Plan that supports the removal of non-native pests that damage the coastal zone and vegetation therein, and policies of the Territory of the Virgin Islands, for reasons described above.

Other planning efforts recently completed or currently underway would not affect the Park's goat and sheep reduction program: including a Commercial Services Plan (NPS 2001); Vessel Management Plan (NPS 2004); and Installation of Moorings in VICRNM (NPS 2004).

Additional planning efforts recently completed or currently underway would affect the reduction program: including a Sustained Reduction Plan for Non-native Rats, Cats and Mongooses (NPS 2002); and a Sustained Reduction Plan for Non-native Wild Hogs (NPS 2003). All of these plans have similar objectives for reducing non-native animal populations within VINP. However, there would be no impairment due to cumulative impacts as a result of the implementation of Alternative 1.

IV.B.2. Alternative 2. Reduce Goats and Sheep within VINP and Sustain a Near-zero Population, Environmentally Preferred Alternative

The program goals for the Environmentally Preferred Alternative would substantially decrease the goat and sheep populations throughout the Park, with periodic monitoring and goat and sheep removal and

fence maintenance ongoing indefinitely. Minor impacts associated with periodic monitoring, goat and sheep removal, and fence maintenance would be well below the deleterious impacts from the present situation where goat and sheep populations are expanding throughout the Park. Because Park-wide eradication is unfeasible, the next-best choice is to dramatically reduce the goat and sheep populations and sustain the reduction.

Air Quality Impacts

No adverse air quality impacts would be expected under this alternative. However, there would be no impairment of air quality as a result of the implementation of Alternative 2.

Cumulative Effects: In general, air quality emissions from activities associated with implementation of the Environmentally Preferred Alternative would be negligible.

Scenic Value Impacts

This alternative would result in the most rapid reduction of non-native goats and sheep and, therefore, the least damage to natural, cultural, marine and terrestrial resources through reduced goat and sheep depredations on Park sites. Scenic values would increase under this alternative because goats and sheep would no longer be eating, trampling, crushing and uprooting native flora. The aesthetics of the Park would be greatly increased due to the increase of native wildlife, increase of native plant cover, and increase protection of archeological and historic sites. The natural and cultural values of the Park would greatly increase. However, there would be no impairment of scenic values as a result of the implementation of Alternative 2.

Cumulative Effects: If the Environmentally Preferred Alternative is taken, scenic value impacts would be greatly increased due to the increase of native wildlife, increase of native plant cover, and increased protection of archeological and historic sites that have been disturbed by past goat and sheep grazing.

Cultural Resource Impacts

Within three years of implementation, non-native goats and sheep would no longer continue to damage irreplaceable archeological and historical sites and degrade the scientific importance of the St. John archeological record. This alternative would likely result in the most rapid reduction of goats and sheep and, therefore, the least continued damage to cultural resources through goat and sheep depredations on archeological and historical sites at Cinnamon, Reef, Leinster, Brown, Francis, Maho, Lameshur bays, and the Lind Point area and Hassel Island. Goat and sheep grazing through disturbance has already adversely impacted the integrity of some of the Park's National Register-listed archeological sites.

Impacts to the Park's cultural resources by fencing and direct reduction operations are anticipated to be insignificant. The primary movement would take the form of foot traffic, and some may be near archeological sites. These areas are currently open to the public and risk destruction by goats and sheep unless this alternative is taken. Impacts of this nature could be minimized by orienting the reduction groups to the sensitivity of these sites to damage and requesting they avoid traffic over historic structures whenever possible. Campsites, fences and trap locations could be assessed in advance using shovel-testing for any cultural resources concerns. Fence posts would require test holes to ensure protection of archeological resources. However, there would be no impairment of cultural resources as a result of the implementation of Alternative 2.

Cumulative Effects: If the Environmentally Alternative is taken, the St. John Island archeological records which are significant for the large number and diversity of pristine sites found in the Park would be fully protected. Sites range from isolated artifacts to huge, stratified sites encompassing habitation areas and specialized activity areas spanning a period of 4,000 years. Goat and sheep depredations throughout the

Park would not result in a truncated archeological database. The number and diversity of sites would be greatly increased, not destroying the values of the district, and not resulting in de-listing of the National Register district, possibly leaving a greater number of individually eligible sites. The value of remaining archeological sites would be greatly increased and future researchers would be able to take advantage of new research techniques that may be developed in the future. Small impacts may continue because some goats would presumably remain in the Park.

Socioeconomic/Visitor Use Impacts

The Environmentally Preferred Alternative to conduct simultaneous Park-wide reduction of non-native goats and sheep would have some short-term negative impacts on socioeconomic issues but would also have long-term positive impacts on the quality of the visitor experience. Goat and sheep ranchers would discontinue their use of Park lands for livestock grazing, and the associated negative affects of the practice. The ranchers would be able to maintain their entire herds, for the production of milk, meat and wool, on their private livestock ranches. Visitor use would be restricted on those specific NPS lands when major collection operations occur. Fences would be located to avoid crossing roads. Gates, who would potentially impact resident or visitor movements, would not be installed.

Under this alternative, Park-wide reduction would be an intense effort over a short period of 3 to 4 years. Depending on the planned operation in the initial three years of intensive reduction effort, relatively small portions of VINP could be closed for brief (for example, two consecutive days) periods of time.

Over the last ten years, the annual visitation to St. John Island averages approximately 550,000 visitors per year. Depending on when and how long the closure is in place, access to some areas may be limited for brief time periods (for example two consecutive days). The public could be redirected to another site on the island. Wildlife Control Agents would also contribute to island economy through increases in salaries for personnel, purchases of goods and services, rental of vehicles and equipment. The Park would contact St. John residents who have requested hunting permits, and ask them to participate in the Volunteers-In Parks (VIP's) program to participate with the goat and sheep reduction program.

The quality of the visitor experience would no longer be impacted by the presence of goats and sheep and their effects, which include evidence of goat and sheep trampling and grazing, the occasional sighting of goats and sheep, and continued impacts to native plant communities and wildlife habitat associated with grazing and trampling, that the public hopes to observe.

Health and sanitation impacts would necessarily improve under this action. Under the Park-wide reduction alternative, non-native goats and sheep would be less likely to serve as co-hosts with native wildlife and livestock for infectious and parasitic diseases. However, there would be no impairment of socio-economic/visitor uses as a result of the implementation of Alternative 2.

Cumulative Effects: If the Environmentally Preferred Alternative were taken, the overall visitor experience would be enhanced upon reduction of goats and sheep populations. Park-wide, the extensive areas that have been heavily disturbed by goats and sheep would begin to heal, resulting in better visual appeal. Goat and sheep ranchers would no longer continue to use Park lands to graze their livestock, with associated negative affects on their ability to make a living in the Park for the production of milk, meat and wool. They would continue to graze their livestock on non-Park land (approximately 48 percent of St. John). Small impacts may continue because some goats would presumably remain in the Park.

Soil Impacts

Soil disturbing activities from non-native goats and sheep would be greatly reduced within three years of implementation of this alternative. Substantial reductions would eventually allow disturbed areas to heal

over with vegetation. No new goat and sheep trampling and vegetation grazing areas would be established.

Eventually, erosion from already disturbed sites would decline as the sites establish vegetation cover. As vegetation cover increases, overall watershed conditions would continue to improve. As watershed conditions improve, runoff within the watershed would be more readily intercepted by vegetation and be absorbed on site. This would cause less intense runoff events and decrease the rate of gully erosion (aggredation and widening). Less intense runoff events would cause less sediment delivery into local waterways.

Under Alternative Two, the use of existing trails could also lead to a short-term increase in soil erosion. The increase in soil erosion and the impacts to the soil micro-flora would likely decline once the goats and sheep are reduced from the Park and use of the hunting trails is discontinued. These trails would be ephemeral and not heavily used. Traps would be placed in already disturbed areas to reduce any potential impacts to soils.

Trampling of the soil by vehicles and the hunters could cause alterations in the soil micro-flora and cryptobiotic soil crusts may be damaged. As discussed previously, cryptobiotic soils are important components of soils in arid and semi-arid environments. Trampling, especially during the dry season easily damages these soil crusts. These soil crusts have the ability to re-colonize disturbed areas from nearby non-disturbed land; however re-colonization and re-establishment of soil crusts in an area can be somewhat slow depending on various environmental factors. However, there would be no impairment of soils as a result of the implementation of Alternative 2.

Cumulative Effects: If the Environmentally Preferred Alternative is taken, effects from this alternative would have within the two to three year time period goat and sheep reduction would decrease the duration of goat and sheep trampling and grazing on the Park. Soil compaction would likely occur by the trampling of hunters and dogs, but the relatively short time period of this disturbance and the removal of goats and sheep and goat and sheep trampling disturbance would negate the compaction. The removal of goats and sheep would decrease soil erosion by eliminating goat and sheep trampling and by allowing plant species recovery in previously trampled areas. Small impacts may continue because some goats would presumably remain in the Park.

Threatened and Endangered Species Impacts

Under Alternative Two, non-native goats and sheep would no longer be a threat to each of the twenty-eight Federally or Territorially listed Endangered and Threatened (T&E) plant species found on St. John (see Appendix A). Under this alternative, the threats to each of the listed species would be reduced by the goat and sheep reduction program, involving the use of teams of hunters simultaneously in a Park-wide intensive hunting effort. Direct impacts to listed plant species would occur if fencing were placed within listed plant occurrences. Individual plants could be crushed or uprooted when fence posts are placed in the ground. NPS employees could also inadvertently crush plants by walking over them. This could occur when initially constructing the fence or during maintenance of the fence.

However, with proper planning and botanical surveys, known rare plant occurrences could be avoided. Indirect impacts to listed plants could occur if invasive non-native seeds are transported into listed plant occurrences either on the fencing material itself or on the boot and clothing of the NPS employees or contractors constructing the fence or on the pack stock used to move the fencing material. Measures such as washing vehicles, removing seeds from boots and clothing, and educating those involved in constructing the fences about the dangers of invasive weed species, can be enacted to minimize the risk of spreading these weed species.

Threatened and endangered plant species would experience increased survivorship and seedling establishment and recruitment. T&E plant species are likely to benefit from decreased disturbance levels, increased litter retention, and re-development of the soil crusts. As T&E populations recover, they would be able to better withstand any subsequent natural disturbance events that may occur. Larger population numbers provide insurance against the formation of genetic bottlenecks. Replenishment of the seed bank -- for those species that rely on natural disturbance events -- means adequate seedling establishment and recruitment would occur when the next disturbance event hits.

The VINP would no longer fail to actively remove or destroy non-native species that are known to predate listed species. In St. John, the listed species include the Endangered St. Thomas Lidflower (*Calyptranthes thomasianum*), Prickly Ash (*Zanthroxyllum thomasianum*) and Marron Bacora (*Solanum conocarpum)*, which has been proposed for listing. Non-native goats and sheep would also no longer be impacting twenty-five Territorially Threatened and Endangered listed plant species with extinction. However, there would be no impairment of threatened and endangered species as a result of the implementation of Alternative 2 (Appendix A).

Cumulative Effects: If the Environmentally Preferred Alternative is taken, effects from this alternative would have very positive consequences for National Park Service lands, plants and wildlife. Many native terrestrial plant, animal and invertebrate species would be positively impacted under this alternative. The greatest impact would be recovery of native plant species communities and the associated changes in native fauna, including birds, reptiles, small mammals and insect species. Serious negative impacts to the listed species from goats and sheep grazing include the Endangered St. Thomas Lidflower (*Calyptranthes thomasiana*), Prickly Ash (*Zanthroxyllum thomasianum*) and Marron Bacora (*Solanum conocarpum)*, which has been proposed for listing, would be greatly reduced. Goats and sheep grazing would also no longer be impacting twenty-five Territorially Threatened and Endangered listed plant species with extinction.

Past grazing disturbance is the largest factor that created unsuitable habitat for Saint John Island's T&E species. Present and future activities, as described in chapter III – Threatened and Endangered Plants section on page 37, would only cause negligible additive impacts when considered with the impacts of this Alternative. This is because activities that could impact listed species or their habitat require review by NPS botanists for impacts. In addition, projects that may affect a T&E species' viability must have approval from the U.S. Fish and Wildlife Service in order to be implemented. To avoid or minimize impacting T&E species, mitigation would be incorporated into the program design. Prior to final approval for a project, NPS biologists are required to conduct field surveys to identify if T&E plants would be impacted by the project (as was done for this program). Small impacts may continue because some goats would presumably remain in the Park.

Vegetation Impacts

Non-native goats and sheep are voracious browsers of vegetation and prefer native plants because these plants evolved in isolation from large herbivores and lack defenses against ungulates. Alternative 2 would initially involve Wildlife Control Agents in an intensive reduction effort. This reduction effort would be expected to last two to three years. Negative effects to native vegetation and individual plants by wildlife control agents would be short-term, insubstantial, and ephemeral, if any. Short-term impacts to native vegetation would occur as non-native goats and sheep are chased and cornered. These impacts would include trampling of the vegetation, damage to individual plants as leaves, branches and shoots are torn by running animals and hunters.

Twenty-six long-term ecological monitoring sites (Weaver 1999) could potentially be permanently fenced to exclude goat and sheep populations. Valuable ecological data would be saved. Additionally, even

with the current road and trail systems, the teams might create trails as they moved between different areas in the Park. These trails would be ephemeral and not heavily used. These temporary trails are consistent with park use and management guidance. Impacts associated with the installation of trails are very minimal compared to the current impacts goats and sheep are having on scenic values, cultural resources, public safety, soils, threatened and endangered species, vegetation, wildlife, water quality and wetlands. Trails and fencing would avoid any vegetation over one inch DBH and would consist of underbrush thinning sufficient to permit passage of humans or installation of fences. Vegetation would be allowed to regrow after fence installation to mitigate potential visual impacts. However, there would be no impairment of vegetation as a result of the implementation of Alternative 2.

Cumulative Effects: If the Environmentally Preferred Alternative is taken, the effects from this alternative would eliminate goats and sheep disturbance within two to three years, a major vector known to facilitate the spread of weedy species. The removal of goats and sheep in a relatively short period of time would decrease disturbance dramatically on Saint John Island. With the removal of heavy disturbance, it is expected that ruderal (establishes following disturbance) invasive species would have a more difficult time invading native communities. There are opportunities for restoration in these now degraded landscapes. Generally annual and perennial forbs are the first species to begin the successional process. Small impacts may continue because some goats would presumably remain in the Park.

Wildlife Impacts

Under this alternative, the entire non-native goat population, estimated at approximately 600 to 1000 individuals, would be removed from the Park over a two to three year period. Goats and sheep would be killed either by live-trapping and then shooting with a handgun or by hunting teams and shooting. The non-native sheep population of less than 50 animals would be similarly removed from the Park over a 3 to 4 year period.

The near-cessation of goat and sheep grazing and trampling in specific locales would also improve habitat for lizards, snakes, salamanders and insects that are dependent upon the consumption of leaves, fruits and berries for their survival. Goat and sheep removal from riparian areas would improve riparian habitat for frogs and aquatic invertebrates that are likewise dependent upon the consumption of plants for their survival. The removal of goats and sheep would provide fruits and berries in years of very large food production would improve habitat for those species which depend upon these crops, such as many bird species (pigeons and doves) and bats.

Goat and sheep reduction actions themselves would have slightly negative impacts on Park wildlife and fauna over the two or three year removal period. The hunting teams, which would necessarily traverse almost all areas of the Park at least once, would have the following impacts such as hunters moving through the brush may encounter and inadvertently harass wildlife species.

Fence building itself could have temporary negative impacts, as presence and activities of fence builders may disturb wildlife. However, this is unlikely, since many fences would be along road or areas of human habitation with little cover and less chance of harboring wildlife at any particular time. It is assumed that little clearing of vegetation and associated impacts on wildlife habitat would occur during fence building. However, there would be no impairment of wildlife as a result of the implementation of Alternative 2.

Cumulative Effects: If the Environmentally Preferred Alternative is taken: past activities, such as the initial introduction of goats and sheep to St. John Island, has resulted in the current goat and sheep populations. Under this alternative, the entire goat and sheep populations would be removed from the Park over a two to three year period. Present and future activities, as identified in chapter III, would have

a large effect to the goat and sheep populations residing in the Park. The cessation of goat and sheep grazing and trampling in specific locales would also improve habitat for lizards, snakes, salamanders and insects that are dependent upon the consumption of leaves, fruits and berries for their survival. Ranchers would continue to graze their livestock on non-Park land (approximately 48 percent of St. John). Small impacts may continue because some goats would presumably remain in the Park.

Water Quality Impacts

Major adverse water quality impacts from non-native goats and sheep would be reduced within three years of the implementation of this alternative. Goat and sheep carcasses can release compounds affecting water quality, including: nitrates, total dissolved solids, chloride, and ammonium-nitrogen. The rate of these releases is largely temperature dependent, and they readily dissipate harmlessly into the atmosphere. Most collected animals would be removed and only rarely would one or more is abandoned in extremely remote areas. These would generally be lightly limed.

To reduce concentrations of these compounds requires carcass deposition away from standing water sources and obvious drainage guts. Final placement would not occur within 50 feet of saltponds or guts, and may include a small portion of lime. Lime accelerates the rate of decomposition in the warm, moist subtropical weather. Only in extremely rare occasions when overland transport is impossible and topography and wetland proximity prevent liming, then collected animals would be brought to the sea, then weighted and released a minimum of one nautical mile from the shore. However, there would be no impairment of either marine nor terrestrial water quality as a result of the implementation of Alternative 2.

Cumulative Effects: If the Environmentally Preferred Alternative is taken, water quality impacts would greatly diminish, because sediment and nutrient loading from watersheds that have been disturbed by past goat and sheep grazing would improve. Small impacts may continue because some goats would invariably remain in the Park.

Wetland, Saltpond and Floodplain Impacts

Major adverse wetlands and floodplain impacts from non-native goats and sheep would be reduced within several years of the implementation of this alternative. Adverse impacts to wetlands would no longer occur under this alternative as the native flora and fauna would change under natural conditions, but that those impacts inflicted by goats and sheep would no longer be present throughout the Park.

High sedimentation rates with low watershed soil stability due to goat and sheep trampling and grazing would no longer be a concern for decline in the quality of the Park's wetlands and floodplains communities. These impacts would decrease as the numbers of goats and sheep decrease. Goats and sheep would no longer continue to forage on red, black and white mangrove seeds, propagules and seedlings, protected species in the Virgin Islands. A decrease in goat and sheep grazing and trampling would reduce rates of erosion and sediment deposition in wetland communities in Cruz Bay, Mary's Creek, Haulover Bay, Newfound Bay, Hurricane Hole, Coral Harbor, Fish Bay and Hassel Island. However, there would be no impairment of wetlands, saltponds and floodplains as a result of the implementation of Alternative 2.

Cumulative Effects: If the Environmentally Preferred Alternative is taken, wetland impacts would no longer continue to occur because of the sediment and nutrient loading in wetland habitats that have been disturbed by past goat and sheep grazing. Small impacts may continue because some goats would presumably remain in the Park.

Park Operations Impacts

This alternative would have the lowest potential for adverse operational affects because non-native goat and sheep populations would be greatly reduced throughout the Park at all visitor use, administrative, cultural and natural resources sites. Under this alternative, the overall costs of administration of the non-native wildlife control program would be increased with the implementation of contracts to remove exotic wildlife ($60,000 with the U.S. Department of Agriculture's Animal Plant Health Inspection Service / Wildlife Services Division).

This program would necessitate an increase in on-Park personnel, jeep or truck style vehicles and all-terrain vehicles. Other methods of transportation may also be used, such as horses. Housing would utilize existing structures whenever possible, including government approved facilities on NPS owned property. Temporary tent camps may also need to be established to ensure efficient operations in remote areas, such as boat-only accessible anchorages and rough, roadless terrain. These camps would be located in areas already impacted by vegetation clearing associated with construction of historic buildings sites located in the Park's backcountry.

Under Alternative 2, the non-native goat and sheep reduction program would occur in three phases: 1) administration, infrastructure acquisition and selective fencing; 2) collection using baits, traps, dogs and contract hunters; and 3) monitoring for and removal of immigrant goats and sheep, resource education, community outreach, record keeping and fence maintenance.

Fences would be constructed to exclude non-native animals from all long-term monitoring plots, some campgrounds and limited selective areas of the boundary where new animals can easily reenter the Park (Herman Farm, L' Esperance and Catherineberg). However, there would be no impairment of Park operations as a result of the implementation of Alternative 2.

Cumulative Effects: If the Environmentally Preferred Alternative is taken, it would complement other programs in the Park such as a Sustained Reduction Plan for Non-native Rats, Cats and Mongooses (NPS 2002); and a Sustained Reduction Plan for Non-native Wild Hogs (NPS 2003). All of these plans have similar objectives for reducing non-native animal populations within VINP. This proposal would also mesh well with a Commercial Services Plan (NPS 2001); Vessel Management Plan (NPS 2003); and Installation of Moorings in VICRNM (NPS 2003).

Cumulative Impacts and Conclusions

Alternative Two would result in a vigorous reduction in non-native goats and sheep from within the Park. This alternative would reduce goat and sheep disturbance of native plant communities within several years. This would greatly reduce the numbers of these exotic (introduced) quadrupeds, animals that are known to facilitate the spread of weedy species. Their removal would reduce the impacts to the Park's native plant communities by invasive species disturbance. The lack of trampling and grazing in the Park's plant communities would reduce impacts to and facilitate the recovery of native T&E species. The lack of disturbance would allow natural regeneration of T&E via germination of seeds beneath shrub and forest canopies. The regeneration may also lead to the spread of T&E species into surrounding plant communities, and the continued recovery of other disturbed plant communities throughout the Park. Serious negative impacts to the listed species including the Endangered St. Thomas Lidflower (*Calyptranthes thomasiana*), Prickly Ash (*Zanthroxyllum thomasianum*) and Marron Bacora (*Solanum conocarpum)*, which has been proposed for listing, would be greatly reduced (Appendix A).

Alternative Two has high probability of success for goat and sheep population reduction. However, potential for failure exists should resource constraints become evident any time during program implementation. This alternative is totally reliant on amassing a high intensity reduction effort for a short

period of time. Failure to maintain either component (high intensity or short duration) would result in a lower probability of success.

The cumulative impacts from this alternative would have very positive consequences for National Park Service lands, plants, wildlife and operations. Many native terrestrial plant, animal and invertebrate species would be positively impacted under this alternative. The greatest impact would be recovery of native plant species communities and the associated changes in native fauna, including birds, reptiles, small mammals and insect species.

Health and sanitation impacts would necessarily improve under this action. Under the Park-wide reduction alternative, non-native goats and sheep would no longer serve as co-hosts with native wildlife and other livestock for infectious and parasitic diseases. Goat cholera, goat brucellosis, trichinosis, foot and mouth disease, African goat fever, and pseudo-rabies are all diseases that would no longer be transmitted from goats to livestock within the Park. Small impacts would be expected to continue, because some goats would presumably remain in the Park.

This alternative is consistent with the National Park Service Organic Act (16 U.S.C.), the Virgin Islands National Park General Management Plan (NPS 1983), and the Resources Management Plan (1999): non-native and exotic pests such as goats and sheep are threats to native fauna and flora and should be controlled.

This alternative is consistent with the approved Coastal Zone Management Plan that supports the removal of non-native pests that damage the coastal zone and vegetation therein, and policies of the Territory of the Virgin Islands government, for reasons described above.

Other planning efforts recently completed or currently underway would not affect the Park's goat and sheep reduction program: including a Commercial Services Plan (NPS 2001); Vessel Management Plan (NPS 2004); and Installation of Moorings in VICRNM (NPS 2004).

Additional planning efforts recently completed or currently underway would affect the reduction program: including a Sustained Reduction Plan for Non-native Rats, Cats and Mongooses (NPS 2002); and a Sustained Reduction Plan for Non-native Wild Hogs (NPS 2003). All of these plans have similar objectives for reducing non-native animal populations within VINP. However, there would be no impairment due to cumulative impacts as a result of the implementation of Alternative 2.

IV.B. Table 1. Summary Table of Environmental Consequences

This section describes the environmental consequences of the two alternatives that were analyzed in this environmental assessment for a non-native goat and sheep control program within Virgin Islands National Park. The alternatives include (1) no action, and (2) environmentally preferred alternative, reduction through trapping, shooting and fencing.

	Alternative 1 **II.A.3**	**Alternative 2** **II.A.4**
Impact Category	**Goats and Sheep Control** No Action	**Goats and Sheep Control** Environmentally Preferred Alternative: Trapping, Shooting and Fencing
Air Quality Impacts	No adverse impacts would be expected.	No adverse impacts would be expected.
Scenic Value Impacts	Highest potential for adverse impacts. The aesthetics of the Park would be lessened due to the reduction of native wildlife, reduction of plant native cover, and damage to cultural sites, wetland and marine resources.	Lowest potential for adverse impacts. The aesthetics of the Park would be increased and enhanced due to increased native wildlife, increased native plant cover, and increased protection of cultural sites; underwater viewsheds would be greatly enhanced.
Cultural Resources Impacts	Highest potential for adverse impacts as goats and sheep continue to damage irreplaceable archeological and historical sites on St. John and Hassel Island and degrade the scientific importance of these sites that makes them eligible for listing on the National Register of Historic Places.	Lowest potential for adverse impacts as goats and sheep would no longer continue to damage irreplaceable archeological and historical sites on St. John and Hassel Island and degrade the scientific importance of these sites that makes them eligible for listing on the National Register of Historic Places.

	Alternative 1 II.A.3	Alternative 2 II.A.4
Impact Category	**Goats and Sheep Control** No Action	**Goats and Sheep Control** Environmentally Preferred Alternative: Trapping, Shooting and Fencing
Socio-economic/ Visitor Use Impacts	Highest potential for adverse impacts as goat and sheep ranchers continue to use Park lands to graze their livestock, with associated negative affects on their ability to make a living in the Park. Goat and sheep ranchers would continue to use Park and non-Park lands to graze their livestock for the production of milk, meat and wool. Health and sanitation impacts would continue to decline. Park visitors would continue to experience a decline in the normal flora, fauna, wetland and marine environments and associated wildlife, thereby depreciating the quality of their experience. Cultural sites would diminish, as well.	Lowest potential for adverse impacts as goat and sheep ranchers would no longer use Park lands to graze their livestock, with associated negative affects on their ability to make a living in the Park. Goat and sheep ranchers would no longer continue to use Park lands to graze their livestock for the production of milk, meat and wool. They would continue to graze their livestock on non-Park land (approximately 48 percent of the island of St. John). Health and sanitation impacts would necessarily improve. NPS would contact former St. Johnian residents who have requested a hunting permit. Their participation under the Volunteers-In Parks (VIP's) program would be sought in implementing this goat and sheep reduction program.
Soil Impacts	Highest potential for adverse affects as goats and sheep continue to reduce plant cover and greatly increase soil and organic litter erosion and sedimentation of streams and nearshore ocean water where it adversely affects coral reef, seagrass and other marine communities.	Lowest potential for adverse impacts as soil disturbing activities of goats and sheep would be reduced within 3 years of implementation. Elimination or near-elimination would eventually allow disturbed areas to heal over with vegetation. No new goat and sheep grazing and trampling areas would be established.

	Alternative 1 II.A.3	Alternative 2 II.A.4
Impact Category	**Goats and Sheep Control** No Action	**Goats and Sheep Control** Environmentally Preferred Alternative: Trapping, Shooting and Fencing
Vegetation Impacts	Highest potential for adverse affects as goats and sheep continue to damage plant community composition and structure by selective grazing of native vegetation and distributing seeds of exotic plant species in their feces and transmission to new sites on their hair and coats. Numerous long-term ecological monitoring sites would be inundated and eventually destroyed by goat and sheep trampling and herbivory.	Lowest potential for adverse affects as fewer goats and sheep would cause less damage to plant community composition and structure by selective grazing of native vegetation, and distributing seeds of exotic plant species in their feces and transmission to new sites on their hair and coats. Several long-term ecological monitoring sites would be entirely fenced and therefore protected from all large non-native herbivores including goats, donkeys, hogs, sheep, and white-tailed deer.
Threatened/ Endangered Species Impacts (T&E)	Highest potential for adverse affects as goat and sheep grazing continue to impact T&E plants protected under the Endangered Species Act (ESA). In St. John, the listed species include the Endangered St. Thomas Lidflower, Prickly Ash and Marron Bacora, which has been proposed for listing. Goat and sheep grazing would also to continue to potentially impact twenty-five Territorially T&E listed plant species.	Lowest potential for adverse affects as goat and sheep grazing would no longer continue to impact T&E plants protected under the Endangered Species Act (ESA). In St. John, goat and sheep grazing would no longer continue to consume listed species including the Endangered St. Thomas Lidflower, Prickly Ash and Marron Bacora, which has been proposed for listing. Goat and sheep grazing would also no longer continue to impact twenty-five Territorially T&E listed plant species.

	Alternative 1 II.A.3	Alternative 2 II.A.4
Impact Category	**Goats and Sheep Control** No Action	**Goats and Sheep Control** Environmentally Preferred Alternative: Trapping, Shooting and Fencing
Wildlife Impacts	Highest potential for adverse impacts from goat and sheep populations in the Park on native wildlife and their associated habitats would continue. Native wildlife would continue to be adversely impacted because goats and sheep consume a very large number of native plants upon which a very large number of native fauna including several bird, reptile and amphibian species and numerous insect and spider species depend for habitat. Of particular concern are the varied native reptile and amphibian populations in the Park and their associated links in the food and ecological web of the island. The Park has listed over 232 common insect species, including 13 species of dragonflies and damselflies and over 1500 beetle species.	Lowest potential for adverse native wildlife impacts because goat and sheep populations would be substantially reduced within the Park and immigrants would be periodically removed. Large numbers of native fauna, and their associated habitats, including several native bird, reptile and amphibian species and numerous insect and spider species would benefit when goat and sheep populations are kept low or at zero. The cessation of goat and sheep grazing and trampling in specific locales would also greatly improve habitat for lizards, snakes, salamanders and insects that are dependent upon the consumption of leaves, fruits and berries for their survival. Bats, the only native mammal, would benefit from an enhanced and protected habitat as plant species recover under this alternative.

Impact Category	Alternative 1 II.A.3 **Goats and Sheep Control** No Action	Alternative 2 II.A.4 **Goats and Sheep Control** Environmentally Preferred Alternative: Trapping, Shooting and Fencing
Water Quality Impacts	Highest potential for adverse affects as goats and sheep would continue to reduce plant cover and greatly increase soil erosion, nutrient loading and sedimentation of streams and nearshore ocean water where it can affect coral reef, sea grass and mangrove ecosystems and associated marine fisheries, nurseries and relate communities. Goat and sheep carcasses would continue to decompose naturally on land. Nutrient loading facilitates algal and bacterial blooms that readily consume the oxygen necessary for photosynthesis (eutrophication).	Lowest potential for major adverse water quality impacts from goats and sheep would be reduced within three years of the implementation of this alternative. Reduced sedimentation and nutrient loading would enhance water quality and increase the oxygen available for photosynthesis. Goat and sheep carcasses would readily decompose on land after being treated with lime. The few (if any) animals buried at sea would not affect water quality, as they would be weighted and deposited in open ocean a minimum of one mile from shore.
Wetland, Saltpond and Floodplain Impacts	Highest potential for adverse impacts to wetlands and saltponds would continue as native flora and fauna change under the foraging and predation pressures of goats and sheep throughout the Park. Goats and sheep would also continue to forage on red, black and white mangrove seeds, propagules and seedlings, a protected species in the Virgin Islands. There would also continue to occur increased sedimentation rates and nutrient loading into wetlands and marine ecosystems under the no action alternative. Saltponds would experience increased soil deposition, nutrient loading and accelerated forest encroachment, especially by invasives, reducing migratory and resident waterfowl and associated habitat.	Lowest potential for adverse impacts to wetlands from goats and sheep would be reduced within several years of implementation of this alternative. Goat and sheep removal from riparian areas would improve riparian habitat for frogs, salamanders & aquatic invertebrates. Adverse impacts to wetlands and marine environments would be reduced under this alternative, as the native flora and fauna would no longer change under the foraging and trampling pressures of goats and sheep throughout the Park. Extremely limited and important saltpond habitat would remain open for migratory and resident waterfowl.

Impact Category	Alternative 1 II.A.3 **Goats and Sheep Control** No Action	Alternative 2 II.A.4 **Goats and Sheep Control** Environmentally Preferred Alternative: Trapping, Shooting and Fencing
Park Operations Impacts	Highest potential for adverse operational affects from non-native goats and sheep on the Park's administrative, resources management, interpretation, law enforcement and maintenance costs would be expected to continue. Under this alternative, NPS would continue to animal-proof trash receptacles, dumpsters and buildings at campgrounds, day use sites, concession areas, park overlooks, and employee housing areas. In 2002, NPS contracted for the installation of a 1-mile donkey-exclusion fence with four barbed-wire strands around the perimeter of the Cinnamon Bay Campground at an estimated cost of $67,000 that is not designed to also exclude goats and sheep.	This alternative would have the lowest potential for adverse operational affects because non-native goat and sheep populations would be greatly reduced throughout the Park at all visitor use, administrative, cultural and natural resources sites. Under this alternative, the overall costs of administration of the non-native wildlife control program would be increased with the implementation of contracts to remove exotic wildlife ($60,000 with the U.S. Department of Agriculture's Animal Plant Health Inspection Service / Wildlife Services Division). Goat and sheep reduction program would occur in three phases: 1) administration and infrastructure acquisition and fencing; 2) collection using baits, traps, dogs and contract hunters; and 3) monitoring for remnant goats and sheep, periodic goat and sheep removal, resource education, community outreach, record keeping and fence maintenance. This program would necessitate an increase in on-Park personnel, jeep or truck style vehicles and all-terrain vehicles. Other methods of transportation may also be used, such as horses. Housing would utilize existing structures whenever possible, including government approved facilities on NPS owned property. Temporary tent camps may also need to be established to ensure efficient operations in remote areas, such as boat-only accessible anchorages and rough, road-less terrain. These camps would be located in areas already impacted by vegetation clearing associated with construction of historic buildings sites located in the Park's backcountry. Fences constructed to exclude animals from some long-term monitoring plots. $60,000 contract with APHIS to control goats and sheep and construct 2 to 3 miles of fence where animals easily enter the Park.

	Alternative 1 II.A.3	Alternative 2 II.A.4
Impact Category	**Goats and Sheep Control** No Action	**Goats and Sheep Control** Environmentally Preferred Alternative: Trapping, Shooting and Fencing
Cumulative Impacts and Conclusions	The cumulative impacts from this alternative would have severe negative consequences for National Park Service lands, plants and wildlife. Many native terrestrial plant, animal and invertebrate species would be adversely impacted under this alternative. The greatest impact would be changes in plant species composition and the associated changes in native fauna, including birds, reptiles, small mammals and insect species; in particular, four of the five bat species-St. John's only native mammal-rely exclusively on vegetation for food, shelter and habitat. Public (resident, visitor, and employee) health and safety would continue to deteriorate as picnic areas and cultural ruins are overrun and vehicular collision increase. This alternative is inconsistent with the National Park Service Organic Act, and the Virgin Islands National Park General Management Plan and Resources Management Plan. This alternative is not consistent with the approved Coastal Zone Management Plan.	Alternative Two would result in a vigorous reduction in non-native goats and sheep from within the Park. This alternative would reduce goat and sheep disturbance of native plant communities within several years. This would greatly reduce the numbers of these exotic (introduced) quadrupeds, animals that are known to facilitate the spread of weedy species. Their removal would reduce the impacts to the Park's native plant communities by invasive species disturbance. The lack of trampling and grazing in the Park's plant communities would reduce impacts to and facilitate the recovery of native T&E species. The reduced disturbance would allow natural regeneration of T&E via germination of seeds beneath shrub and forest canopies. Native seedlings would have enhanced survival rates with fewer livestock grazing on them. The regeneration may also lead to the spread of T&E species into surrounding plant communities, and the continued recovery of other disturbed plant communities throughout the Park. Serious negative impacts to the listed species including the Endangered St. Thomas Lidflower, Prickly Ash and Marron Bacora, which has been proposed for listing, would be greatly reduced. Health and sanitation impacts would necessarily improve. This alternative is consistent with the National Park Service Organic Act, Virgin Islands National Park General Management Plan, and the Resources Management Plan. This alternative is consistent with the approved Coastal Zone Management Plan.

V. CHAPTER V. COMPLIANCE WITH ENVIRONMENTAL LAWS AND REGULATIONS

The proposed program for a reduction of non-native goats and sheep populations within Virgin Islands National Park is consistent with the **National Park Service Organic Act (16 U.S.C.)** "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations."

(a) Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) (7 U.S.C. 136 *et seq.*) – Occasionally, immobilization drugs would be used to sedate trapped goats and sheep. Currently, only one drug (Telazol) is available to immobilize goats and sheep. Intramuscular injections of Telazol would be administered by either a jab stick, blow gun or CO2 pistol. Immobilization drugs and drug delivery equipment would be restricted to employees responsible for goat and sheep management; these employees would complete specialized training as required by NPS-77. Immobilization drugs would be stored in a locked safe and records would be maintained to include the date, amount used, purpose, and signature of the user. Since Telazol is listed as a Class II substance, all guidelines for use and storage specified by the Drug Enforcement Administration would be followed. The Park has also obtained pesticide use approval through the Southeast Regional Integrated Pest Management Program (IPM) and the Washington IPM Office.

(b) Endangered Species Act of 1973 (ESA)(7 U.S.C. 136, as amended) and VI Endangered and Indigenous Species Act of 1990 (Act No. 5665) – Virgin Islands National Park provides habitat for Endangered Hawksbill and Leatherback sea turtles at numerous beach areas along the north, east and southern beaches. Endangered Roseate and Threatened Least Terns nest at several sites in the Park. Habitat for Endangered St. Thomas Lidflower, Prickly Ash, and Marron Bacora (which has been proposed for listing) are located at numerous sites throughout the Park. Grazing and trampling by goats and sheep potentially impacts these listed species with extirpation. In order to comply with the ESA of 1973, the Park must protect endangered species and their habitats (PL 93-205). With release of Final EA, NPS will initiate formal consultation with the U.S. Fish and Wildlife Service (see Appendix C).

Virgin Islands National Park also provides habitat for one Territorially Endangered and Threatened animal species, the Slipperyback Skink and many other Territorial Endangered species include ground-nesting species such as Bridled Quail Dove, Bahama Pintail Duck and West Indian Nighthawk, all of which may suffer egg and chick depredation due to wild hogs. Grazing and trampling by goats and sheep potentially impacts twenty-five Territorially Threatened and Endangered listed plant species with extirpation (see Pages 35 and 36).

(c) Migratory Bird Treaty Act of 1918 (40 Stat 755) provided clear authority and direction for the proposed action. With release of Final EA, NPS will initiate formal consultation with the U.S. Fish and Wildlife Service (see Appendix C).

(d) Animal Damage Control Act of 1931 gives authority to remove injurious animals for the protection of birds and other wildlife.

(e) Coastal Zone Management Act (16 U.S.C. 1 {1916} *et seq.*) "Preserve, protect, develop and where possible restore or enhance the resources of the nation's coastal zones" supports the removal of non-native pests that damage the coastal zone and wildlife therein. With release of Final EA, NPS will

initiate formal consultation with the Territory's Department of Planning and Natural Resources in conformance with the Coastal Zone Management Act.

(f) **General Management Plan – Virgin Islands National Park, 1983** – feral and exotic pests such as non-native goats and sheep are identified as a threat to native fauna and flora and must be controlled.

(g) **National Historic Preservation Act of 1966 (16 U.S.C. 470 *et seq,*), Archeological Resources Protection Act of 1979 (16 U.S.C. 470aa-11).** With release of Final EA, NPS will initiate formal consultation with the State Historic Preservation Office regarding effects on the Park's archeological and cultural resources.

(h) **National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4332, as amended).** Title I of NEPA require that Federal agencies plan and carry out their activities..."so as to protect and enhance the quality of the environment. Such activities shall include those directed to controlling pollution and enhancing the environment."

(i) **Resource Management Plan – Virgin Islands National Park, 1999** – feral and exotic pests such as non-native goats and sheep are identified as a threat to native fauna and flora and must be controlled.

VI. CHAPTER VI. CONSULTATION AND COORDINATION

Personnel from the following agencies and organizations have been consulted or participated in the formulation of this Environmental Assessment:

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Consultation with Local St. Johnian Neighbors and Former Park Residents

These individuals will be given an opportunity to comment on this Final document which will be made available at two local libraries, two Park visitor centers and on the Park and Friends of the Virgin Islands Internet sites. Or, they may request a copy of this Final plan after learning about it by reading a press release in one of several local island newspapers.

We would also contact local St. Johnian residents who have requested a hunting permit. They would be asked to participate as Volunteers-In Park (VIP) program in implementing this goat and sheep reduction program. Island residents collectively possess much valuable information regarding goat and sheep ecology, habitat, food and water preferences, mortality and seasonal movements. (Please see also Community Outreach on page 22)

Goat hunting was unofficially "allowed" in the Park, to varying degrees, until approximately 1999, when it was determined the VINP Enabling Legislation did not authorize hunting. For additional information see page 21, Use of Field Volunteers.

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IX. CHAPTER IX. REFERENCES CITED

Acevedo-Rodriquez, Pedro (and Collaborators). 1996. Flora of St. John, U. S. Virgin Islands. The New York Botanical Garden. Memoirs of the New York Botanical Garden, Volume 78. Bronx, NY. 581 pages.

Alexander, W.D. 1870. On the crater of Haleakala, Island of Maui, Hawaiian group. American Journal of Science 49(145) 43-48.

Anderson, S. J., and C. P. Stone. 1993. Snaring to control feral hogs (*Sus scrofa*) in a remote Hawaiian rain forest. Biological Conservation 63(2):195-201.

American Veterinary Medicine Association, Animal Welfare Forum. 1996. The welfare of cats. Journal of the American Veterinary Medicine Association 208(4): 497-527.

Baker, J. K., and D.W. Reeser. 1972. Goat management problems in Hawaii Volcanoes National Park: a history, analysis and management plan. National Park Service Natural Resource Report 2. 22 pages.

Barrett, R. H., and C. P. Stone. 1983. Hunting as a control method for wild pigs in Hawaii Volcanoes National Park. Unpublished report for resources management, Hawaii Volcanoes National Park. 37 pages + appendices.

Barrett, R. H. 1984. Hog control methods in Hawaii. Techniques for controlling wild hogs in Great Smoky Mountains National Park: Proceedings of a Workshop Jane Tate (editor). U. S. Department of the Interior, National Park Service, Uplands Field Research Laboratory, Great Smoky Mountains National Park. November 29-30, 1983, Research/Resources Management Report SER-72. Pages 38-39.

Boulon, Ralf H. 1999. Reducing threats to eggs and hatchlings: *In situ* protection. Research and Management Techniques for the Conservation of Sea Turtles. K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois, M. Donnelly (Editors). IUCN/SSC Marine Turtle Specialist Group Publication No. 4, 1999. Pages 169-174.

Bratton, Susan P. 1974b. An integrated ecological approach to the management of European wild boar (*Sus scrofa*) in Great Smoky Mountains National Park. Management Report No. 3, Uplands Field Research Laboratory, Southeast Region, NPS, Great Smoky Mountains National Park, Gatlinburg, Tennessee. 42 pages.

Bratton, Susan P. 1975. The effect of European wild boar (*Sus scrofa*) on the Gray Beech Forest in the Great Smoky Mountains. Ecology 56:1356-1366.

Bratton, Susan P, M. E. Harmon, and P. S. White. 1982. Patterns of European wild boar rooting in the Western Great Smoky Mountains. Castanea 47:230-242.

Brisbin, I. Lehr, Jr., and John J. Mayer. 2001. Problem pigs in a poke: a good pool of data. Science 294:1280- 1281.

Chambers Consultants and Planners. 1981. Final environmental statement feral animal removal program, San Clemente Island, California. Naval Air Station, North Island, San Diego, California. 50+ pages.

Coblentz, Bruce E. 1974. Ecology, behavior and range relationships of the feral goat. Ph.D. Thesis. University of Michigan, Ann Arbor. 256 pages.

Coblentz, Bruce E. 1978. The effects of feral goats (*Capra hircus*) on island ecosystems. Biological Conservation 13:279-286.

Coblentz, Bruce E. 1980. Effects of feral goats on the Santa Catalina Island ecosystem. The California Islands. Proceedings of a multidisciplinary symposium. Dennis M. Power, editor). Santa Barbara Museum of Natural History, Santa Barbara, California. Page(s) 167-170.

Coblentz, Bruce E. 1983. Exotic animal influences in Virgin Islands National Park. Report to NPS, St. John, Cruz Bay. 16 pages.

Coblentz, Bruce E., and Brenda A. Coblentz. 1985. Control of the Indian Mongoose *Herpestes auropunctatus* on St. John, U. S. Virgin Islands. Biological Conservation 33:281-288.

Coblentz, Bruce E., and Brenda A. Coblentz. 1985. Reproduction and the annual fat cycle of the mongoose on St. John, U. S. Virgin Islands. Journal of Mammalogy 66(3): 560-563.

Curry, C. 1970. Entomological checklist for the Virgin Islands Ecological Research Station and Virgin Islands National Park Museum. Report to NPS. 25 pages.

DieterSpatz, Gunter, and D. Mueller-Dombois. 1973. The influence of feral goats on koa tree reproduction in Hawaii Volcanoes National Park. Ecology 54(4): 870-876.

D.Ohashi, Tim J, and Sandford Schemnitz. 1987. Birth pattern of feral goats on Haleakala. 'Elepaio 47(10): 99-102.

Fowler, Murray E. 1978. Restraint and handling of wild and animals. Iowa State University Press. Ames, Iowa. 332 pages.

Davis, Gary E. 1987. Santa Rosa Island feral pig removal plan. Channel Islands National Park, California. 20 pages.

Goatcher, B. L. 1989. An assessment of feral pigs on Santa Rosa Island, Channel Islands National Park, California. A Report to the Superintendent, Channel Islands National Park, California. 58 pages.

Graf, William, and Lyman Nichols, Jr. 1995 The Axis deer in Hawaii. Journal of the Bombay Natural History Society 63(3): 629-734.

Great Smoky Mountains National Park. 1993. Wild hog management guideline. Great Smoky Mountains National Park. 36 pages.

Griffin, J. 1978. Ecology of feral pig on the island of Hawaii. Final Report, Pittman-Robertson Project W-15-3, Study 11, 1968-1972. Hawaii Department of Land and Natural Resources, Honolulu. 122 pages.

Harrelson, Dave. 2001. Partnering with plants. U.S Fish and Wildlife Service, Endangered Species Bulletin XXVI(1):34-35.

Hegdal, Paul L., and Bruce A. Colvin. 1986. Radio-telemetry. Inventory and monitoring of wildlife habitat; Cooperrider, A. Y., R. J. Boyd, and H. R. Stuart , editors. U.S. Department of Interior, Bureau of Land Management, Service Center, Denver, CO. Pages 679 to 698.

Hone, Jim, and Charles P. 1989. A comparison and evaluation of feral pig management in two national parks. Wildlife Society Bulletin 17(4):419-425.

Ivie, M. 1983. The Cicendelidae (Coleoptera) of the Virgin Islands. Florida Entomology 66: 191-199.

Ivie, M., and R. Miller. 1984. The Buprestidae (Coleoptera) of the Virgin Islands. Florida Entomology 67: 288-300.

Kurtz, J.C., and R.L. Marchington. 1972. Radio-telemetry studies of feral hogs in South Carolina. Journal of Wildlife Management 36:1240-1248.

Kuikart, G., L. Geilly, L. Excoffiwier, J-D. Vigne, J. Bouvet, and P. Taberlet. 2001. Multiple material origins and weak phylogenetic structures in domestic goats. Proceedings of the National Academy of Sciences of the United States of America 98:5927-5932.

Jones, Harry Lee. 1973. The birds of San Clemente Island, an annotated species list; plus supplement number 1 and the impact of feral goats on the bird population of San Clemente Island. Recovery plan for the endangered and threatened species of the California Channel Islands by R. M. Beauchamp, Ken Hyde and William Mautz (editors).

Katahira, L. 1980. The effects of feral pigs on a montane rain forest in Hawaii Volcanoes National Park. C. W. Smith (editor). Proceedings of the 3rd Conference of Natural Science, Hawaii Volcanoes National Park. University of Hawaii, Cooperative National Park Resources Studies Unit, Honolulu. Pages 173-178.

Katahira, L., P. Finnegan, and C. P. Stone. 1993. Eradicating feral pigs on a montane seasonal habitat in Hawaii Volcanoes National Park. Wildlife Society Bulletin 21:269-274.

Katahira, L., and C. P. Stone. 1982. Status of management of feral goats in Hawaii Volcanoes National Park. Proceedings of the 4th Conference of Natural Science, Hawaii Volcanoes National Park. University of Hawaii, Cooperative National Park Resources Studies Unit, Honolulu. Pages 102-108.

Larson, Jan. 1972. A Natural Resources Survey of San Clemente Island, Summer 1972. Channel Islands National Park, California. 30 pages.

Leopold, A. S., S. A. Cain, C. M. Cottam, I. M. Gabrielson, and T. L. Kimball. 1963. Report of the advisory board on wildlife management. National Parks Magazine, Insert 4-63, April:I-VI.

Matschke, George H. 1964. The influence on oak mast on European wild hog reproduction. Proceedings of the Eighteenth Annual Conference, Southeastern Association of Game and Fish Commissioners, October 18-21. 3 pages.

Morris, D. K. 1969. Summer food habits of feral goats in Hawaii Volcanoes National Park. Unpublished National Park Service Report. 17 pages.

Muchmore, W. 1987. Terrestrial invertebrate animals of the Virgin Islands National Park, St. John, USVI: an annotated checklist. University of Rochester, Rochester, NY.

Mueller-Dombois, D., and G. Spatz. 1975. The influence of feral goats on the lowland vegetation in Hawaii Volcanoes National Park. Phytocoenologia 3 (1):1-29.

Mull, Mae E. 1979. Palila triumphs in court. 'Elepaio 40(1) 4.

Naehu, Maria. 1995. Axis deer and aggressive weed threaten East Maui forests. TNC of Hawaii membership newsletter, Summer 1995.

Nicholis, Robert W. 2003. Remarkable big trees of cultural interest in the U. S. Virgin Islands. University of the Virgin Islands and the Urban and Community Forestry Assistance Program, V. I. Department of Agriculture. www.bigtrees.net 8 pages.

National Park Service. 1983. General Management Plan and Environmental Assessment, Virgin Islands National Park. National Park Service, Denver Service Center, Lakewood, Colorado. 350 pages.

National Park Service. 1989. Natural Resources Management Guideline (NPS-77). U. S. Department of the Interior, Washington, D. C. 750 pages.

National Park Service. 1997. Land Protection Plan, Virgin Islands National Park. Cruz Bay, St. John. 120 pages.

National Park Service. 2003. Park Compendium, Virgin Islands National Park. Cruz Bay, St. John. 12 pages.

National Park Service. 1997. Collections Management Plan, Virgin Islands National Park. Cruz Bay, St. John. 120 pages.

National Park Service. 1999. Scope of Collections, Virgin Islands National Park. Cruz Bay, St. John. 40 pages.

National Park Service. 1999. Resources Management Plan, Hawaii Volcanoes National Park. Division of Resources Management, Hawaii National Park, HI. 350 pages.

National Park Service. 1999. Resources Management Plan, Virgin Islands National Park. Division of Resources Management, Biosphere Research Buildings, Cruz Bay, St. John. 250 pages.

National Park Service. 2000. Integrated Pest Management Manual. U. S. Department of the Interior, Washington, D. C. 350 pages.

National Park Service. 2001. Management Policies. U. S. Department of the Interior, Washington, D. C. 137 pages.

National Park Service. 2001. Conservation Planning, Environmental Impact Analysis, and Decision-making: Director's Order #12 and Handbook. U. S. Department of the Interior, Washington, D. C. 123 pages.

National Park Service. 2001. Use of Pharmaceuticals for Wildlife: Director's Order #77-4. U. S. Department of the Interior, Washington, D. C. 7 pages.

National Park Service. 2001. Santa Cruz Island Primary Restoration Plan, Final Environmental Impact Statement. Channel Islands National Park, California. 117 pages.

National Park Service. 2001. Commercial Services Plan and Final Environmental Assessment, Virgin Islands National Park. Cruz Bay, St. John, U.S. Virgin Islands. 114 pages.

National Park Service. 2002. Sustained Reduction of Non-native Rats, Cats and Mongooses from Virgin Islands National Park Final Environmental Assessment. Cruz Bay, St. John, U.S. Virgin Islands. 93 pages.

National Park Service. 2004. Vessel Management Plan and Final Environmental Assessment, Virgin Islands National Park. Cruz Bay, St. John, U.S. Virgin Islands. 117 pages.

National Park Service. 2003. Sustained Reduction Plan for Non-native Wild Hogs within Virgin Islands National Park Final Environmental Assessment. Cruz Bay, St. John, U.S. Virgin Islands. 93 pages.

National Park Service. 2004. Installation of Moorings in Virgin Islands Coral Reef National Monument Final Environmental Assessment, Virgin Islands National Park. Cruz Bay, St. John, U.S. Virgin Islands. 50 pages.

Nellis, David W. 1982. Mongoose influence on the ecology of islands. Transactions of the Congress of Game Biology 14:311-314.

Nellis, David W. and C.O.R. Everard. 1983. The biology of the mongoose in the Caribbean. Studies on the Fauna of Curacao and other Caribbean Islands, No. 195. P. Wagenaar Hummelinck and L. J. van der Steen (Editors). Foundation for Scientific Research in Surinam and the Netherlands Antilles, Utrecht. 162 pages.

Nellis, David W., and Vonnie Small. 1983. Mongoose predation on sea turtle eggs and nests. Biotropica 15(2):159-160.

Nellis, David W., Rebecca Rudman, and Ann B. Swanbeck. 1985. The behavior and ecology of feral burros on St. John, U. S. Virgin Islands. Virgin Islands Division of Fish and Wildlife. Report to the National Park Service. St. Thomas, U.S.V.I. 215 pages.

New, John c. Jr., Claude E. Barton, Patrick J. Morris, and Leon N. D Potgieter. 1994. A serologic survey of selected viral and bacterial diseases of European wild hogs, Great Smoky Mountains National Park, USA. Journal of Wildlife Diseases 30(1): 103 – 106.

Nicholis, Robert W. 2003. Remarkable big trees of cultural interest in the U. S. Virgin Islands. University of the Virgin Islands and the Urban and Community Forestry Assistance Program, V. I. Department of Agriculture. www.bigtrees.net 8 pages.

Olwig, Karen Fog. 1985. Cultural adaptation and resistance on St. John: three centuries of Afro-Caribbean life. University of Florida Press, Gainesville, FL. 227 pages.

Parsons, D. J., D. M. Graber, J. K. Agee, and J. van Wagtendonk. 1986. Natural fire management in national parks. Environmental Management 10:21-24.

Patronek, Gary J. 1997. Free-roaming and feral cats: their impact on wildlife and humans. Tufts Center for Animals and Public Policy, and the Department of Environment and Population Health. Tufts University, School of Veterinary Medicine, North Grafton, Massachusetts. 35 pages.

Peine, John D, and Jane Allen Farmer. Date Unknown. Wild hog management program at Great Smoky Mountains National Park. Great Smoky Mountains National Park.

Ray, G. 1990. Feral donkey impacts to native forests. Letter to NPS Resources Management Specialist. Rogers, Caroline. 1988. Recommendations for Long-term Assessment of Coral Reefs: U.S. National Park Service Initiates national program. NPS Report. 11 pages.

Santa Rosa Island, Channel Islands National Park. Date Unknown. Environmental assessment for eradication of swine from Santa Rosa Island, Channel Islands National Park, Santa Barbara County, CA. Channel Islands National Park, California. 10 pages.

Schauss, M., H. Colette, R. Barrett, and D. A. Jessup. 1979. Wild pig immobilization: presentation at the Wild Pig Workshop. University of California, Berkeley, CA. 3 pages.

Scowcroft, Paul G., and Robert Hobdy. 1987. Recovery of goat-damaged vegetation in an insular tropical montane forest. Biotropica 19(3):208-215.

Seaman, George A., John E. Randall. 1962. The mongoose as a predator in the Virgin Islands. Journal of Mammalogy 43(4):544-546.

Singer, Francis J. 1981. Wild pig populations in the national parks. Environmental Management 5: (3):263-270.

Singer, Francis J, and B. B. Ackerman. 1981. Food availability, reproduction, and condition of the European wild boar in Great Smoky Mountains National Park. U. S. Department of the Interior, National Park Service, NPS-SER Research/Resources Management Report No. 43. 52 pages.

Singer, Francis J., Wayne T. Swank and Edward E.C. Clebsch. 1982. Some ecosystem responses to European wild boar rooting in a deciduous forest. U. S. Department of the Interior, National Park Service, NPS-SER Research/Resources Management Report No. 54. 31 pages.

Singer, Francis J., Wayne T. Swank and Edward E.C. Clebsch. 1984. Effects of wild pig rooting in a deciduous forest. Journal of Wildlife Management. 48(2):464-473.

Soule, M. E. 1990. The onslaught of alien species and other challenges in the coming decades. Conservation Biology 4:233-239.

Spatz, G., and D. Mueller-Dombois. 1973. The influence of feral goats on koa tree production in Hawaii Volcanoes National Park. Ecology 54: 870-876.

Spatz, G., and D. Mueller-Dombois. 1975. Succession patterns after pig digging in grassland communities on Mauna Loa, Hawaii. Phytocoenologia 3 (2/3):346-373.

Sterner, J. David. 1990. Population characteristics, home range and habitat use of feral pigs on Santa Cruz Island, California. Ph.D. Dissertation. University of California, Berkeley. 110 pages.

Sterner, J. David. 1993. Removing feral pigs from Santa Cruz Island, California. The Wild Pig in California Oak Woodland: Ecology and Economics (W. Tiejte and R. Barrett, editors). Integrated Hardwood Range Management Program & Department of Forestry and Resource Management, University of California, Berkeley. 34 pages.

Stone, C. P. 1991. Feral pig (*Sus scrofa*) research and management in Hawaii. Biology of Suidae (R. H. Barrett and F. Spitz (editors). Institute Nationale de Recherche Agronomique, Tolosan, Cedex, France. Pages 141-154.

Stone, Charles P., and S. J. Anderson. 1988. Introduced animals in Hawaii's natural areas. Proceedings of Vertebrate Pest Conference 13:134-140.

Stone, Charles P., and Lloyd L. Loope. 1987. Reducing negative effects of introduced animals on native biotas in Hawaii: what is being done, what needs doing, and the role of national parks. Environmental Conservation 14(3):245-258.

Stone, Charles P., L. W. Cuddihy, and J. T. Tunison. 1992. Responses of Hawaiian ecosystems to removal of feral pigs and goats. Alien Plant Invasions in Native Ecosystems of Hawaii: Management and Research, Stone, Charles P., C. W. Smith, and J. T. Tunison (editors). University of Hawaii, Cooperative National Park Resources Studies Unit, Honolulu. Pages 666-704.

Stone, Charles P., and Lloyd L. Loope. 1996. Alien species in Hawaiian national parks. Science and Ecosystem Management in the National Parks. William L. Halvorson and Gary E. Davis (editors). The University of Arizona Press, Tucson. Pages 132-158.

Stuht, John N. 2001. Parasites of white-tailed deer and free-ranging goats on the island of St. John in the Caribbean: helminths and coccidia of the gastrointestinal tract. Technical Report 20011. Medeco, 9707 Peacock Road, Lainsburg, MI 48848 and School of Veterinary Medicine, Michigan State University, East Lansing, Michigan 48824. 16 pages.

Tate, Jane. 1984. Techniques for controlling wild hogs in Great Smoky Mountains National Park: Proceedings of a Workshop. U. S. Department of the Interior, National Park Service, Uplands Field Research Laboratory, Great Smoky Mountains National Park. November 29-30, 1983, Research/Resources Management Report SER-72. 87 pages.

Taylor, Dan, and Larry K. Katahira. 1988. Radio-telemetry as an aid in eradicating remnant feral goats. Wildlife Society Bulletin 16:297-299.

Treshy, B.R., and D.A. Croll. 1994. Avoiding the problems of fragmentation by conserving natural fragments: the benefits of restoring and protecting small islands. In: Abstracts, Society for Conservation Biology Annual Meeting, Guadalajara, Jal., Mexico. June 7-11.

U. S. Environmental Protection Agency. 1988. The Federal Insecticide, Fungicide and Rodenticide Act, as Amended. Washington, D. C. 73 pages.

U. S. Fish and Wildlife Service. 1988. St. Thomas Prickly-ash (*Zanthoxylum thomasianum*) Recovery Plan. Southeast Region, Atlanta, Georgia. 35 pages.

U. S. Virgin Islands. 2002. Stray Animal Registration and Impoundment Program. Department of Agriculture. Virgin Islands Code, Act 5911. 2 pages.

Vtorov, I. 1996 Restoration of soil micro-arthropod population after feral pig removal in a Hawaiian rain forest ecosystem. Pacific Science.

Weaver, Peter L. 1999. NPP tropical forest: Cinnamon Bay, U.S. Virgins Islands. Data set 1982-1993. International Institute of Tropical Forestry, USDA Forest Service, Rio Pedras, Puerto Rico.

White, Gary C., and Robert A Garrott. 1990. Analysis of Wildlife Radio-tracking Data. Academic Press, Inc. Harcourt Brace Jovanovich, Publishers. 1250 Sixth Avenue, San Diego, California 92101. 383 pages.

Williamson, Michael J., and Michael R. Pelton. 1975. Some biochemical parameters of serum of European wild hogs. Proceedings of the 29th Annual Conference of the Southeastern Association of Fish and Game Commissioners. Page(s) 672 – 679.

Williamson, Michael J., and Michael R. Pelton. 1976. Some hematological parameters of European wild hogs (Sus scrofa). Journal of the Tennessee Academy of Science Volume 51(1): 25 – 28.

Woodbury, R., and P. Weaver. 1987. The vegetation of St. John and Hassel Island, U. S. Virgin Islands. NPS Research/Resources Management Report, SER-83, St. Thomas, U.S.V.I. 101 pages.

World Conservation Monitoring Centre. 1992. Global Biodiversity: Status of the Earth's Living Resources. Chapman and Hall, London.

Yocum, Charles F. 1967. Ecology of feral goats in Haleakala National Park, Maui, Hawaii. The American Midland Naturalist 77 (2): 418-451.

XI. CHAPTER XI. APPENDICES

APPENDIX A. List of Endangered Plants and Animals of the U. S. Virgin Islands

Compiled by the Division of Fish and Wildlife (DPNR), the UVI Cooperative Extension Service, Eleanor Gibney (Caneel Bay), Gary Ray (U. of Wisconsin) and William Mclean (UVI).

Scientific Name	Common Name	Distribution/Remarks
PLANTS		
Federal List		
Buxaceae		
Buxus vahlii	Vahi's Boxwood	Endangered, St.X.- May be Extinct
Rutaceae		
Zanthoxyllum thomasianum	Prickly Ash	Endangered, St T., St .J.
Myrtaceae		
Calyptranthes thomasiana	St. Thomas Lidflower	Endangered, St. T., St. J.
Virgin Islands List		
Agavaceae		
Agave eggersiana	Egger's Agave	St. X.
Aizoaceae		
Cypselia humifusa		St. T., St. J.
Aquifoliaceae		
Ibex urbanii	Urban's Holly	St. J., Tortola
I. sideroxyloides	Central Amer. Oak	St. J.
Bromeliaceae		
Tillandsia lineatispica	Pinon	Rare bromeliad, St. J., St. T
Cactaceae		
Mammilaria nivosa	Wooly Nipple	St. X, St. J, St. T, offshore cays
Opuntia triacantha		Buck Is. (St. X,), St. T.
Celastraceae		
Maytenus cymosa		St. X., St. T.
Convolvulaceae		
Operculina triquetra		St. X., St. T. endemic
Euphorbiaceae		
Croton fishlocklii		Recent St. J. sightings
Fabaceae		
Erythrina eggersii	Egger's Cockspur	St. X, St. J, St. T,
Galactia eggersii	Egger's Galactia	St. T., St. J.
Malpighiaceae		
Malpighia woodburyana	Cowage Cherry	St. T., St. J., offshore cays
M. infestissima (=pallens)	Stinging Bush	St. X.
M. linearis		All VI
Malpighia sp.		Similar to M. coccigera, St. J.
Byrsonima sp.		New Species, St. J.
Malvaceae		
Psidium amplexicaule		St. J.
Psidium sp.		St. J., new species?
Sida eggersii		N. Offshore cays
Myrtaceae		
Eugenia sp.		Recent St. J. sightings

Endangered Plants and Animals of the U. S. Virgin Islands (Cont.)

Olacaceae		
Schoepfia schreberi		St.T., *St.J., St.X.*
Orchidaceae		
Brassavola cuccullata		St.T.
Psychilis macconelliae	Sandy Pt. Orchid	St.X.
Encydia ciliare	Christmas Orchid	St.T., St.J., St.X.
E. cochleata	Cockle-shell Orchid	*St.X.*
Habenana alata		St.T.
Tolumnia (Oncidium) prionochila	Yellow Dancing Lady	St. J, St.T.
T. variegatuni	White Dancing Lady	St.T., St.J., St. X.
Polystachya concreta		St.T., Virgin Gorda
Ponthieva racemosa		St.T., St.J., Tortola
Prescottia oligantha		St.T., St.J., Tortola.
P. stachyoides		*St.J.*
Spiranthes torta		St.T.
Tetrainicra canaliculata		St.T., St.J., St. X.
T. canaliculata alba		End. subsp., Water Is.
Vanilla barbellata	Vanilla Orchid	St. T.
Piperaceae		
Peperomia myrtifolia	Myrtle-leaved Peperomia	*St.J., St.X*
Polygonaceae		
Coccoloba rugosa		May be extinct in VI
Rubiaceae		
Catesbaea melanocarpa		St.X.
Machâonia woodburyana		New St. J. sightings
Sapotaceae		
Manilkara bidentata	Bulletwood	St.T., St.J.
Solanaceae		
Solanum mucronatuni		Confused taxonomy, *St.T., St.J.*
S. conocarpum		Rediscovered 1993, 2 indivs., St.J.
Urticaceae		
Pilea richardii	Richard's Clearweed	St.T.
Verbenaceae		
Callicarpa ampla	Capa Rosa	Info. needs update
Nashia inaguensis		St.X.
Zygophyllaceae	Lignum Vitae	
Gualacum officinale		W..I., High hort. demand

ANIMALS

Federal List

Chelonia mydas	Green turtle	Threatened, Resident, breeding
Eretmochelys imbricata	Hawksbill turtle	Endangered, Resident, breeding
Dermochelys coriacea	Leatherback turtle	Endangered, Migrant, breeding
Pelecanus occidentalis	Brown pelican	Endangered, Resident, breeding
Falco peregrinus	Peregrine falcon	Endangered, Winter migrant
Epicrates monensis granti	VI Tree boa	Endangered, Resident, breeding
Ameiva polops	St. X. ground lizard	Endangered, Resident, breeding
Sterna dougallii	Roseate tern	Threatened, migrant, breeding

Virgin Islands List

Mabuya inabouia	Slipperyback skink	Resident, breeding
Otus nudipes newtom	VI Screech owl	Resident, breeding?
Chordeiles gundlachii	West Indian nighthawk	Resident, breeding?
Anthracothorax dominicus	Antillean mango	Resident, breeding?
Podiceps dominicus	Least grebe	Migrant, breeding
Sterna antillarum	Least tern	Resident, breeding
Phaethon lepturus	White-tailed tropicbird	Resident, breeding
Ardea herodius	Gt. blue heron	Resident, breeding
Casmerodius albus	Great (common) egret	Resident, breeding
Egretta thula	Snowy egret	Resident, breeding
Nycticorax nycticorax	Black-cr. night heron	Resident, breeding?
Ixobrychus exilis	Least bittern	Resident, breeding
Anas bahaniensis	Bahama duck	Peripheral resident
Oxyura jamaicensis	Ruddy duck	Resident, breeding
Rallus longirostris	Clapper rail	Resident, breeding
Fulica caribea	Caribbean coot	Resident, breeding?
Charadrius alexandrinus	Snowy plover	Resident, breeding
Catoptrophorus semipalmatus	Willet	Migrant, breeding
Puffinus Iherminieri	Audubon shearwater	Resident, breeding
Aratinga pertinax	Brown-throated parakeet	Resident, breeding
Columba leucocephala	White-crowned pigeon	Resident, breeding
Geotrygon mystacea	Bridled Quail dove	Resident, breeding
Myiarchus stolidus	Stolid flycatcher	Resident, breeding
Noctilio leporinus	Fisherman bat	Resident, breeding
Stenoderma rufum	Red fruit bat	Resident, breeding
Brachyphylla cavernarum	Cave bat	Marine benthic, high demand
Order Antipatharia	Black coral	Resident, breeding
Epinephelus itajara	Goliath Grouper	Marine

The above list represents plants and animals occurring in the US Virgin Islands which are protected by either the US Endangered Species Act of 1973 or the VI Endangered and Indigenous Species Act of 1990 (Act No. 5665). This list is promulgated under Act 5665, Section 104(g) and may be revised as new information becomes available.

Roy E. Adams, Commissioner, DPNR
5 June 1991

APPENDIX B. List of Introduced Animals to St. John, U. S. Virgin Islands

Common Name	Scientific Name	Area of Origin	When Introduced	Introduced By
MAMMALS				
Cat,	*Felis catus*	Afr./SW Asia	?	Europeans
Cattle,	*Bos taurus*	Eurasia	?	Europeans
Deer, White-tail	*Odocoileus virginianus*	U.S.	1700's	Europeans
Dog,	*Canis familiaris*	Eurasia	?	Europeans
Donkey	*Equus asinus*	N. Africa	?	Europeans
Goat,	*Capra hircus*	SW Asia	1500's	Spaniards
Horse	*Equus caballus*	Eurasia		Europeans
Pig,	*Sus scrofa*	Eurasia	1500's	Spaniards
Mongoose, Indian	*Herpestes auropunctatus*	India	1880's	Europeans
Mouse, house	*Mus musculus*	Mid E/Asia	?	Europeans
Rat, black	*Rattus rattus*	SE Asia	?	Europeans
Rat, Norway	*Rattus norvegicus*	SE Asia	?	Europeans
Sheep,	*Ovis aries*	Mid East	?	Europeans
BIRDS				
Bullfinch, L.Ant.	*Loxigilla noctis*	Lesser Ant.	1960's	Natural
Fowl,	Various sp.		?	Various
Parakeet, Brn-thr	*Aratinga pertinax*	Curacao	1900's	Unknown
Sparrow, English	*Passer us*	Eurasia	1980's	Ship
AMPHIBIANS				
Tree frog, Cuban	*Osteopilus septentrionalis*	Cuba	1980's	Plant trade
Tree Frog, Coqui	*Eleutherodactylus Coqui*	Puerto Rico	1970's	Residents
REPTILES				
Iguana, green	*Iguana iguana*	S. America	<1500's	Native Ams.
Tortoise, redfoot	*Geochelone carbonaria*	S. America	<1500's	Native Ams.

APPENDIX C. Consultation Letter from U. S. Fish and Wildlife Service